INFLUENCE OF SELECTED ALTERNATIVE EXTENSION APPROACHES ON THE ACQUISITION OF KNOWLEDGE AND SKILLS FOR IMPROVED FARM PRODUCTIVITY AND HOUSEHOLD FOOD SECURITY IN THE LAKE VICTORIA REGION, KENYA

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A Thesis Submitted to the Graduate School in Fulfillment for the Requirements of the Award of the Degree of Doctor of Philosophy in Agricultural Extension of Egerton University

EGERTON UNIVERSITY

DECLARATION AND REOMMENDATION

Declaration

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I declare that this is my original work and it has not been submitted in this form or any other
for the award of a degree in this and any other University.
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DEDICATION

This work is dedicated to my dear wife: Consolata; Children: Charity, Metrine, Michael, Triza, James and Ruth; My father, James and Mother, Prisca.

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I am heavily indebted to the many individuals and institutions that collectively or individually contributed to the successful completion of this study. First and foremost I acknowledge my Supervisors, Prof. Christopher Onyango and Dr. James Obara for their able guidance that enabled me to conduct the research and write this thesis. Secondly I sincerely thank the National Commission for Science, Technology and Innovation (NACOSTI) for funding the study. Thirdly, my employer, Jaramogi Oginga Odinga University of Science and Technology for the timely processing of research funds. The Vice - Chancellor, Prof Stephen Gaya Agong' gave me adequate time out to conduct the research and I thank him so much. Fourthly, the extension workers in the three sub counties for their support during field data collection. Lastly, my entire family and all other people who helped me in one way or the other during this research. Despite the assistance and guidance from all the above, I am, however, fully responsible for the facts presented in this thesis including any unforeseen omissions and errors.

ABSTRACT

The role of agricultural extension is vital to the diffusion of new technologies, but extension is currently not very effective in many African nations, with conventional extension approaches having minimal impact. In Kenya, there have been gaps on the availability of studies and documentation of the specific extension approaches and their influence on the acquisition of knowledge and skills for improved farm productivity despite the various extension efforts and resources put in place in many parts of the country. This study therefore investigated the influence of three selected alternative extension approaches namely: Farmer Field Schools, On-Farm Research and Focal Area approaches on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria Region, Kenya. The purpose of the study was to compare the individual and collective influence of each approach on the acquisition of knowledge and skills and their contribution farm productivity and household food security in the Lake Victoria region of Kenya. A cross sectional survey design was adopted in order to develop a detailed account of the effect of the three approaches. The total population of the study area was 188,661 households from which a random sample of 396 was selected comprising of small-scale farmers from three Sub -Counties: Bondo, Rachuonyo and Nyamira. Data was analyzed using both descriptive and inferential statistics with the aid of Statistical Package for Social Sciences (SPSS 18.0) at 5 percent level of significance. Findings revealed that Farmer Field Schools contributed most to the acquisition of knowledge and skills in various agricultural production activities and an increase in farm productivity. Results on On-Farm Research revealed that it contributed to knowledge and skills as well as improvement of farm productivity, especially on livestock based technologies; however, a hypothesis test showed that the approach had no significant influence on knowledge and skills for improved farm productivity and household food security. Findings about Focal Area approach revealed that it contributed to the acquisition of knowledge and skills for improved farm productivity followed by Farmer Field Schools and lastly On-Farm Research. The study recommends that the Ministry of Agriculture and research organizations use Farmer Field Schools and Focal Area approaches in technology development and transfer; however On-Farm Research should be used in combination with other approaches.

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ABBREVIATIONS AND ACRONYMS

AESA Agro- Ecosystem Analysis

CBS Central Bureau of Statistics

DAO District Agricultural Officer

FAO Food and Agriculture Organization

FFS Farmer Field Schools

FPR Farmer Participatory Research

FSRET Farming Systems Research Extension and Training

GOK Government of Kenya

KARI Kenya Agricultural Research Institute

LRNP Legume Research Network Project

MOALD Ministry of Agriculture and Livestock Development

MOARD Ministry of Agriculture and Rural Development

MOLD Ministry of Livestock Development

NALEP National Agriculture and Livestock Extension Programme

NEPAD Partnership for Africa's Development

OFR On- Farm Research

PRSP Poverty Reduction Strategy Paper

SIDA Swedish International Development Corporation

SPSS Statistical Package for Social Sciences

SRA Strategy for Revitalizing Agriculture

SSA Sub- Saharan Africa

T & V Training and Visit

USAID United States Agency for International Development

WMS Welfare Monitoring Survey

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Agricultural extension is considered to be an important service in increasing agricultural productivity and attaining sustainable development (Kibet, Omunyinyi & Muchiri, 2005). Its role is to help people identify and address their needs and problems. There is a general consensus that extension services if successfully applied should result in outcomes which include observable changes in attitudes and adoption of new technologies and improved quality of life based on indicators such as health, education and housing. It has been recognized that agricultural extension accelerates development in the presence of other factors such as markets, agricultural technology, availability of supplies, production incentives and transport (Kibet *et al.*, 2005).

Farmer education and extension service delivery are important components in improving people's lives. However, traditional extension approaches and methods have proved unsuccessful (Purcell & Anderson, 1997). Efforts to provide farmers with a voice seldom form an integral part of agricultural programmes (Duveskog, 2006). In response to this concern, elements of participation and downward accountability have gradually reformed advisory services in agriculture and approaches to participatory extension (World Bank, 2008). Alternative approaches have emerged that place the emphasis on farmer groups that provide a 'voice' for the poor (Leeuwis, 2004).

Eradication of extreme poverty and hunger is given top priority by the United Nations and is listed as Millennium Development Goal Number One (Haines & Cassels, 2004). The role of agricultural productivity in alleviating poverty in developing countries as presented in some empirical results suggest that there are significant relationships between productivity growth and both poverty and nutrition (Thirtle, 2001). These studies have shown that the empirical estimates of this relationship appear to be robust and that regardless of the differences in data and formulation, the results showed that a one percent increase in yields leads to a reduction in the number of people living on less than one US dollar per day of between 0.6 percent and 1.2 percent.

In Kenya, agriculture is the leading economic sector, accounting for 25 percent of the Gross Domestic Product (GDP), employing 61 percent of Kenyans; predominantly small scale

mainly in the high potential areas and accounting for 75 percent of the total agricultural output and 70 percent of agricultural produce (GoK, 2009). According to the Central Bureau of Statistics (2003), more than half of Kenya's population is poor with 7.5 million people living in extreme poverty and over 10 million people suffering from chronic food insecurity. There are about two million people who are permanently on food relief; the number of people on food relief increases rapidly to over five million during drought years and over four million live below the absolute poverty line (GoK, 2001). It has been documented that the low level use of farm inputs amongst the small scale farmers has often resulted in suboptimal levels of production (Joetzold, Schmidt, Brethold, & Shisanya, 2006).

Agricultural extension serves as a means of appropriate technology generation and dissemination and it has been demonstrated that it has the potential to improve yields in Kenya (Evenson & Mwabu, 1998). Although many institutions offering extension services have emerged, there is limited study of the extent to which these agencies are strengthening and influencing change in farmer ability to increase agricultural productivity (World Bank, 2004). It has been demonstrated that sustained high levels of agricultural production are not possible without an effective agricultural extension supported by agricultural research that is relevant to farmers' needs (Benor & Baxter, 1984).

Conventional extension also referred to as general extension approach or public extension in contrast to several other approaches is also called Ministry-Based General Extension (Moris, 1991). Venkatesan (1997) noted that Face-to-face extension, where the extension agent visits farmers in their fields according to a fixed schedule, is practiced in all the Sub Saharan Africa (SSA) countries. Face-to-face extension would support the emphasis on farmer participation in technology generation implicit in the "farmer- first" paradigm and that the phrase "top-down" is often used in this context.

Conventional Extension approach to extension or public agricultural extension service in Kenya has been practiced by many countries but its performance has not been satisfactory (Gautam & Anderson, 1999). The National Development Plan, 2002-2008 and Kenya Vision 2030 document that the realization of Kenya's full agricultural potential has been hampered by the ineffective system under which extension services are provided by the government (GoK, 2004a). The extension system was perceived as top-down, uniform and inflexible and considered a major contributor of the poor performance in the agricultural sector (GoK,

2005). It has been demonstrated that extension workers must learn the principles of community-organizing and group management skills (Chamala & Mortiss, 1990) in order to help the community, especially the poor or weaker sections, to organize themselves for development. Agricultural extension as a public sector institution has an obligation to serve the needs of all agricultural producers, either directly or indirectly (Anderson, 2007). A consensus exists that extension services, if properly designed and implemented, improve agricultural productivity (Romani, 2003; Bindlish & Evenson, 1993). This study involved three selected alternative extension approaches namely: On-Farm research, Farmer Field Schools and Focal Area.

Farmer Field Schools is a participatory method of learning, technology adoption, and dissemination based on adult learning principles such as experiential learning (Davis & Place, 2003). This approach provides farmers with an opportunity to make a choice in the methods of production through a discovery-based approach. It is a 'school without walls' that teaches basic agro-ecology and management skills that make farmers experts in their own farms. After the training period, farmers continue to meet and share information with less contact with extension officers (Mweri & Khisa, 2001).

On-Farm Research (OFR) is a tool for developing and validating technology. It is research carried out on farmer's fields and in a farmer's environment (Rocheleau, Weber, & Field-Juma, 1988). OFR involves the following segments: first and foremost, the Farmer, In OFR, it is essential to specify the type of farmer for which a particular intervention is aimed, whether for development or for testing. The "type of farmer" issue is not linked only to resource base, but may also be linked to the production system;

Secondly, the farmer's Land- for research to be classified as on-farm, it should be carried out on a plot of land belonging to the farmer and within the farm environment of the farmer; thirdly, the Farmer's Involvement -The exact nature and degree of farmer involvement is determined by the objective of the OFR and the nature of the research in terms of components, systems, or technologies being assessed. The degree of farmer involvement also has an effect on the design of the experiment and the interpretation of results obtained. The four possible ways in which farmers are usually involved in OFR are: landlord/tenant relationship, passive on-looker involvement, active involvement - researcher controlled, and active involvement - farmer controlled; and lastly-the Farmer's Environment-the socio-

cultural, anthropological, and economic environment within that community will have to be taken into account in the design of the technology, in its testing, and eventually in the assessment of its acceptability to farmers. The other aspect of the farmer's environment has to do with the cropping and farming system in which the farmer operates and the big-physical base within which the farming activity goes on (Rocheleau, Weber & Field-Juma, 1988).

According to Kang, Reynolds and Atta-Krah (1990), OFR is commonly used as a means to ensure that technologies developed on-station will be relevant to the problems and priorities of the targeted client adopters. To validate on-station results, OFR is carried out to assess the performance of particular systems or technologies on-farm, with the farmer's involvement. Such research will likely lead to the observation of yield gaps or shortfalls, and consequently research is then initiated to address the gaps and eliminating or narrowing the gaps.

The Focal Area approach has been adapted and applied by the public agricultural extension service in Kenya to harness the comparative advantages of various players for the overall development of rural areas. According to Kiara (2011), for improved effectiveness and efficient extension provision, Focal Area approach as implemented by NALEP focused its support on the Division and Location where implementation took place. According to GoK (2005(b), NALEP was the main government extension programme which was implemented by the Ministry of Agriculture with support from the government of Kenya (NALEP-GoK) and Swedish International Development Agency (NALEP-Sida).

The programme aimed at enhancing the contribution of agriculture and livestock to development and poverty alleviation by promoting pluralistic, efficient, effective and demand-driven extension services among farmers and agro-pastoralists. The premise of this approach is that development agents should not do extension alone, but together with all other stakeholders in the area that could provide valuable inputs to the process in order to gain synergy effects. It involved the shifting focal area approach in which officers with specialized skills were deployed in an area to work with frontline extension workers and farmers for a specific period (one year) before shifting to a new area (GoK, 2005(b).

The study was carried out in selected Sub-Counties in the Lake Victoria region, namely Bondo, Rachuonya and Nyamira. These are the regions found within the basin of Lake

Victoria. The Lake itself has several names depending on the tribe, for example: *Nam Lolwe* in Luo; "Nalubaale" in Luganda; *Nyanza* in Kinyarwanda and some Bantu language) and is one of the African Great Lakes. The lake was named after Queen Victoria by the explorer John Hanning Speke, who was the first European to discover it. Speke accomplished this in 1858, while on an expedition with Richard Francis Burton to locate the source of the Nile River (Dalya, 2011).

With a surface area of 68,800 square kilometres (26,600 sq mi), Lake Victoria is Africa's largest lake by area, and is also the largest tropical lake in the world. Lake Victoria is the world's second largest fresh water lake by surface area; only Lake Superior in North America is larger. In terms of its volume, Lake Victoria is the world's ninth largest continental lake, and it contains about 2,750 cubic kilometers (2.2 billion acre-feet) of water (Dalya, 2011).

The Lake Victoria basin is one of the most densely populated rural areas in the world. Its shores are dotted with cities and towns, including Kisumu, Kisii, and Homa Bay in Kenya; Kampala, Jinja, and Entebbe in Uganda; and Bukoba, Mwanza and Musoma in Tanzania. These cities and towns also are home to many factories that discharge their waste directly into the lake and its influent rivers. These urban areas also discharge raw sewage into the river, increasing its eutrophication that in turn is helping to sustain the invasive water Hyacinth (World Digital Library, 2013).

The first area of study was Bondo Sub-County. The Sub-County is one of the thirty six sub-counties that make up the former Nyanza Province, located in the Lake Victoria region. The Sub-County was curved out of the original Siaya District in 1998. In 2007 the District was further sub divided in to Bondo and Rarieda Districts. It has a total area of 1,328 km² of which 587.2km² is land surface, while 740.8 km² is covered with water of Lake Victoria. It borders Siaya and Busia sub counties to the North – West, Kisumu West and Rarieda Sub-County to the East and Rachuonyo, Homa-Bay and Suba Sub-County across the Lake on the South – East and South, to the West lies the Republic of Uganda. Bondo Sub-County has a total of 3 Divisions, which are, Nyangoma, Maranda and Usigu, It has a total of 11 Locations and 26 Sub – locations. The Sub-County is a one constituency Sub-County i.e. Bondo constituency and has a total of 13 Council Wards with a population of 157522 persons (GoK, 2009).

The Second area of study was Rachuonyo Sub- County. It is one of the Sub Counties in the former Nyanza Province in the Lake Victoria Region. It is bordered by Nyando Sub County to the North East, Kisii and Nyamira to the South East, Homa-Bay to the South East, Kericho to the East, and Lake Victoria to the North and West. Administratively it is divided into four divisions and forty locations all previously part of the larger South Nyanza District with a population of 382711 persons (GoK, 2009).

The third area of study was Nyamira Sub-County. This Sub- County is composed of three constituencies (Kitutu Masaba, West Mugirango and North Mugirango Borabu). It was formerly part of Kisii district when Kisii County was a district, and is sometimes called North Kisii. The Sub-County has an area of 352.3 sq miles (912.5 km²) and a population of 325690 persons. In Nyamira Sub- County the small scale farmers grow bananas, small acreages of tea and coffee. In Bondo Sub-County, the farmers are involved in fishing, growing of maize and sorghums for subsistence and keeping of local cattle (GoK, 2009).

1.2 Statement of the Problem

Improving agricultural extension services is critical in addressing the existing knowledge and skills gaps in agricultural production in many parts of the World. It has been documented that extension services may improve returns to agricultural production by between 34 and 84 percent. In Kenya, there is little information on the availability of studies and documentation of the specific extension approaches and their influence on the acquisition of knowledge, skills for improved farm productivity and household food security. Despite the various extension efforts and resources put in place in many parts of Kenya including the Lake Victoria region, there still exist wide gaps in knowledge and skills needed to improve on farm productivity in order to enhance household food security. This study therefore investigated the influence of Farmer Field Schools, On Farm Research and Focal Area as alternative approaches on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region, Kenya.

1.3 Purpose of the Study

The purpose of this study was to investigate selected alternative extension approaches, namely: Farmer Field Schools, On- Farm Research and Focal Area and their influence on acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria Region, Kenya.

1.4 Objectives of the Study

The objectives of the study were to:

- Determine the changes in food production under the influence of Farmer Field Schools, On-Farm Research and Focal Area extension approaches in the Lake Victoria region of Kenya.
- ii) To determine the influence of Farmer Field Schools extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- iii) To determine the influence of Focal Area extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- iv) To determine the influence of On-farm Research extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- v) To determine the influence of Farmer Field Schools, Focal Area and On-Farm Research Approaches combined on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

1.5 Research Question

What are the changes in food production under the influence of Farmer Field Schools, On-Farm Research and Focal Area extension approaches in the Lake Victoria region of Kenya?

1.6 Hypotheses of the Study

The following were the null hypotheses of the study:

Ho₁ There is no statistically significant influence of Farmer Field Schools

approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

- $H_{O\,2}$ There is no statistically significant influence of Focal Area approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- $H_{\rm O3}$ There is no statistically significant influence of Farmer Field Schools approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- H_{O4} There is no statistically significant influence of Farmer Field Schools, Focal Area and On-Farm Research approaches combined on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

1.7 Significance of the Study

This study was designed to bring to the fore salient issues on the selected alternative extension approaches on the acquisition of knowledge, skills and farm productivity for household food security in the Lake Victoria region of Kenya. A comparison was made between farmers exposed to the selected alternative approaches individually and collectively and Conventional Extension approaches. The study expected first that findings would contribute to greater understanding of agricultural extension approaches. This was important in light of the changing trends in agricultural production in addressing the knowledge gaps. Secondly, that it would contribute to future research especially in regard to agricultural production in view of the challenges currently being experienced regarding food shortages. Lastly it would provide both strategic and facilitative information regarding extension services to small scale farmers on knowledge and skills in order to improve their fram productivity and household food security.

1.8 Scope of the Study

The study investigated three selected alternative extension approaches namely: Farmer Field Schools, On-Farm Research and Focal Area approaches and their influence on the acquisition

of knowledge and skills for improved farm productivity and household food security. It was carried out in the Lake Victoria region, Kenya with a focus in three sub- counties namely: Bondo, Rachuonyo and Nyamira. A total of 396 respondents drawn from small-scale farmers were sampled in the study.

1.9 Assumptions of the Study

The study adopted the following assumptions:

- i) that farmers recalled food production records over the years;
- ii) that acquisition of knowledge and skills would lead to increased farm productivity and lastly and;
- iii) that farmers who did not participate in the three selected extension approaches had a chance to participate in the conventional extension approach.

Limitations of the Study

The study had the following limitations:

- i) Due to climatic changes, certain years may have had more rains than usual; a scenario that may have resulted to abundant crop yields, thereby distorting the actual food production situation at the time of data collection in the region. Reviewing farm production trends over a long period of time helped to address this limitation.
- ii) The design (cross-sectional) entails data collection at one point in time and inferences drawn from the results of this information. There was a possibility that changes observed could be due to factors other than extension approaches. This was however overcome by randomization and selection of a large sample.

1.11 Definition of Terms

The study adopted the following definitions:

Conventional Approaches: These also referred to as the general extension approaches in n contrast to several other approaches, assume that technology and knowledge that are appropriate for local people exist but are not being used by them. The approaches are usually fairly centralized and government-controlled. Success is measured in the adoption rate of recommendations and increases in national production (Axin, 1988). In this study the term referred to general extension approaches provided by the government covering the whole country.

Extension Approach In this study refers to deliberate extension efforts implemented within communities aimed at imparting knowledge and skills whose objective is to enhance household food production. The selected extension approaches in this study were: Farmer Field Schools, On- Farm Research and Focal Area. They are strategic because they are systematically adopted in implementing technologies fronted by a given project or programme.

Farmer Field Schools (FFS): Farmer Field Schools (FFS) is a participatory Extension approach whereby farmers are given opportunity to make a choice in the methods of production through a discovery-based approach. It is a group extension method based on adult education methods. It is a school 'without walls' that teaches basic agro-ecology and management skills that make farmers experts in their own farms. After the training period, the farmers continue to meet and share information with less contact with extension officers (Mweri & Khisa, 2001). In the study the term was used refer to a group of farmers learning in the field, observing and recording basic data on the growth changes in a named crop for a whole cropping season from planting to harvesting.

Farm Productivity: Refers to the ratio of agricultural outputs to agricultural inputs applied on a farm (Dharmasiri, 2005). In the study, farm productivity referred to the amount of food (crops and livestock) produced by the farms in the study area.

Focal Area Approach: Focal Area is an approach implemented by the National Agricultural and Livestock Extension Programme (NALEP) and focuses in one geographical area called the Focal Area, usually a location or sub-location, whereby resources and efforts are concentrated for one year before moving to another area (MoALD, 2004). In this study it

referred to an extension approach whereby all extension efforts and resources are concentrated in one mapped geographical area referred to as focal area, usually for one year and comprises of about 400 farmers.

Household food Security: Refers to a situation when all households, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active healthy life (FAO/WHO, 1996). In the study refers to a situation whereby a household has access to the food needed for a healthy life for all its members (adequate in terms of quality, quantity, safety and culturally acceptable), and when it is not at undue risk of losing such access.

Knowledge and skills: In this study knowledge referred to the respondents' capability to acquire information about farming practices, while skills refers to their ability to comprehend and practically carry out informed practical farm operations. In the study the two terms are captured together and knowledge level refers to both knowledge and skills.

Lake Victoria Region: In this study, referred to the regions found within the basin of Lake Victoria. In the study, Lake Victoria region referred to the sub- counties found in the Lake Victoria region of Kenya especially those in the former Nyanza Province, and in this study, the sample sub counties were: Bondo, Nyamira and Rachuonyo.

On- Farm Research Approach: These are part of the Regional Research Programme activities which are demand-driven, focusing on solving farmers' problems of immediate nature and are mainly conducted in the farmers' fields and environment in order to incorporate farmer evaluations (Kenya Agricultural Research Institute, 2012). In the study it referred to the extension approach whereby research is carried out in the farmer's field by researchers and extensionists with the farmer's involvement and participation.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter summarizes a review of literature carried out to identify research gaps and offer other literature related to this study. It has been organized to reveal important studies carried out in relation to agricultural productivity Worldwide, Africa and in Kenya. It then reviews literature on Agricultural extension worldwide, Sub Saharan Africa and in Kenya. The Chapter proceeds to review socio- economic and cultural factors in agricultural productivity in Kenya, namely gender and agricultural policy. It finally reviews studies on the three selected extension approaches in the study. It concludes by giving the theoretical and conceptual frameworks adopted for this study.

2.2 Agricultural Productivity Worldwide

The past half-century has seen marked growth in food production, allowing for a dramatic decrease in the proportion of the World's people that are hungry, despite a doubling of the total population (World Bank, 2008). Nevertheless, more than one in seven people still do not have access to sufficient protein and energy from their diet, and even more suffer from some form of micronutrient malnourishment (FAO, 2009). The World is facing a new set of intersecting challenges, with the global population continuing to grow and likely to plateau at some 9 billion people by roughly the middle of this century (Evans, 2009). A major correlate of this population growth is increased wealth, and with higher purchasing power comes higher consumption and a greater demand for processed food, meat, dairy, and fish, all of which add pressure to the food supply system. At the same time, food producers are experiencing greater competition for land, water, energy and the need to curb the many negative effects of food production on the environment is becoming increasingly clear (Tilmanet, 2001).

It has been estimated that in those parts of Southeast Asia where irrigation is available, average maximum climate-adjusted rice yields are 8.5 metric tons per hectare, yet the average actually achieved yields are 60 percent (Evenson & Gollin, 2003). There is wide geographic variation in crop and livestock productivity, even across regions that experience similar climates. The difference between realized productivity and the best that can be achieved using current genetic material and available technologies and management is termed the "yield gap." The best yields that can be obtained locally depend on the capacity of farmers to

access and use, among other things, seeds, water, nutrients, pest management, soils, biodiversity, and knowledge. The study explored the knowledge and skills of farmers and on various technologies and how this influenced farm productivity. This would confirm studies that the best yields that can be obtained locally depend on the capacity of farmers to access and use, among other things, seeds, water, nutrients, pest management, soils, biodiversity and knowledge (Evenson & Gollin, 2003).

A study by Hall, Dore and Chow (2009), documented that the volume of food produced globally is more than sufficient to feed a healthy population, however significant amounts of food produced around the world are lost or wasted after harvesting. The study showed that in developed countries this primarily occurs in the retail, home and municipal food-handling stages. For example in the USA, around 40 per cent of all food produced is wasted, resulting in losses of all embedded inputs such as energy (equivalent to wasting 350 million barrels of oil per year), water (equivalent to about 40 trillion litres of water every year) and huge volumes of fertilizers and pesticides.

The most significant factors contributing to the increasing demand for food are the continued growth of the global population, especially in developing Countries and a rise in income levels in emerging economies, coupled with demand for meat and processed food rising, with growing affluence (FAO 2010). The current global population of more than 6 billion, of which 925 million are undernourished, is forecast to reach 8.5-9 billion by 2050, and per capita incomes are expected to rise by as much as a factor of 20 in India and 14 in China, respectively (Goldman, 2007).

Irz, Lin, Thirtle and Wiggins (2001), note that agriculture has tremendous potential to alleviate poverty with a large proportion of the rural population and labour force in developing countries employed in agriculture. On average, the contribution of agriculture to raising the incomes of the poorest is estimated to be at least 2.5 times higher than that of non-agriculture sectors in developing countries. Underscoring the relationship between increasing yields and return on labour with poverty estimate that for every 10 per cent increase in farm yields, there was a 7 per cent reduction in poverty in Africa and more than a 5 per cent poverty-reduction effect for Asia. Growth in manufacturing and services do not show a comparable impact on poverty reduction (Irz *et al.*, 2001). The World Bank (2010) reported that an increase in overall Gross Domestic Product derived from agricultural labour productivity was, on average, 2.9 times more effective in raising the incomes of the poorest

quintile in developing countries than an equivalent increase in GDP derived from non-agricultural labour productivity.

2.3 Food Security Worldwide

The World Health Organization states that there are three pillars that determine food security: food availability, food access, and food use (WHO, 2005). The FAO adds a fourth pillar: the stability of the first three dimensions of food security over time (FAO, 2012). In 2009, the World Summit on Food Security stated that the "four pillars of food security are availability, access, utilization, and stability" (FAO, 2013). Food availability relates to the supply of food through production, distribution, and exchange (WHO, 2013). Food production is determined by a variety of factors including land ownership and use; soil management; crop selection, breeding, and management; livestock breeding and management; and harvesting (Gregory, Ingram & Brklacich, 2005). Crop production can be impacted by changes in rainfall and temperatures (WHO, 2013). The use of land, water, and energy to grow food often competes with other uses, which can affect food production Land used for agriculture can be used for urbanization or lost to desertification, salinization, and soil erosion due to unsustainable agricultural practices (FAO, 1997). Crop production is not required for a country to achieve food security. Nations do not have to have the natural resources required to produce crops in order to achieve food security, as seen in the examples of Japan (Godfray et al.2010) and Singapore (Japan Times, 2011).

The second pillar is food access, which refers to the affordability and allocation of food, as well as the preferences of individuals and households (WHO, 2013). The UN Committee on Economic, Social, and Cultural Rights noted that the causes of hunger and malnutrition are often not a scarcity of food but an inability to access available food, usually due to poverty (FAO, 2009). Poverty can limit access to food, and can also increase how vulnerable an individual or household is to food price spikes. Access depends on whether the household has enough income to purchase food at prevailing prices or has sufficient land and other resources to grow its own food (Fiona, 2011). Households with enough resources can overcome unstable harvests and local food shortages and maintain their access to food (Japan Times, 2011).

The third pillar is food stability which refers to the ability to obtain food over time. Food security can be transitory, seasonal, or chronic (Gregory *et al.*2005). In transitory food insecurity, food may be unavailable during certain periods of time. At the food production

level, natural disasters and drought result in crop failure and decreased food availability (Luther, 1999). According to Luther (1999), civil conflicts can also decrease access to food and instability in markets resulting in food-price spikes can cause transitory food insecurity. Other factors that can temporarily cause food insecurity are loss of employment or productivity, which can be caused by illness. Seasonal food insecurity can result from the regular pattern of growing seasons in food production (Gregory *et al.*2005).

Chronic (or permanent) food insecurity is defined as the long-term, persistent lack of adequate food (Luther, 1999). In this case, households are constantly at risk of being unable to acquire food to meet the needs of all members. Chronic and transitory food insecurity are linked, since the reoccurrence of transitory food security can make households more vulnerable to chronic food insecurity (Gregory *et al.*2005).

"Famine and hunger are both rooted in food insecurity. Chronic food insecurity translates into a high degree of vulnerability to famine and hunger; ensuring food security presupposes elimination of that vulnerability (FAO, WFP, IFAD, 2012).

2.4 Agricultural Productivity in Africa

Productivity of Sub-Saharan Africa agriculture depends on climate; efficient and effective use of the factors of production (farmland, water, and labor); agricultural inputs (fertilizers, irrigation, seeds, and capital equipment); and farmers' skills. The region's agriculture involves diverse crops and livestock but productivity is particularly important for cereals and starchy roots, which provide two-thirds of the total energy intake for the population (three-quarters for the poor) (Diao, Thurlow, Benin, & Fan, 2012). According to the Africa Human Development Report 2012 (United Nations Development Programme [UNDP], 2012), more than 75 percent of cereals and almost all root crops come from domestic agriculture and not imports. Farm incomes continue to be crucial to the survival of the 70 percent of the extremely poor population living in rural areas. This is because rural non-farm activity (accounting for 30-40 percent of earnings) tends to prosper when farm incomes are rising. As in the rest of Sub-Saharan Africa, nearly two-thirds of the economically active populations in the selected countries are involved in agriculture; in some countries, such as Burkina Faso, that proportion exceeds 90 percent.

Grain output in 2011 fell below the bumper crop of 2010 as several countries—including Angola, Burkina Faso, Chad, Madagascar, Mali, Niger, and South Sudan—had below-

average production (United States Department of Agriculture [USDA], 2012). Historically, countries including Liberia, Rwanda, Niger, Ethiopia, and Sierra Leone have suffered low production levels due to political instability. However, following the introduction of stable governments, they have experienced stable production patterns. Notably, Ethiopia has more than doubled its domestic grain production (from 8 million metric tons in 2000 to 15.6 million metric tons in 2010) and is now Sub-Saharan Africa's second largest grain producer behind Nigeria (USDA, 2012). Kenya, on the other hand, in the past decade has witnessed slow growth in its grain output, which has even declined in per capita terms due to frequent droughts. Production growth, however, is projected to accelerate over the coming years, triggered by stronger yields. Increasingly, Kenya has relied on imports to satisfy its food needs; in the early 2000s grain imports accounted for about 27 percent of grain supplies, but this has jumped to more than 40 percent (Chauvin, Mulungu, & Porto, 2012).

In developing countries, the root causes of food insecurity include: poverty, war and civil conflict, corruption, national policies that do not promote equal access to food for all, environmental degradation, barriers to trade, insufficient agricultural development, population growth, low levels of education, social and gender inequality, poor health status, cultural insensitivity, and natural disasters (FAO,1996). Many farmers in Sub-Saharan Africa countries face declining crop yields, which has constrained economic growth (Hassan, 1998). The underlying constraints are caused by low and unreliable rainfall, pests and diseases, and inherently infertile soils. The soil infertility is related mainly to the low nutrient status of the soils while the qualities of some soils have declined as a result of continuous cultivation without returning enough nutrients back to the soil (FAO, 1996).

Half of all undernourished people, three-quarters of malnourished African children and the majority of people living in absolute poverty are found on small farms (Millennium Project Task Force on Hunger, 2004; IFAD 2001). In the majority of countries, poor rural people are both sellers of food commodities and buyers of foodstuffs at different times of the year. Typically, they sell immediately after harvest, usually at very low prices, to meet their immediate cash requirements, and buy food in the months prior to the following harvest, usually at higher prices, to meet their food needs.

Falling yields during the early 1990's are attributed to the poor sequencing of market reforms and subsequent declines in the use of fertilizer and hybrid seeds (Karanja, Jayne & Strasberg,

1999; Odhiambo, Nyangito & Nzuma, 2004). Although recent evidence suggests that fertilizer use is rising rapidly, it is concentrated in favourable agro-ecological regions (Ariga, Jayne & Nyoro, 2006). Furthermore, increased population pressure in these favourable regions has caused migration to less-favourable lands where existing technologies are often inappropriate (Nyoro & Jayne, 1999). Funding for agricultural research is insufficient for the development of more appropriate seed varieties (Odhiambo *et al.*, 2004). Accordingly, increased spending on research and the provision of extension services is identified as a binding constraint to agricultural growth (Nyangito, 1999). In order to address some of these challenges, a number of studies have examined the determinants of agricultural productivity. Firstly, it has been established that information sources rather than subsidies are more effective in encouraging adoption through enhancing farmers' allocative ability and revising their perceptions on profitability of the new technology (Lohr & Salomonsson 2000; Genius, Christos, & Vangelis, 2006).

Secondly, studies have shown that agricultural research has been a major factor in increasing global food security by 80 percent since the mid-1960's, with more than half of the increase in developing countries, contributing to household food production by developing improved breeds and varieties of livestock, fish and trees to enhance livestock production, aquaculture, agro forestry and mixed farming systems (Kibwika, Wals & Nassuna-Musoke, 2009).

The third component is farmers' knowledge of improved markets for their farm produce and inputs. It has been documented that market development is a critical ingredient in farm productivity (Nyoro, Wanzala & Awour, 2001). This is because higher input prices and lower output prices reduce the incentive for small-scale farmers to purchase fertilizers and hybrid seeds (Owuor, 1999). Therefore, increasing market access by investing in roads is considered complementary to enhancing on farm technology. Furthermore, improved market access and commercialization are found to increase input use and yields for both food and cash crops (Strasberg, Jayne, Yamano, Nyoro, Karanja & Strauss, 1999).

The fourth determinant of agricultural productivity is innovations. In the context of farming, innovations are concerned primarily with increasing production of food, fodder, secondary products and enhancing quality of produce, growing conditions, and production process (Evenson & Mwabu, 1998). Innovations involve one or more of the following areas: First, Crop and animal genetic changes, such as the introduction of new breeds or varieties which

have specific advantages and new husbandry skills to make them more productive; Secondly, Growing conditions which involves the addition of manure or other fertilizers; Thirdly, Implements including more efficient ploughs that can cope with different soil types; and fourthly, harvesting machinery which includes, milling equipment, water-lifting devices among others; and lastly-management practices, which includes changes in the mode of production, land ownership and inheritance (Evenson & Mwabu, 1998).

This study examined the trends in farm productivity when farmers were exposed to alternative extension approaches. This was important since it has been demonstrated that implementation of scientific research findings into practical solutions that would translate into higher agricultural productivity is faced with several challenges such as lack of access to information and uptake of new technologies through effective dissemination pathways that are crucial in optimizing the adoption process especially of 'knowledge-based' innovations (Padel, 2001).

2.5 Agricultural Productivity in Kenya

The critical challenge facing Kenya is to raise the rate of economic growth to levels incorporating broad-based improvement in the standards of living and well-being of Kenyans in order to reduce poverty which has increased rapidly in the recent past (GoK, 2000). Kenya's economic growth rate declined dramatically from an average of 6.6 percent in 1970s to 4.2 percent in 1980s to an average of 2.1 percent in the 1990s. The living conditions of the vast majority of Kenyans were deteriorating rapidly with a marked increase in the number of people unable to access clean water, clothing, shelter, health services and education. There have been growing disparities in access to services which further undercut the living conditions of low-income households, school enrolments; infant mortality and life expectancy have deteriorated (UNDP, 2002). It has been documented that about a half of Kenya's estimated 38 million people are poor with some 7.5 million of them living in extreme poverty. It is likely that over 10 million suffer from chronic food insecurity and poor nutrition with an estimated 2 million people requiring food assistance at any one time (GoK, 2006).

2.5.1 Agricultural Productivity and Employment in Kenya

Agriculture employs 70-80 percent of the rural work force and accounts for 70 percent of the country's foreign exchange earnings, however, it has been noted that agricultural production

in the country has been declining for more than two decades (GoK, 2004b; Mwangi, 1996). Unemployment was a problem in Kenya with an average unemployment rate at 23 percent, and was even higher for youth that drop out of school and for women, averaging 25 percent in both cases (Chune, 2003). Furthermore, while crop incomes are less important for urban households, the livestock sector still comprises a tenth of the informal economy, which in turn provides employment for poorer urban workers (Kiringai, Thurlow, & Wanjala 2006). In addition, food production has declined, for example maize production in 2000 recorded a deficit of 11 million bags and in 2001 it registered a shortfall of three million bags, forcing the government to import food resulting into the loss of much needed foreign exchange (CBS, 2001).

Since 80 percent of poor people live in rural areas and make their living from agriculture (Central Bureau of Statistics, 2006), the Government of Kenya realized that enhanced agricultural production particularly among smallholder farmers is the key to eradication of extreme poverty and food insecurity in the country. Agriculture is the largest sector in the Kenyan economy, generating a quarter of gross domestic product (GDP) and two-fifths of export earnings and unlike many other African countries, agricultural production in Kenya is relatively diverse, with export crops and higher value horticultural crops being as important as cereals and root and oil crops (Kiringai, Thurlow & Wanjala, 2006).

2.5.2 Agricultural Productivity and Levels of Growth in Kenya

FAO (2006) report indicates that Kenya's agricultural sector has experienced low growth over the last two decades, thus mirroring the weak overall performance of the economy. The report further shows that agricultural production grew at 1 percent annually during the 1990s, driven by marginal improvements in crop yields or productivity; however this growth was well below the population growth rate of 2.5 percent. Additionally the report shows that although agricultural growth has doubled since 2000, this more recent period has been characterized by rapid area expansion with stagnant yields.

Over 80 percent of farmers in Western Kenya are small holder farmers and have grown maize for many generations (Jaetzold, Schmidt, Hornetz & Shisanya, 2005). In the former Nyanza Province, it was reported that food poverty level stood at 46 percent, against a population of 5.3 million persons, while the average poverty level was 63.82 percent (Ministry of Agriculture, 2010).

2.5.3 Key Crops in Kenya

Maize is the most important staple food crop in Kenya, contributing to more than 25 percent of agricultural employment and 20 percent of total agricultural production (GoK, 2001). Although maize plays a major role in household food production and income generation in Kenya, its productivity has not been adequate especially in the past four decades during which stagnation/decline in maize yield led to frequent food security problem (Ariga *et al.*, 2006) have attributed maize yield decline to soil fertility and increase in world fertilizer prices. The situation has been exacerbated by maize price fluctuation and occasional importation of cheap maize grains.

The problem of declining maize yields is magnified by the fact that population continues to increase annually at a rate of about 2.9 percent leading to decreasing *per capita* consumption and due to the increasing human population and declining soil fertility, demand for maize continues to outstrip supply due to such factors including: Poor soil fertility which is the main cause of reduced yields; Low quality post harvest storage practices such as at farm level; high cost of seed and fertilizer leading to low usage of the same; Striga weed infestation and diseases such as maize streak and; Tendency of some farmers to continue using local seeds whose production is low (CBS, 1996; Karanja, Renkuro & Crawford, 2003).

Studies have shown that some of the factors that contribute to farm productivity include other forms of rural infrastructure, such as irrigation, investments to improve water management, elements that have slowed over the last two decades, yet they remain fundamental for growth in some areas of the country (Odhiambo *et. al.*, 2004). Similarly, agricultural services that improve livestock management and disease control are found to have a positive impact on growth (Karanja, 2003). Furthermore access to credit and working capital has been another constraint for rural households (Nyoro, Wanzala & Awour, 2001; Kibaara, 2006). Therefore, extensive empirical evidence was needed in this study to identify the causes of low farm productivity and the knowledge gaps needed to reverse the trends needed to enhance agricultural productivity and accelerate rural growth in Kenya.

2.6 Agricultural Extension Worldwide

Extension as an institution is only one component in agricultural and rural development processes and that it is only one vehicle for fostering change in agricultural and rural development (Drucker, 1999). Yet the importance of knowledge and the rapidity of its transfer and exchange in the modern World are increasingly recognized as central to trade and development, in high income as well as in low-income countries. Extension's high economic rates of return indicate its potential to bring about change (Birkhaeuser, Evenson & Feder, 1991).

2.6.1 The Role of Agricultural Extension

Agricultural extension services provide farmers with important information, such as patterns in crop prices, new seed varieties, crop management, marketing; exposure to such activities is intended to increase farmers' ability to optimize the use of their resources and causing awareness of existing technologies to generate effective demand by providing a critical signal to input distribution systems (Davidson, Munir & Tanvir, 2001). Thus, extension systems and input distribution systems are mutually reinforcing — the contribution of extension to agricultural productivity growth depends on functioning input distribution systems, and vice versa, besides providing a feedback from farmers to research centres. The World's expansion beyond the global village is a reality that has strongly affected public sector extension. Globalization is inextricably linked to privatization, and countries are finding themselves confronted by a new and highly competitive global market (Davidson, Munir & Tanvir, 2001).

Studies which have proved that while knowledge of farmers' preferences for various information sources is imperative in evaluating the effectiveness and efficiency of dissemination pathways, it has been shown that sources and methods of information communication should not only be based on their effectiveness and capacity to reach larger number of farmers, but also according to their perceived credibility, relevance and preference among target audience (Roderick, Knight, Jaramillo, Coble, Patrick & Baquet, 2008).

Major economic restructuring is taking place in both the developed and the developing countries and has greatly changed the balance of responsibility between the public and private sectors (Fresco, 2000). In many cases, trade liberalization places the developing countries at a disadvantage in the global market and increasingly privatized, agricultural

information has in fact become a price-tag commodity (Buttel, 1991). This commodification' of agricultural knowledge is a major factor in the present worldwide transformation of public sector agricultural extension and the advancement of private sector technology transfer systems. This change towards information commodification reflects the privatization of information and agricultural industrialization (Wolf, 1998).

Agricultural extension operates within a broader knowledge system that includes research and agricultural education, the larger system which Food and Agriculture Organization and the World Bank refer to as Agricultural Knowledge and Information Systems for Rural Development (AKIS/RD. The three pillars of this system namely: research, extension and agricultural higher education is also described as the agricultural knowledge triangle and suggests that since the three pillars involve complementary investments they should be planned and sequenced as a system rather than as separate entities (Eicher, 2001). Doss (2003) noted that farmers require access to information about new technologies before they can consider adopting them and since extension is one important means for farmers to gain information on new technologies, the latter is often used as a measure of access to information. Supe (1988) documented that the level of agricultural development is closely related to the ability of the farmers to understand and adopt new technology.

2.6.2 Liberalization of Agricultural Extension

The movement towards liberalization of agricultural extension in the nineties, as well as rising concerns of the efficacy of Government-Led extension services, brought a shift of Government responsibility for extension through structural reform with the aim of shifting extension to the private sector and third sector institutions (Bikketi, 2005). According to Spielman (2007), this has resulted in the increasing plurality of extension provision hence a multiplicity of extension agencies such as private and civil society sectors, cooperatives, and cooperative unions, domestic and foreign firms, rural investors and entrepreneurs and Non Government Organizations (NGOs), Community Based Organizations (CBOs), Faith Based Organizations (FBOs) and individual consultancy groups came up as forms of service delivery systems. Plurality in extension provision is believed to help in facilitating a greater interaction with clients, enhance the response to local problems and opportunities, increase accountability to clients, and increase local participation by making information available and accessible to the farmers.

2.6.3 Shifting Paradigms in Agricultural Extension

There are four possible combinations of factors, each of which represents a different extension paradigm as follows (Swanson, 2006): Technology transfer (persuasive and paternalistic)-This paradigm was prevalent in colonial times, and reappeared in the 1970's when the Training and Visits system was established across Asia. It involves a top-down approach that delivers specific recommendations to farmers about the practices they should adopt. Secondly, advisory work (persuasive and participatory), which can be seen where government organizations or private consulting companies respond to farmers' enquiries with technical prescriptions. It also takes the form of projects managed by donor agencies and NGO'S that use participatory approaches to promote pre-determined packages of technology.

Thirdly, the human resource development(educational plus paternalistic), which dominated the earliest days of extension in Europe and North America, when universities gave training to rural people who were too poor to attend full time courses. It continues today in the outreach activities of colleges around the World. Top-down teaching methods are applied, but students are expected to make their own decisions about how to use the knowledge they acquire; Fourthly facilitation for empowerment (educational plus participatory). This paradigm involves methods such as experiential learning and farmer to farmer exchanges. Knowledge is gained through interactive processes and the participants are encouraged to make their own decisions. The best know examples in Asia are projects that use Farmer Field Schools (FFS) or Participatory Technology Development (PTD). There is also the aspect of 'demand- driven' concept in service delivery in extension services. The term demand driven refers to the economic concepts of supply and demand in economic theory; demand refers to the amount of good or service that a customer is willing and able to buy at a given price (Rivera, 1996).

Notably, none of these measures captures whether the information was available to the farmer (Doss, 2003); instead, they indicate whether the farmer took advantage of the resources. More rarely, an effort is made to look at the effectiveness of extension; for example, by measuring whether the farmer is aware of the relevant recommendations of a technology, presents a measure that actually captures the effectiveness of the information resources and whether the farmer took advantage of them. Thus, it may tell us whether farmers who are aware of the technology and understand it are more likely to adopt it, but it is not a measure of access to information (Doss, 2003).

2.7 Agricultural Extension in Sub Saharan Africa

The role of agricultural extension is vital to the diffusion of new technology, but extension is currently failing (Government of Malawi, 2000) in many nations in Africa. In other low-income developing countries, extension is barely functioning at all. There is also little, if any, coordination between extension and research, and even less between extension and agricultural higher education. Meanwhile, other forces are affecting the development of agricultural and rural extension services emphasizing issues and challenges for much needed reforms (Qamar, 2000). A complex of extension providers has emerged, involving nonprofit, Non-Governmental Organizations, profit making private companies, farmer organizations and commercial associations of extension specialists. In some cases, these non-public sector extension service providers hire public sector extension agents on secondment, which has been termed contracting-in (Anderson & Crowder, 2000).

Most of the Sub Saharan African countries (SSA) have introduced national extension programmes replacing many of the bundles of small-scale extension initiatives that existed before, most of which were parts of donor-assisted projects. These included Integrated Rural Development Projects (IRDP) (Lele, 1975: Ruttan, 1984) or Area Development Projects. Others were crop-oriented projects, such as, projects for increasing the production of cotton for example Gezira in Sudan, tea, coffee or cocoa in many countries in SSA).

In Francophone West Africa including Senegal, Mali, Burkina Faso, the latter type of projects were more common in the agricultural development scene, and were typically implemented by parastatals, who provided the participating farmers with a variety of services, such as, extension, inputs (including seedlings of tree crops), plant protection, postharvest and marketing (Moris, 1991). When the World Bank started supporting research and extension reforms in SSA, many of these projects were absorbed in the national programs when they closed, their extension components being merged with the national extension programme, the research components with the national research programmes and so on. In Madagascar when the national extension programme was introduced in 1995, the ongoing donor-funded extension activities were to be integrated under the umbrella of the national programme. At that time there were many extension-related activities funded by other donors (Venkatesan, 1997).

The World Bank became heavily involved in extension services in Kenya, Uganda and Tanzania and the Training and Visit (T & V) system was used in the region during the 1980's

and 1990's (Bindlish & Evenson, 1993). Training and Visit was designed to fix some of the weaknesses in the previous extension approaches, such as weak linkages with research and low training of field extension workers. However, impact assessment of the Training and Visit approach in Kenya found a large number of shortcomings. Training and Visit was supply-driven system, with technologies and messages designed and developed by research scientists with limited input by the ultimate users of the technologies. The packages were too mechanistic and not flexible enough to meet the needs of the large variety of farming systems. The T & V approach, like the general extension approach, was characterized by weak feedback mechanisms. It relied on contact farmers who were not necessarily representative, and neglected the larger rural population, besides being unsustainable without donor support (Moris, 1991).

Table 1 outlines some of the alternative extension methods tested in Kenya, Tanzania and Uganda.

Table 1:
Alternative Extension Methods Tested in Kenya, Tanzania and Uganda

Extension Approaches	Uganda	Kenya	Tanzania
Technology transfer	$\sqrt{}$	$\sqrt{}$	V
T & V	$\sqrt{}$	\checkmark	$\sqrt{}$
Modified T & V	\checkmark	\checkmark	-
Unified extension	\checkmark	\checkmark	-
Village level participatory	\checkmark	-	-
Farming systems	\checkmark	\checkmark	$\sqrt{}$
Farmer group	\checkmark	-	$\sqrt{}$
Farmer Field Schools	\checkmark	\checkmark	$\sqrt{}$
Participatory integrated	\checkmark	\checkmark	-
development			

Source: Anandajayasekerem et al. (2001).

T &V is no longer in use, but other extension approaches and philosophies are cropping up, including pluralistic extension approaches (Feder, Willett & Zijp, 1999). In pluralistic approaches, information and technologies are exchanged by many different players in a manner that is interactive, dynamic and cyclical in nature and because of the potentialities to

capitalize on the strengths of various players, pluralism is being promoted worldwide in extension systems. With the emergence of many institutions offering extension services, there is limited study of the extent to which these agencies are strengthening and influencing change in farmer ability to increase agriculture productivity (World Bank, 2004).

The phrase "top-down" is often used in this context of conventional Extension. Farmers in most parts of the developing world are fortunately free to take their own production decisions in the light of their resource endowments and other relevant factors. They would not adopt an extension recommendation, and certainly not the second time, if it is irrelevant to them and not arrived at after considerable discussion with and participation by them. An extension system in the free world, by definition, cannot be top-own, if field visits and the Monitoring and Evaluation (M&E) surveys indicate wide- spread adoption of the extension recommendations (Venkatesan, 1997).

This "top-down" view was a result of a theoretical concept of extension based on the linear model (Ro"ling, 1995): "first, research develops a technology, then it trains Subject Matter Specialists (SMS) in this new technology, the SMSs train the Village Level Workers (VLWs) and the VLWs train the contact farmers, who pass on chunks of information to follower farmers." The actual process in the field is very rarely what was recently described. First, extension in SSA increasingly works with groups where diffusion of information is better and quicker. Second, farmers are involved in various phases of technology generation and transfer, such as on-farm adaptive research. The "old style" extension systems where the researcher used to meet the extension staff at his/her farm in frequent intervals and "handed down" research recommendations on such "field days" were actually "top down," as research recommendations were often given on "a take it or leave it basis" (Moris, 1991).

2.7.1 Private Sector Involvement in Agricultural Extension

Private sector involvement is on the increase in certain lucrative areas such as the horticultural industry, whereby many farmers are successfully growing cut flowers, fresh vegetables, and fruits for the international market (Rivera & Alex, 2004) with a renewed emphasis on contract farming in Kenya, Uganda and Tanzania. According to Rivera and Alex (2004), Non-governmental organizations, farmer groups and other non-state actors may not be able to effectively provide extension services without the assistance of the state and other players, while the state has the advantage of formal linkages with research and other

stakeholders; well-trained personnel and infrastructure in place; and wide geographic coverage. Only the public sector can carry out certain functions and assume responsibility for delivery of public goods, therefore the government and other stakeholders need to work out the most effective and efficient roles for the various players in extension in order to meet the goals of reducing poverty and food insecurity (Edwards & Hulme, 1996).

Kanyinga (1993) documented that pluralistic systems result in part from the inability of state services to sufficiently address farmers' needs, with Non-Governmental Organizations (NGO's) being one of the major actors who have helped to fill this gap. There has been a dramatic expansion in the role played by International and National NGO's in developing technologies for farmers, and providing a whole range of services including the provision of seeds and tools, technology generation and diffusion with some having their own extension staff. NGO's have emerged as a sector with several comparative advantages over the traditional extension providers and with their flexible and cost-effective techniques, grassroots-level contacts and participatory approach, they are at the foreground in many donors' eyes in providing support and service where the government has been unable to (Kanyinga, 1993).

2.8 Agricultural Extension in Kenya

Kenya's small-scale farmers have over the years benefited from two major types of extension systems (Milu & Jayne, 2000). The first is the government extension system whereby the ministry in charge of agriculture has played a leading role. This system focused mainly on food crops and livestock. The government has tried a number of extension models and styles, including the progressive (or model) farmer approach, integrated agricultural rural development approach, farm management, training and visit, attachment of officers to organizations, farming systems approaches and Farmer Field Schools.

All these approaches have emerged with varying levels of success. The system has been perceived as top-down, uniform (one-size-fits-all) and inflexible and considered a major contributor of the poor performing agricultural sector (GoK, 2005). Thus, there has been a desire to reform extension into a system that is cost effective, responsive to farmers' needs, broad-based in service delivery, participatory, accountable and sustainable. Smallholder farmers not only require advice to increase farm productivity, but also advice on a

diverse range of rural development options including markets, value addition, and diversified income opportunities. An extension system that does not significantly contribute to improving the lives of its clientele is inappropriate.

The second type of extension system is the commodity-based system run by the Government parastatals, out grower companies, and cooperatives (Muyanga & Jayne, 2006). This system deals mainly, but not exclusively, with commercial crops such as coffee, tea, pyrethrum and sisal. This system is consciously motivated by profits and tends to work well when both the firm and farmers clearly benefit from the extension expenditures. All aspects of producing and marketing a particular commercial crop are tightly vertically coordinated, spanning the whole range from research, advice, and material support given to farmers, to organizing marketing and even exports (Muyanga & Jayne, 2006).

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 (GoK, 2010). Several public training institutions offer services to the agricultural sector including universities, middle-level colleges and institutes, and farmer and pastoral training centres.

Agricultural training institutions run by the private sector also offer general and specialized courses. Other public support institutions involved in human resource capacity building include a livestock-recording centre, a national beekeeping station, fish breeding and demonstration farms, sheep and goat stations, livestock farms, agricultural mechanization stations and rural technology development stations. These institutions provide specialized training to clients (farmers and extension personnel) and act as demonstration centres for improved technologies (GoK, 2010).

2.9 Gender Characteristics and Agricultural Productivity in Kenya

Gender refers to the socially and culturally constructed differences between men and women; as distinct from sex which refers to their biological differences and the social constructs vary across cultures and time (Ministry of Gender, Sports, Culture and Social Services, 2008). According to GoK (2009), women are food producers and caretakers of their families,

manage farms and allocate household resources to various needs as well as caring for their children hence their access to productive resources such as land, they need access to agricultural and nutrition extension information, better access to technology, access to credit and control over income as well as decision making authority both at household and national level. Their most important role of women is to provide household food production for their households, which they are able to do by supplementing household earnings, diversification of household incomes and raising livestock to augment household assets.

Gender is one of the socio-cultural issues that affect agricultural productivity. Gender refers to the socially and culturally constructed differences between men and women; as distinct from sex which refers to their biological differences and the social constructs vary across cultures and time (Ministry of Gender, Sports, Culture & Social Services, 2008). Two thirds (67.7%) of Kenya's population lives in rural areas (GoK, 2010), and significantly more women (77.8%) than men are rural dwellers (FAO, 2011).

Women are food producers and caretakers of their families, manage farms and allocate household resources to various needs as well as caring for their children hence their access to productive resources such as land, they need access to agricultural and nutrition extension information, better access to technology, access to credit and control over income as well as decision making authority both at household and national level. Their most important role is to provide household food security for their households, which they are able to do by supplementing household earnings, diversification of household incomes and raising livestock to augment household assets (GoK, 2009).

The household is able to depend on crops grown by women, for example the vegetables, when prices of food crops go up and they can also spend on other foodstuffs in order to improve their diets (GoK, 1999). Generally there is increasing number of *de facto* and *de jure* female headed households. In particular *de jure* households are among the poorest and hence suffer more from food insecurity. *De facto* female-headed units are those where the women are heads of household on temporary basis because their husbands are absent due to labour migration but they have ongoing contact, accompanied by the sending home of remittances (Feldstein, Poats & Cloud, 1989).

The development of technologies relevant to the roles of women in agricultural production and food processing has significantly lagged behind. It has been demonstrated that even in those households where the woman is the head, she remains household head only in as far as her name appears in the official documents and most of the decisions on farming are taken out of the hands of women (Mudege, 2007).

2.10 Policy Reforms to Improve Agricultural Productivity in Kenya

In Kenya, agriculture has remained the mainstay of the economy since independence in 1963 and although its contribution to the GDP decreased from 35 per cent in 1963 to 25 per cent in 1996, it employs about 75 per cent of the labour force, provides most of the food requirements for the nation and earns the country about 60 per cent of the foreign exchange (Kenya, 1997). Despite the importance of the agricultural sector in Kenya, and in most sub-Saharan African countries, the performance of the sector has been poor for most years since 1970 (World Bank, 1981; Mosley and Smith, 1989).

2.10.1 Policy Issues in the Agricultural Sector in Kenya Since 1964

A diverse range of policies has been used to foster growth of the agricultural sector in Kenya. The first set of policies for the period 1964 to 1980 emphasized government intervention in nearly all aspects of agricultural production and marketing (Smith, 1976). This meant that the government had control on almost all the institutions involved in agricultural development. From 1981, however, there was a major shift from government controls to liberalized markets. The shift meant that the government had to reduce its control of agricultural production and marketing and provide an enabling environment for enhanced participation by the private sector.

Upon attainment of independence, agricultural policies were based on principles outlined in the Sessional Paper No. 10 on African Socialism and its Implications to Planning in Kenya which emphasized political equality, social justice, and human dignity. These principles, following the example of the Soviet Union, were based on state control of the economy and defined the state as the entity that not only maintains law and order but also outlines and implements social and economic programmes in a bid to remedy historical and social inequalities. The principles were reinforced by the failure of capitalism and markets after the Great Depression when state intervention in the form of the Marshal Plan, the Keynesian demand management, and the welfare state seemed to record one success after another (World Bank, 1997).

2.10.2 Policy Issues in the 1980's

From 1980, however, there was a shift in economic policy towards a liberal state ideology in developing countries. This ideology emphasized a reduction of state intervention in the economy and free market operations. Part of the reason for the shift was the high cost of socialist development strategies which became clear with Kenya's Agricultural Policy & Sector Performance: 1964-1996 which resulted to the failure of most publicly-owned enterprises.

2.10.3 Policy Issues in the 1980's and 1990's

The liberal state ideology - which was strongly marketed through aid conditions set out by the World Bank and the International Monetary Fund in the 1980s and 1990s, emphasizes that the state's role should be limited to creating an enabling environment for individuals and associations to freely pursue their economic and social objectives, subject to obeying the law .Most developing countries started curbing controls in production, pricing and trade and advocated market-friendly policies from 1980. The first attempt to introduce liberal policies in Kenya was indicated in the 4th Development Plan, 1979-83, but it was not until 1982 that reforms gained momentum mainly because of the World Bank's requirement that distortions in the markets be removed as a condition for loan disbursement (Swamy, 1994).

The stages, based on the government's rigour and commitment, of the implementation of the reforms can be divided into two: 1980 to 1992 and 1993 to 1997. Initially, policy reforms in the agricultural sector emphasized a liberalisation of the grain market and a removal of price controls for all agricultural commodities. This emphasis was followed with proposals on a decontrol and relaxation of fertiliser import licensing systems, price decontrol and removal of obstacles in the marketing and distribution system. Detailed policy reforms for the whole economy were spelt out in Sessional Paper No. 1 on Economic Management for Renewed Growth (GoK, 1986). The policies spelt out in the paper included a liberalisation of markets from government controls and a concomitant shift to open market operation and a removal of government support (subsidies) on most investments and services and a corresponding shift towards privatisation and cost sharing.

2.10.4 Policy Issues in the 2000's

In the 2000 the government came up with policy reforms all aimed at improving agricultural productivity. One such policy was Kenya Government strategic paper, commonly referred to as the Poverty Reduction Strategic Paper, 2001-2004 (GoK, 2001). According to this paper

the country has over the years been faced with increasing food defaults as a result of prolonged droughts and low agricultural productivity. This has exacerbated the household food security situation and increased reliance on food relief which may be attributed to: lack of effective early warning systems, lack of adequate strategic food reserves, high post harvest losses and lack of effective control of crop and livestock diseases (GoK, 2001). The strategy recommended that the government and stakeholders should promote household food security by instituting a national early warning and food distribution system, maintain a national strategic reserve but encourage the private sector to get involved in the international trade through a more predictable policy and tariff regime as well as undertake policy reforms to lower the cost of production for crops and livestock including reforms to the extension delivery system.

The PRSP has been termed hitherto the most comprehensive and most focused policy document in the fight against poverty since independence (Omiti, Owino, Otieno & Odundo, 2002). The paper aimed at facilitating sustainable, rapid economic growth; improve governance and security; increase the ability of the poor to raise their incomes; and improve the quality of life of all citizens especially the poor. A consultative and participatory approach was used in its preparation, which involved various stakeholders within and outside the government.

Poverty reduction broadly defined requires processes that help people to improve their capabilities and functioning that enable them to take charge of their affairs. Kenya has come up with many poverty reduction policies since independence, most of which have had little success. Poverty reduction policies before 1990s erroneously assumed that the benefits of rapid growth of key sectors such as industry, service and agriculture would automatically trickle down to all sectors of society. So more effort was injected into improving economic performance including: export incentive, agricultural food processing, among others, at the expense of promoting societal welfare enhancing projects. For example, some policies like the rural and informal sector development did not receive the much-needed political will and required resource allocation, to be effective (Gondi,2005).

The importance of agricultural extension in relation to the fight against poverty was underscored in the Strategy to Revitalize Agriculture (SRA) (GoK, 2005). The declining effectiveness of the public extension service was identified as one among the factors

impeding agricultural growth in Kenya. In this regard, SRA had suggested reform of the extension system to create more effective linkages between research, extension and farmers, who are the ultimate beneficiaries. Extension is thus one among the six SRA first-tracked areas requiring urgent fix.

In 2007, the Government of Kenya developed a blue print referred to as the Kenya Vision 2030, which is anchored on three pillars: Economic, Social and Political (GoK, 2010). The key drivers in achieving the vision are increasing value in agriculture, a better and more inclusive wholesale and retail trade sector, manufacturing for the regional market and business process off shoring. Kenya Vision 2030 recognizes land reform and infrastructure as foundations for socio-economic development.

The current Government policy is referred to as Agricultural Sector Development Strategy 2010–2020 (ASDP). This new programme is aligned with the Government's commitments to the agricultural sector through the Agricultural Sector Development Strategy 2010–2020 (ASDS) and the Kenya CAADP Compact. The Agricultural Sector Development Support Programme (SDSP) supports the Government's multiple goals of: 'an integrated form of commercialization and market-led growth [in agriculture], the pursuit of increased productivity, and strategies to address the special needs of vulnerable rural populations (GoK, 2010).

The overall objective of the ASDS is to achieve an agricultural growth rate of 7 per cent per year over the next five years. The Medium-Term Investment Plan 2010–2015 (MTIP) operationalizes the ASDS in the short term. It identifies and lists specific investment interventions proposed for implementation to achieve *Vision 2030* and CAADP goals as follows: Increasing productivity, commercialization and competitiveness; Promoting private sector investment and participation in all aspects of agricultural development including research; Promoting sustainable land and natural resources management; Reforming and improving delivery of agricultural services and research; Increasing market access and trade; and Ensuring effective coordination and implementation of interventions (GoK,2010).

2.11 Extension Approaches to Improve Farm Productivity

According to Katz, (2002), Agricultural extension services provide farmers with important information, such as patterns in crop prices, new seed varieties, crop management, and

marketing. Exposure to such activities is intended to increase farmers' knowledge and skills that would optimize the use of their resources and increase farm productivity. The study involved three selected alternative extension approaches namely: Farmer Field Schools, Focal Area and On-Farm Research. As a benchmark, Conventional or Public Extension approach was used for comparison. Each approach is discussed in turn:

2.11.1 Conventional Extension Approach

Conventional extension also referred to as general extension approach or public extension in contrast to several other approaches is also called Ministry-Based General Extension. Extension conventionally comprises several of the following functions (Moris, 1991): First, diagnosis of farmers' socio-economic and agro-ecological conditions and of their opportunities and constraints; secondly, message transfer through direct contact between extension agent and farmer or indirect contact involving intermediaries such as 'contact farmers' or voluntary organizations; through training courses and through mass media. Messages may comprise advice, awareness creation, skill development and education; thirdly, feedback to researchers on farmers' reactions to new technology to refine future research agenda; fourthly, development of linkages with researchers, government planners, NGOs, farmers' organizations, banks, and the private commercial sector. In remote areas, extension agents have taken on a number of these functions directly; and lastly monitoring of the extension system, and evaluation of its performance at farm level.

According to Nagel (1992) shortly before or after independence, organizing agricultural extension work under the wings of the ministry of agriculture seemed to be an ideal solution for many African and Asian governments. All options for reaching large numbers of clients and serving their needs in terms of quality information and assistance appeared to be open. The original colonial model combined research and extension within the same organization. All important aspects of small-holder agriculture - plant production, animal husbandry, home economics - could be attended to as the ministry established respective sections under its jurisdiction. The fact that the ministerial hierarchy followed the country's territorial subdivision allowed the systematic expansion of the system "down" to the village. The generalist nature of field extension staff functions corresponded to the set of problems faced by noncommercial growers. To cater to specific needs - in terms of technology or in terms of target groups - specialists could be employed. Thus clientele included in principle all persons engaged in agriculture. Commercial service and support organizations lacking, village-level

extension staff could be expected to supplement information by rendering services necessary to apply it productively. A uniform and nationwide organizational pattern seemed to facilitate information flow - including the infusion of expatriate expertise - and corrective measures whenever weaknesses were identified. Public interest was to guide goal setting, programme formulation, and the implementation of fieldwork (Nagel, 1992).

Conventional extension also referred to as general extension approach or public extension in contrast to several other approaches, assumes that technology and knowledge that are appropriate for local people exist but are not being used by them. The approach is usually fairly centralized and government-controlled (Axinn, 1988). This approach has in recent times been criticized for failing to contribute sufficiently to agricultural development, for not reaching poor and marginalized farmers, and for being too costly and inefficient (Ikiara, Jama, & Amandi, 1992). Inspite of this, public extension service is still seen as a keyway to reduce poverty and rural livelihoods with a few issues to be addressed including: how to improve extension services; adjustment programmes, poverty reduction strategies, redefined role of government (limited mostly to policy and regulatory services), modernization and commercialization of smallholder agriculture, public-private partnerships, and commitment to participatory approaches (World Bank, 2006). Although there are many critics of public extension systems, a worldwide study of agricultural research and extension institutions carried out by the International Food Policy Research Institute (IFPRI), based on 80 studies Worldwide, estimated that the annual median rate of return was an average of 63 percent for extension expenditures and 48 percent for agricultural research expenditures (Alston et al., 2000).

2.11.2 On-Farm Research

For any new technology or technology component to be accepted by farmers, it has to be shown to be superior to the existing system. The most reliable means of proving this is through OFR, in which the farmer is involved and the trial is run within the farm environment. Such OFR trials provide an excellent opportunity to compare the performance of the proposed system and farmer's traditional practice in a reliable way (Figure 1).

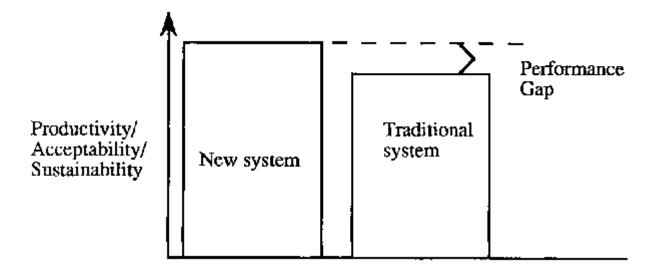


Figure 1: Demonstration of the new systems' improved performance (Atta-Krah & Francis 1987)

On-Farm Research (OFR) creates links with extension in at least three ways: Firstly, if On-Farm Research clearly demonstrates the viability of the technology, it may create a "neighbourhood effect," whereby innovation waves spread outward from the research sites (Atta-Krah & Francis, 1987). Since On-Farm Research is likely to be conducted in many locations across the region, the innovation waves will spread from many centres and thus speed up both generation and diffusion of the technology. Moreover, horizontal (farmer to farmer) diffusion is likely to take place, due to lateral learning within each research location: Secondly, OFR promotes collaboration with extension and development agencies which helps to improve the efficiency of the technology generation and diffusion process. Involvement of extension and development agencies as partners and participants in the technology generation process brings them directly into contact with the farmers. It acquaints them with the salient features of the technology while it is being generated. This is a step ahead of the more typical situation where such agencies have to wait until some best-practice technology package is made available to them for dissemination; lastly, the OFR stage may test the suitability of the existing institutional framework for proper delivery of the technology to the users.

In Kenya, On- Farm Research has been adopted by the Kenya Agricultural Research Institute (KARI) as an integral component of the Regional Research programme. According to KARI (2002) although Regional Research Programme (RRP) is not in itself an extension approach, its presentation manifests a lot of extension characteristics as it involves working directly

with farmers on their farms by setting up trials on- Farmers' fields. A Regional Research Programme (RRP) is a set of biophysical and socio-economic research activities that address priority agricultural constraints of farmers in a given mandate region of a KARI centre covering specific agro-ecological zones (AEZs). These constraints emanate from diagnostic activities conducted by interdisciplinary teams composed of researchers and extension officers with active participation of farmers. The RRP activities are demand driven, focusing on solving farmers problems of immediate nature and are mainly conducted in the farmers' fields in order to incorporate farmer evaluations. Thus RRPs are involved in both adaptive research and research-extension-farmer linkage activities including field days, demonstrations, farmer field visits germplasm multiplication and packaging of dissemination materials. The RRP work closely with the research extension linkage divisions of the Ministry of Agriculture and that of livestock and fisheries development (KARI, 2012).

2.11.3 Farmer Field Schools

The second extension approach in the study was Farmer Field Schools. One of the pluralistic education and extension programme practised worldwide is the Farmer Field Schools (FFS) approach, being implemented in at least 78 countries (Braun, Jiggins, Roʻling, Van Den Berg, & Snijders, 2006). The main objective of a Farmer Field School is to bring farmers together in a learning situation to undergo a participatory and a practical season-long training in a particular topic/technology. The focus is field observation, hands-on activity and season long evaluation of technologies demonstrated for scaling-up (Abate & Duveskog, 2003). Farmers are facilitated to conduct their own research, diagnose and test problems, and come up with solutions. FFS training programmes help farmers develop analytical skills, critical thinking, and creativity, and learn to make better decisions (Kenmore, 1996). Such an approach, in which the trainer is a facilitator rather than an instructor, reflects a paradigm shift in extension (Roʻling &Van de Fliert, 1994). Through group interactions, attendees sharpen their decision making abilities and their leadership, communication, and management skills (Van de Fliert, 1993). Three major learning tools of FFS include discovery-based learning exercises, group experiments, and agro-ecosystem analysis (Duveskog, 2006).

Farmer Field Schools (FFS) provide a platform for farmers to meet regularly in groups to study the 'how and why' of farming (Braun, 2007). There is currently a multitude of FFS initiatives in more than 27 countries in Africa funded by various development agencies.

Published research indicates that FFS has a substantial impact in terms of increase in farm productivity, reductions in farmers' use of pesticides and improved farming knowledge (Rola, Quizon & Jamias, 2002). Developmental benefits reported include poverty reduction, greater empowerment and collective action (Davis, Nkonya, Kato, Mekonnen, Odendo & Miiro, 2012). Farmer Field School (FFS) approach to extension was first introduced in Kenya on a small-scale basis in 1995 by a special programme for food security (Abate & Duveskog, 2003). Since then, it has been tested and adapted for a wide range of crops and livestock enterprises. Farmer field school involves 25-30 farmers in a given locality facilitated to find solutions to their problems.

Figure 2 is a diagrammatic representation of the various steps in the FFS process. Minjauw (2001) refers to this as classical approach to FFS.

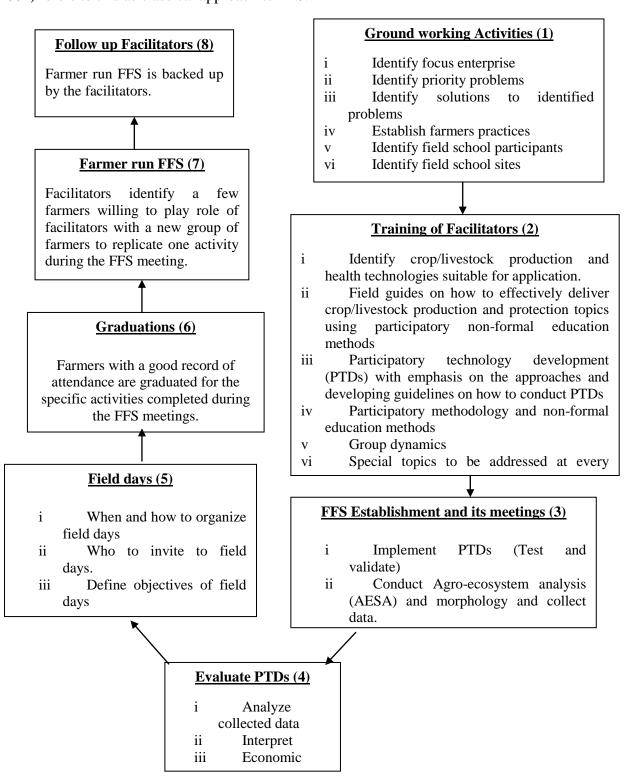


Figure 2: Classical approach to Farmer Field Schools *Source*: Adopted from Minjauw (2001).

2.11.4 Focal Area Approach

The third approach in the study was Focal Area. Focal Area is an approach implemented by the National Agricultural and Livestock Extension Programme (NALEP) and focuses in one geographical area called the Focal Area, usually a location or sub-location, whereby resources and efforts are concentrated for one year before moving to another area (MoALD, 2004). The programme is anchored on the principle that extension staff members in collaboration with other stakeholders mobilize the Focal Area community to spearhead their area development. The strategy entails strong collaboration, participation and partnership between the extension staff and other stakeholders. The mobilization involves creating awareness, training, empowering and development of action plans.

As a successful approach to extension in the Kenyan context, Focal Area Extension focuses on poverty reduction measures, empowerment of small-scale farmers, strengthened capacity of extension staff, awareness creation on HIV/AIDS, and on legal rights in relation to natural resource management (NRM), awareness creation on the adverse effects of drugs and other harmful substances, research–farmer–extension linkages, and gender and socio-economic issues (MoAL&FD, 2007). This approach therefore had little bearing on the traditional extension service as often understood. It went beyond providing information on general agriculture technologies to mobilizing rural communities to realize their potential in developing themselves and their areas.

Results from the NALEP Phase I (July 2000 – June 2005) project review indicated that most groups and members had managed to improve their production and food security (GoK, 2006). Farmers' groups formed around a common purpose (CIGs) are a cost-efficient manner to propagate extension messages. However, earlier project review had indicated that the approach reached non-poor farmers and people with high education attainment (GoK, 2005b). These groups had resources to invest and thus exploited the potential of the introduced technologies. The farmers who could exploit the project benefits were usually those who had access to other sources of income than farming. Also farmers with small pieces of land tended to benefit less. Poor farmers are risk-averse and thus not willing to engage their meager resources to try new technologies, consequently adopting 'wait and see' strategy. However, this approach was credited to have spillover in the form of improved food security situation even in the neighbouring project areas.

2.12 Theoretical Framework

The study adopted a theoretical framework by Swanson, Bentz and Sofranko (1998) referred to as awareness-knowledge–adoption-productivity (AKAP) sequence. The AKAP Sequence model visualizes extension as achieving its ultimate economic impact by providing information and educational or training services to induce the following sequence:

A: Farmer Awareness

K: Farmer **k**nowledge, through testing and experimenting

A: Farmer **a**doption of technology or practices

P: Changes in farmer's **p**roductivity

The model postulates that changes in farmer behaviour will be reflected in quantities of goods produced, the quantities of inputs used, and their prices. These in turn, can be measured as "economic surplus" which is added value of goods produced from a given set of inputs made possible by the extension services activities. Studies of extension impacts have measured farmer awareness (and sources of awareness) knowledge (and testing of practices) adoption, and productivity. Studies have shown statistical relationship between the quantity of extension services made available to farmers and increases in awareness, knowledge, adoption and productivity.

The AKAP sequence has a natural ordering whereby real resources in the form of skills and activities by both extension staff and farmers are required to move along the sequence (Swanson *et al.*, 1998). Productivity depends not only on the adoption of technically efficient practices but also infrastructure of the community and the available market institutions. Extension services affect each part of the sequence hence complementing the acquired skills for their clientele, the farmers.

The knowledge and skills acquisition happens at demonstration sites as may be the case in Farmer Field Schools (FFS) or On- Farm Research sites or in demonstration plots as in the case of Focal Area. It was envisaged that the skills and knowledge may be adopted by the farmers who would in turn practice the same at their own farms away from the experimental fields. Adoption of the innovations and technologies would sharpen the farmers' crop and animal husbandry skills which would in turn translate to changes in farm productivity, hence improve household food security. This interaction is shown in Figure 3, which demonstrates

how the activities of extension service are expected to raise the farmer' household food security.

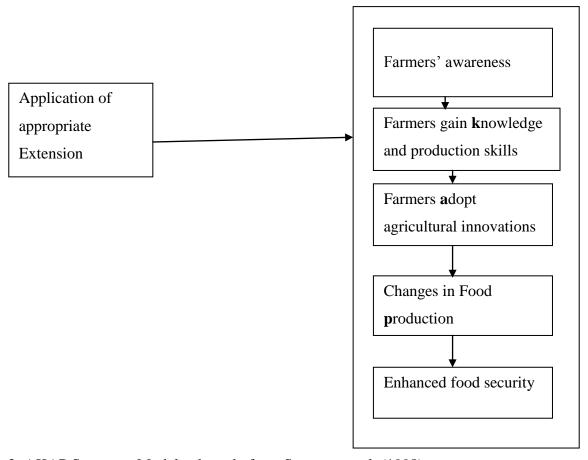


Figure 3: AKAP Sequence Model, adapted from Swanson et al. (1998).

It is worth noting that although extension services are largely poised to contribute to this scenario as shown in the model, other factors are equally critical if household food security is to be realized. These include other sources of information to farmers, agricultural support services such as input supplies systems, credit, markets and processing among others.

2.13 Conceptual Framework

In order to realize the interactions shown in the theoretical framework a Conceptual Framework was developed as illustrated in Figure. 4. The Conceptual Framework was derived from the theoretical framework as follows: the independent variables were the extension approaches (On-Farm Research, Farmer Field Schools and Focal Area). The study conceptualized that different extension approaches had different effects on the acquisition of knowledge and skills at household level. However, the effectiveness of independent variables (extension approaches) could be affected by other variables referred to as the moderator

variables, including other information sources such as NGOs, print and electronic media including Radio, Television, internet among others.

Randomization and use of a large sample of the respondents gave all the extension approaches equal chance of causality and hence giving equal effects of the moderator variables. Other ways to deal with these variables were to in-build them into the study, by including several items in the instrument in order to capture and study them. The dependent variables were the acquisition of knowledge and skills for enhanced farm productivity and household food security. The study conceptualized that appropriate extension approaches could better the farmers' acquisition of knowledge and skills and productivity that would result into improved food security at household level. The knowledge and skills include: Crop and livestock management knowledge and skills. Using a Likert scale the knowledge and skills level was established against each extension approach.

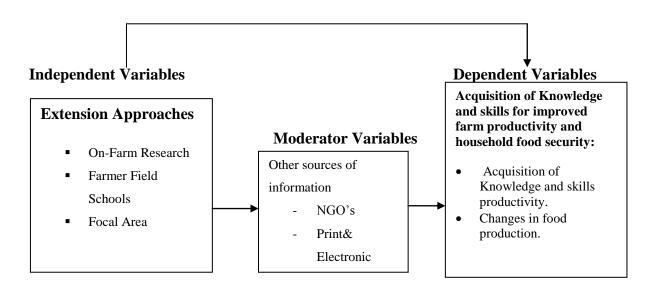


Figure 4: Conceptual framework of the study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This Chapter highlights specific procedures used in the research framework which includes: research design, study location, target population, sampling procedure and sample size, instrumentation, data collection procedure, and analysis, .

3.2 Research Design

The research adopted a cross sectional design. This design involves collecting data from a predetermined and specific population (Fraenkel & Wallen, 2002). It allows the researcher to collect data at one point in time, thus enabling the respondents to describe a phenomenon, in this case selected extension approaches and their effect on agricultural knowledge, skills and household food production. This design allows for comparison of groups without manipulating the independent variable (Mugenda & Mugenda, 2003). In this study, knowledge, skills and productivity for household food security in the study sub counties were determined in relation to the extension approaches used to provide services. Chance differences were minimized by using a large sample and randomization (Borg & Gall, 1989).

3.3 Location of the Study

The study was carried out in three sub counties in the Lake Victoria region basin of Kenya. Lake Victoria basin is located in the upper reaches of the Nile River basin and occupies an area of about 251,000 km² of which 69,000 km² is the lake area (UNEP, 2006a) and is shared by Kenya, Uganda, Tanzania, Rwanda and Burundi. The study was carried out in three sub counties in the Lake Victoria region namely: Bondo, Nyamira and Rachuonyo. The following criteria formed the basis for sampling the 3 sub counties: The sub- counties portrayed a national or regional extension delivery system; they were fairly accessible based on available funds and time; and that they had representation in terms of diverse climatic conditions, agro-ecological zones, agricultural practices and communities.

The sub counties were purposively selected since they were representative of the larger Lake Victoria Region of Kenya. Nyamira, located in the Kisii highlands represent a high potential region for agricultural production, receiving rains most of the year, with rich arable soils. Rachuonyo on the other hand represent a medium potential region especially the Southern part with moderate rains, with fairly rich soils. Bondo Sub- County is typically low potential

with low rains and poor soils, with the main economic activity being fishing in Lake Victoria (See Map of the study Area- Appendix B).

3.4 Target Population

The target population for this study consisted of small-scale farmers drawn from the three sub counties: There are approximately 865,923 persons in the three study sub counties represented by 188,661 households (GoK, 2009). The small-scale farmers in the study sub counties practice subsistence agriculture, involving cultivation of food crops and keeping few heads of cattle mainly for household consumption with little surplus for sale. The demographic characteristics of these Sub- Counties are as shown in Table 2

Table 2:

Population Distribution of the Study Sub- Counties

S/N	Sub- County	Male	Female	Total	Households	Area (Km²)	Density
1	Bondo	76468	81054	157522	37296	593.0	266
2	Rachuonyo	182,967	199744	382711	81426	950.7	403
3	Nyamira	155808	169882	325690	69,939	398.3	818
	Total	415243	450680	865923	188661	1942	

Source: GoK (2009).

3.5 Sampling Procedure and Sample Size

The study adopted multi stage sampling technique, first of the Sub- Counties and secondly of the households. For the selection of sample Sub- Counties, purposive sampling technique was used. This technique allows the researcher to use cases that have the required information with respect to the objectives of the study, cases of subjects are therefore handpicked because they are informative or they possess the required characteristics (Mugenda & Mugenda, 2003). Then within the selected Sub- County, proportionate random sampling was applied to obtain the desired cases (Borg & Gall, 1993). The sample frame for this study comprised of small-scale farmers who had practiced agriculture over the years. The sampling unit was the household. In order to sample the households, proportional stratified random sampling

technique was used. This technique ensures that all subgroups in the population are represented (Wiersma, 1995). Equal allocation was then used to sample the households.

3.6 Sample Size

The probability formula by Mugenda and Mugenda (2003) was adopted to determine the sample size as follows:

$$n = \underline{z^2 pq}$$

Where:

n = desired sample size

z =the standard deviation required confidence level (1.96)

p = proportion in the target population estimated to have characteristic being measured (50%).

q = 1-p and

d = level of statistical significance (0.05)

The study Sub- Counties were: Nyamira with a household population of 69,939; Rachuonyo, 81426 and Bondo, 37,296 according to the 2009 Population Census (GoK, 2009). The total household population was therefore 188, 661, out of which 50% were covered by the extension approaches investigated in the study, the sample size was calculated as follow:

Using the formula: $n = (1, 96)^2 (0.6382) (0.6382)$

384.14

 $(0.05)^2$

To cater for attrition a sample size of 386 was selected as shown in Table 3.

Table 3:
Study Sample by Sub County and Extension approach (n=396)

Sub County		Extension	Approach		Total		
	Farmer Field	Focal Area	On Farm	Conventional			
	Schools		Research	Extension			
Bondo	11	30	11	56	108(27.3%)		
Rachuonyo	19	36	12	81	148(37.4%)		
Nyamira	16	39	32	53	140(35.3%)		
Total	46 (11.6%)	105(26.5%)	55 (13%)	190(48%)	396(100%)		

3.7 Instrumentation

A Questionnaire (Appendix A), was used to collect data from the sample farmers in the study Sub- Counties. The items in the instrument had been constructed to address the two objectives of the study. This instrument had three parts: part one (1) items 1-11 was intended to establish socio - economic conditions of respondents; part two(2) items 12-23 for information on food production (Objective 1); while part three (3) obtained information on knowledge and skills (Objective 2).

3.8 Validity

Validity is the degree to which results obtained from the analysis of the data actually represent the phenomenon under study (Mugenda & Mugenda, 2003). The three main types of validity are: Construct validity- which is a measure of the degree to which data obtained from an instrument meaningfully and accurately represents theoretical concept; criterion-related validities (face validity)-which refers to the use of a measure in assessing subjects' behaviour in specific situations (Borg & Gall ,1989); and content validity- which is the measure of the degree to which data collected using a particular instrument represents a specific domain of indicators or content of a particular concept. Validity was ensured through the comments given by three Extension Experts from among academic staff with specialization in Agricultural Extension, Research Methods and Statistical Methods from the Department of Agricultural Education and Extension of Egerton University and three others from the School of Agricultural and Food Sciences of Jaramogi Oginga Odinga University of Science and Technology; appropriate adjustments were made on the instrument before it was taken to the field for data collection.

3.9 Reliability

In order to establish reliability, pilot testing involved administering the instrument to another area separate but similar to the proposed study site. The instrument was piloted among 30 farmers in Rarieda Sub- County after which reliability was calculated. Rarieda was chosen since it has similar characteristics to two of the study areas, Bondo and Rachuonyo sub counties. In the study, internal consistency of data of the instrument or reliability was computed using Cronbach alpha (Fraenkel & Wallen, 2000).

A reliability coefficient threshold of 0.7 is recommended for survey research to be adopted (Fraenkel & Wallen, 2000). For this study the final reliability was 0.878, which was above the recommended threshold (**See Appendix C**).

3.10 Data Collection Procedure

Upon satisfying the requirements of the Graduate School of Egerton University, the researcher obtained a research permit (appendix C) from the National Commission for Science, Technology and Innovation (NACOSTI) in Nairobi. This was followed by visits to the various Sub- County Agricultural Offices and Kenya Agricultural Research Institute station in Kisii to inform them of the research and to obtain lists of respondents. Subsequent meetings were held with selected respondents. Face-to- face administration of the instrument was done.

3.11 Data Analysis

Qualitative or non-numerical data was used in describing the various aspects of the study. Quantitative data was analyzed using inferential statistics as shown in Table 5. Descriptive statistics involved computing frequencies, percentages, means and standard deviations to summarize data. The purpose was to enable the researcher to meaningfully describe a distribution of scores of measurements using a few indices or statistics. The inferential statistics used in the study was independent *t-test*.

A summary of data analysis procedure is shown in Table 4.

Table 4: Summary of Data Analysis

Hypotheses	Independent Variable	Dependent variable	Statistical Test
H _{O1:} There is no statistically	D D' 11	Acquisition of	T 1 1 .
significant influence of Farmer	Farmer Field School	Knowledge and skills for	Independent Sample t-
Field Schools Approach on the	approach	improved farm	test;
acquisition of knowledge and skills		productivity and	
for improved farm productivity		household food security	
and household food security in the			
Lake Victoria region of Kenya.		Knowledge Acquisition	
H _{O2:} There is no statistically		of Knowledge and skills	
significant influence of Focal Area	Focal Area	for improved farm	
Approach on the acquisition of	approach	productivity and	Independent
knowledge and skills for improved		household food security	Sample t-
farm productivity and household			test;
food security in the Lake Victoria		Acquisition of	
region of Kenya.		Knowledge and skills for	
H _{O3} : There is no statistically		improved farm	
significant influence of Farmer		productivity and	
Field Schools Approach on the		household food security	
acquisition of knowledge and skills	On- Farm		
for improved farm productivity	Research	Knowledge Acquisition	
and household food security in the	approach	of Knowledge and skills	Independent
Lake Victoria region of Kenya.		for improved farm	Sample t-
H _{O4:} There is no statistically		productivity and	test;
significant influence of Farmer		household food security	
Field Schools, Focal Area and On-		·	
Farm Research Approaches	Farmer Field		
combined on the acquisition of	Schools,		Independent
knowledge and skills for improved	Focal Area		Sample t-
farm productivity and household	and On Farm		test;
food security in the Lake Victoria	Research		
region of Kenya.	approaches		

CHAPTER FOUR RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter presents and discusses the results of the study based on the study objectives and the set of hypotheses.

4.2 Socio- Economic Characteristics of the Respondents

The socio – economic characteristics of the respondents include: Gender, education level, land tenure system, family size, family farm income and changes in family incomes.

4.2.1 Gender of the Respondents

Gender remains one of the key factors in agricultural production hence the need for collection of gender desegregated data. Table 5 shows the study sample desegregated by gender.

Table 5:
Gender of Respondents (n=396)

Extension Approach	Ma	ale	Fem	ale	Tota	1
	f	%	f	%	f	%
FFS	21	45.7	25	54.3	46	100
FA	58	55.2	47	44.8	105	100
OFR	30	54.5	25	45.5	55	100
CE	97	51.1	93	48.9	190	100
Total	206	52.0	190	48.0	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

There were more males in the study (52. 0%) than females (48%), however by extension approaches there were more males than females in Focal Area approach. There were more females than males (54.3%) in Farmer Field Schools as compared to the other two approaches. The findings agree with those by Davis, Nkonya, Kato, Mekonnen, Odendo and Miiro (2012) which shows that whereas women are normally excluded from extension services, Farmer Field Schools attract more women than men. Overall, the results of the study point to the fact that quite a large number of women (48%) did not participate in the three extension approaches as depicted by those who only participated in Conventional Extension.

4.2.2 Education Level of Respondents

It has been documented by Ngathou, Bukeny and Chembezi (2005) that formal education is important in the acquisition of knowledge and skills of agricultural technologies and that educated farmers are more flexible in acquisition of information sources, often consult depending on the prevailing circumstances to meet their information needs and associated with more sophisticated sources information sources such as print than would be their less educated counterparts. Results in Table 6 show the level of education for participants of the extension approaches.

Table 6:
Level of Education (n=396)

	No	None		Primary Secondary		Pos	st Secondary	Total		
	f	%	f	%	f	%	f	%	f	%
FFS	1	2.2	19	41.3	20	43.5	6	13	46	100
FA	9	8.6	43	41.0	44	41.9	9	8.6	105	100
OFR	2	3.8	20	38.5	27	51.9	3	5.8	52	100
CE	18	9.3	67	34.7	100	51.8	8	4.1	193	100
Total	30	7.6	149	37.6	191	48.2	26	6.6	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Most of the respondents in the study had some level of education except 30 (7.6%) who had no education at all. The majority of farmers had primary and secondary levels of education (37.6%) and (48.2%) respectively. About 26 (6.6%) had post secondary level of education.

The results show that farmers exposed to On- Farm Research had the highest level of education with 51.9 percent of the respondents having secondary level of education and 5.8 percent having post secondary level of education. Overall, 48.2 percent of the farmers had secondary level with another 6.6 percent having post secondary level of education. According to Ngathou *et al*, 2005) some respondents with high levels of education tend to rely more on outside sources of information than on their own experience and that such farmers more often rely on print as an information source and therefore may get more knowledge through reading than from other sources.

4.2.3 Family Size of the Respondents

Family size is critical as it contributes to the family labour and also the food security of the family. Larger families generally have more farm labour but also more people to feed from the farm produce and *vice versa*. Results indicated in Table 7 that the average family size for the study.

Table 7:
Family Size (n=396)

Extension Above 10 Approach persons		5-10	5-10 persons		low 5 persons	Total		
Approach	f	%	f	%	f	0/0	f	%
FFS	7	15.6	28	62.2	11	23.9	46	100
FA	19	18.1	45	42.9	41	39.0	105	100
OFR	9	16.7	36	66.7	10	18.5	54	100
CE	24	12.6	148	77.9	18	9.5	190	100
Total	59	14.9	257	64.9	80	20.0	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The findings show that in all the categories of approaches, including Conventional Extension most households (64.9%) had a family size of between 5-10, and that conventional extension participants had the highest number of families (77.9%) followed by On Farm Research (66.7%); Farmer Field Schools (62.2%); and Focal Area approach (42.9%). The results are consistent with The Word Bank (1990) which showed that the average family size for Kenya is five compared with the average for less developed countries of 2.17 while for Sub-Saharan Africa, it is six based on average number of surviving children per woman (female over 15 years) and that high fertility rate may translate into low *per capita* income.

4.2.4 Land Ownership by Respondents

The status of land ownership may determine type of land management practice and ultimately farm productivity. Table 8 shows the land ownership status by respondents in the study. The results indicate that 125 farmers (31.6 %) own land with title deeds; Less than half,

188(47.5%) own land without title deeds; 18(4.5%) own leased land while 65 (16.4%) own communal land.

Table 8:
Land Tenure System (n=396)

Extension approach	Owi	ned n title	Owned without title		Leased		Communal		Total	
	deed	i	deed	1	f	%	f	%	f	%
	f	%	f	%						
FFS	15	32.6	25	54.3	4	8.7	2	4.3	46	100
FA	30	28.6	63	60.0	6	6.0	6	5.7	105	100
OFR	20	36.4	28	50.9	3	5.5	4	7.2	55	100
CE	60	31.6	72	37.9	5	2.6	53	27.9	190	100
Total	125	31.6	188	47.5	18	4.5	65	16.4	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

As shown in Table 10, 54.3 percent of the farmers exposed to Farmer Field School own land without title deeds, while 32.6 percent own land with title deeds; 60 percent of those associated with Focal Area approach own land without title deeds, while 28.6 percent own land with title deeds, implying that the land may be rented or communal; 50.9 percent of the On Farm Research farmers own land without title deeds, while 36.4 percent own land with title deeds. For those exposed to Conventional Extension, 37 percent of them own land without title deeds with a sizeable number 31.6 percent owning land with title deeds.

The results point to the fact that over two thirds (69.4%) in the study area own land without title deeds. This confirms a study by Shepherd and Soule (1998) who found out that adoption of economically sustainable land management practices and technologies is constrained by shortage of land and capital resources.

4.3 Findings of the Research Question

What is the status of changes in food production under the influence of Farmer Field Schools, On-Farm Research and Focal Area extension approaches in the Lake Victoria region of Kenya?

Objective 1: To determine the status of changes in food production and farm income under the influence of Farmer Field Schools, On-Farm Research and Focal Area extension approaches in the Lake Victoria region of Kenya.

This section provides a description of the status of changes in food production in the study area under the influence of the selected alternative extension approaches including: the period of participation, the activities, causes of food shortages, amount of food consumed and stored and contribution to farm productivity.

4. 3.1 Farm Family Incomes of Respondents

Family income is an important factor in determining the livelihoods of the family. According to the 1997 WMS, the poverty line per person per year was defined as Kenyan shillings (Ksh) 21,848 (US\$288) in rural areas and Ksh46, 693 (US\$615) in urban areas, both expressed in 2003 prices and unadjusted in US dollars (Government of Kenya, 1997). Table 9 shows the family farm incomes of the respondents. On average, a majority of families (41.7%) earn incomes of over Ksh. 10000 followed by incomes of between Ksh. 5000-10000 represented by 38.6 percent; while less than 19.7 percent earn below Ksh. 5,000.00.

Table 9: Family Farm Incomes (n=396)

	Less	Less than		Ksh.5000-		er	Total		
	Ksh	Ksh.5000		10,000		.10,000			
	f	%	f	%	f	%	f	%	
FFS	10	21.7	25	54.3	11	23.9	46	100	
FA	24	22.9	46	43.8	35	33.3	105	100	
OFR	15	27.3	23	41.8	17	30.9	55	100	
CE	29	15.3	59	31.0	102	53.7	190	100	
Total	78	19.7	153	38.6	165	41.7	396	100	

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The results show that over half of the respondents (58.3%) have an income of below Kenya Shillings 10,000. This implies that they live below the poverty line. Farmers with Farmer Field Schools exposure farmers had slightly higher number of farmers (54.3%) with an income of between 5000-10000. The results concur with studies by Feder, Murgai and Quizon (2004), which documented that Farmer- to -Farmer diffusion effects of FFS are expected to bring about cost effectiveness in knowledge diffusion and financial sustainability.

4. 3.2 Family incomes over a period of 5 years

Despite their higher output per hectare and the significant contribution they make to food production, small-scale farmers often have low incomes and are poor. Results in Table 10, show the trends in farm family income over the last five years in the study area.

Table 10:

Trends in the Family Incomes for a Period of 5 years (n=396)

Extension	Increased	Rem	nained constant	Dec	creased	Total	
Approach	f %	f	%	f	%	f	%
FFS	35 76.1	4	8.7	7	15.2	46	100
FA	43 41.0	14	13.3	48	45.7	105	100
OFR	10 19.6	17	33.3	24	47.1	55	100
CE	51 26.8	24	12.5	115	60.5	190	100
Total	139 35.1	59	14.9	194	50	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The results revealed that over the last five years, 50 percent of the respondents had their family incomes decreased; 35.1percent of them indicated that their incomes had increased whereas 14.9 percent stated that their incomes remained constant. The findings however showed that FFS participants had a majority (76.1%) of the farmers having increased incomes, while Conventional Extension had the highest number with decreased incomes (60.5%) over the last five years. Overall, only 35 percent had their incomes increased while 65 percent of the farmers had their incomes decreased or remained the same over the last five years. The results concur with a study by Jayne *et al.* (2003) who documented that in a survey of smallholder households, 55 per cent in Kenyans and 75 percent of Ethiopians, respectively, fell below the poverty line.

4.3.3 Period of Participation and Activities in Food Production

It is expected that when farmers participate in many farming activities and for a longer time they may acquire more skills and knowledge that would translate to increased farm productivity. Results in Table 11 provides the duration of participation of respondents in food production under the three selected alternative extension approaches and the number of activities undertaken.

Table 11:
Period of Participation and the Number of Activities Undertaken

Extension Approach		Duration in years
Farmer Field Schools	i). Duration of participation	4.5
	ii).No. of activities	2.3
Focal Area	i Duration of participation	15.3
	ii).Number of activities	1.9
On- Farm Research	i) . Duration of participation	2.6
	ii).Number of activities	1.9

The results show that Farmer Field schools respondents had been exposed to the approach for four years and that they had undertaken two activities. For the farmers exposed to Focal Area approach, they had participated in the approach for a much longer time, 15 years, with two activities; for the farmers exposed to On-Farm Research, they had participated in the approach for two years with two activities undertaken. The results show that farmers participated in the three extension approaches with a duration ranging from two to fifteen years and two activities findings indicate that farmers had a choice as to the approach but also the duration to practice farming activities using the extension approaches.

4.3.4 Causes of Low Farm Productivity in the Area

Table 12 presents findings of causes of low farm productivity as reported by the respondents. Several crops were grown as mono crops or in mixed cropping systems in the study area. The crops grown included: maize, sweet potatoes, vegetables, beans, cassava and sorghum among others.

Table 12:

Causes of the Persistent Low Farm Productivity in the Area (n=396)

Causes	f	%
Farming without	40	10.1
fertilizer	40	10.1
Inadequate rains	168	42.4
Poor farming techniques	148	37.4
Use of uncertified seeds	40	10.1
Total	396	100.0

As shown in Table 14, inadequate rains were the major reason for poor performance in farm productivity. This was followed by poor farming techniques occasioned by inadequate extension services. The results show that apart from the poor rains, which are a natural occurrence, extension was an important element contributing to the low farm productivity. This confirms a study by Benor and Baxter (1984) that sustained high levels of agricultural production and incomes are not possible without an effective agricultural extension service supported by agricultural research that is relevant to farmers' needs.

4.3.5 Amount of Food Stored

The amount of food stored by households may have a bearing on the food security status of a household given that stored foods may be available for consumption during period of scarcity especially among the small scale resource poor families. Results in Table 13 show the amount of food stored by respondents per year.

Table13:
Status of Food Storage by Households per year (n=396)

Food Status	Amount of food in 90 kg bags.
Food grains used/family/ per year	18.9
Food grains stored per family/year	5.5
Inadequacy response	20.3

The findings show that on average the families use about 19 bags of maize per family per year and that on average families store only about 5.5 bags per year and that they indicated the inadequacy or deficit was 20 bags per family per year. The findings show that most families produce and store little grains, which concur with studies by Kiome (2003), who documented that low farm productivity may lead to food insecurity and poverty which must be urgently addressed due to their negative impact on life.

4.3.6 Trends in Farm Productivity for the last 10 years

Trends in farm productivity is a key indicator in monitoring farm performance over a period of time to ensure sustainability. Sustained farm productivity over a prolonged duration would entail that there are no shortages of food hence ensuring food security, whereas fluctuations may entail serious shortages that would depict food insecurity. In the study a ten year period was chosen and farmers were asked whether there was an increase, a decrease, or the farm productivity remained the same over the period. Table 14 gives the trends in farm productivity over the last ten years per extension approach.

Table 14:

Trends in Farm Productivity for the last 10 years (n=396)

Extension Approach	Increased	Remained constant	Decreased	Total
	f %	f %	f %	f %
FFS	29 63.04	14 30.4	6 13.04	46 100
FA	48 45.7	14 13.3	43 41.0	105 100
OFR	11 20.0	16 29.1	28 50.9	55 100
CE	51 26.8	29 15.3	110 57.95	190 100
Total	139 35.1	73 18.4	187 47.2	396 100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The results show the trends in farm productivity for all farmers exposed to the extension approaches in the study. As per the results, 35.1 percent of the respondents reported that there was an increase in their incomes, 18.4 percent of the respondents had their yields remained the same, while 47.2 percent of the respondents had their yields decreased over the last 10 years. The findings show that 63.04 percent of the farmers exposed to Farmer Field Schools had their yields increased; followed by Focal Area (45.7%); On -Farm Research (20%); while conventional Extension (26.8%). Most of the Conventional Extension participants (57.9%) had their yields reduced.

The results reveal that there was an upward trend in farm productivity with FFS and Focal Area approaches. For the Focal Area the results concur with the NALEP Phase I (July 2000 – June 2005) project review which indicated that most groups and members had managed to improve their production and food security (GoK, 2006).

4.3.7 Findings of Objective ii, iii, iv and v

ii) To determine the influence of Farmer Field Schools extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

- iii) To determine the influence of Focal Area extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- iv) To determine the influence of On-farm Research extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- v). To determine the influence of Farmer Field Schools, Focal Area and On-Farm Research Approaches combined on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

This section presents a comparative influence of the selected alternative extension approaches on acquisition of knowledge and skills on specific farm operations. These were: ploughing, use of manures and fertilizers, crop husbandry practices, soil testing, crop post-harvest handling technologies, livestock production management skills, field experimentation skills and agricultural support services.

4.4 Knowledge and Skills on Ploughing

Ploughing is an operation in the field whose success is critical in determining the soil fineness or tilth but more importantly in the control of weeds. Three methods of ploughing studied in this research were, tractor, oxen and hand digging. Farmers who practice the three ploughing methods were compared based on the knowledge and skills they posses. Table 15 shows the results on the level of knowledge and skills acquisition on ploughing with respect to each extension approach.

Table 15:
Knowledge and skills on ploughing (n=396)

Exten App	Very know	Somewhat Know	Not sure	Very little Know	No Know	Total	
	f %	f %	f %	f %	f %	f %	
FFS	5 10.9	23 50	3 6.5	4 8.7	11 23.9	46 100	
FA	8 7.6	59 56.2	15 14.3	14 13.3	9 8.6	105 100	
OFR	1 1.8	23 41.8	2 3.6	14 25.5	15 27.3	55 100	
CE	9 4.7	73 38.4	38 20	15 7.9	55 28.9	190 100	
Total	23 5.8	178 44.9	58 14.6	34 8.6	90 22.7	396 100	

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The results show that less than half, 178 (44.9%) were somewhat knowledgeable and had knowledge and skills. Focal Area approach had the highest response on the variable (56. %); followed by Farmer Field Schools (50%); On- Farm Research (41.8%) and lastly Conventional Extension (38.4%).

4.4.1 Use of Fertilizers and Manures

Enhancement of farmers' knowledge and skills on fertilizers and manure use is an important aspect in enhancing soil fertility improvement. Table 16 shows the results on the knowledge and skills on the use of fertilizers and manures.

Table 16:
Knowledge and skills on fertilizers and Manures (n=396)

Exten	Very	•		Very little	No Know	Total		
App	know			Know				
	f %	f %	f %	f %	f %	f %		
FFS	2 4.3	32 69.6	5 10.9	6 13.0	1 2.2	46 100		
FA	7 6.7	55 52.4	20 19.0	20 29.1	3 2.9	105 100		
OFR	1 1.8	29 52.7	7 12.7	16 29.1	2 3.6	55 100		
CE	1 0.5	96 50.5	19 10.0	18 9.5	56 29.5	190 100		
Total	11 2.7	212 53.5	51 12.9	60 15.2	98 24.7	396 100		

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The results show that 53.3 percent of the farmers had knowledge and skills on the fertilizers and manures. The fertilizers and manures examined in the study were: inorganic fertilizers, green manures, compost and farmyard manure. Farmers exposed to Farmer Field Schools had the highest (69.6%) knowledge and skills on the use of fertilizers and manures; followed by OFR (52.7%); FA (52.4%), and CE (50.5%). According to the results 56.2% of the farmers in the study were knowledgeable on the use of fertilizers and manures. Recommendations by the Kenyan Ministry of Agriculture have documented that the use of fertilizer and hybrid seeds may increase yields from 40 percent to 100 percent (KARI, 1994). The study findings concur with (Suri, 2007) that only about 60 percent of Kenyan farmers use fertilizer and hybrid seed and that many farmers switch back and forth between using and not using fertilizer from season to season.

4.4.2 Knowledge and skills on the quantity used for specific fertilizers and manures

The quantity and type of fertilizer used is a useful factor in soil fertility improvement. Findings shown in Table 17 indicate the amount of fertilizers and manures farmers use per extension approach.

Table 17:

Quantity of Fertilizers and Manures used (n=396)

Extension	Type of fertilizer	
Approach	(Wheelbarrows)	Amount of fertilizer used
Farmer Field Schools	Farm yard	39.1613
	Manure(WB) Inorganic fertilizer (kg)	54.4242
	Green Manure (WB)	40.0000
	compost manure (WB)	22.3333
Focal Area	Farm Yard Manure (WB)	42.7500
	Inorganic Fertilizer (kg)	59.6932
	Green Manure (WB)	10.5000
	Compost Manure (WB)	38.6364
On Farm Research	Farm yard manure (WB)	86.8000
	Inorganic Fertilizer (kg)	56.1000
	Green Manure (WB) Compost Manure (WB)	23.7778
Conventional Extension		42.3000
	inorganic fertilizer (kg)	65.0000
	Green Manure (WB) Compost Manure (WB)	38.7000

Key: WB- Wheelbarrows, Kg= Kilogrammes

Findings show that farmers exposed to On- Farm Research used the highest amount of Farm Yard manure (86.8 Wheelbarrows). For inorganic fertilizer farmers exposed to Focal Area had the highest (59.7 Wheelbarrows). For green manure, farmers exposed to Farmer Field Schools had the highest (40 Wheelbarrows) and for Compost manure, farmers exposed to On-Farm Research had the highest (65 Wheelbarrows). According to the results farmers exposed

Conventional Extension had the highest amount of inorganic fertilizer as compared to the selected alternative extension approaches in the study.

Overall, more farmers in the study used inorganic fertilizers as compared to the organic fertilizers, findings which were inconsistent with a study by Hines and Pretty (2008) which showed that incomes of some 30,000 smallholder farmers in Thika, Kenya rose by 50 per cent within three years after they switched to organic production. One reason cited by the study farmers was the bulkiness of the organic fertilizers and the high labour involved, findings which concur with Wanjekeche, Mwangi, Pawon and Khaemba (2000) who documented that the bulkiness of the organic fertilizers namely Farm Yard Manure and compost limit their preparation, storage and application.

4.4.3 Farmers Knowledge and Skills on Soil Testing

In order to determine the type and amount of fertilizer, soil testing is a useful activity so as to establish the nutrient content of specific soils in the farm. Table 18 provides results of responses of participants on the knowledge and skills on soil testing.

Table 18:
Knowledge and Skills on Soil Testing (n=396)

Exten	Very	Somewhat	Not sure	Very little	No	Total
App	know	Know	Know Know		Know	
		f %	f %	f %		f %
	f %				f %	
FFS	6 13.0	29 63.0	10 21.7	1 2.2	0	46 100
FA	11 10.5	58 55.2	22 21.0	14 13.3	0	105 100
OFR	0 0	34 61.8	5 9.1	16 29.1	0	55 100
CE	4 2.1	18 9.5	115 60.5	62 4.2	0	190 100
Total	21 5.3	139 35.1	152 38.4	83 21	0	396 100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The findings show that 40 percent of the respondents were very knowledgeable and on soil testing. This means that about 60% no knowledge on soil testing. Although studies have shown that soil testing is a useful tool in the characterization of the topsoil as well as addressing soil fertility constraints (FAO, 1998) results from this study show that most

farmers do not carry out soil testing on their farms. The results indicate that FFS participants had knowledge and skills on soil testing (63%) under the somewhat knowledgeable category, followed by On Farm Research (61.8%), Focal Area (55.2%); while Conventional (9.5%). Respondents cited lack of resources and awareness as the main reasons for not testing their soils. The cost of soil testing ranged from Ksh.250.00 to Ksh.800 per sample, which farmers found to be unaffordable.

4.4.4 Knowledge and Skills on Seed Variety Selection

Knowledge and skills on the choice of seed variety is necessary in the selection of the seed variety to be planted in the right agro – ecological zone. Without such knowledge and skills farmers may plant crops suited to high altitude conditions in the low altitude areas where they would not do well. Table 19 shows the knowledge and skills on seed variety selection by farmers.

Table 19:

Knowledge and Skills on Seed Variety Selection (n=396)

Exten App	Very know		·		Somewhat Know		No	Not sure		Very little Know		No Know		Total	
	f	%	f	%	f	%	f	%	f	%	f	%			
FFS	1	2.2	27	58.7	13	28.3	5	10.9	0	0	46	100			
FA	4	3.8	40	38.1	28	26.7	32	30.5	1	1.0	105	100			
OFR	2	3.6	24	43.6	8	14.5	21	38.2	0	0	55	100			
CE	2	1.1	81	42.6	26	13.9	29	15.3	52	27.4	190	100			
Total	9	2.3	172	43.4	75	18.9	87	22	53	13.4	396	100			

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Results show that 43.4 percent of the farmers had somewhat knowledge and skills on seed variety selection, while over 54.3 percent had little or no knowledge and skills on seed variety selection. The findings concur with a study which showed that farmers do not use improved seed, mainly because very often it is not available to them or they are not aware of

the advantages of using improved varieties. Good quality seed is also not accessible to them as there is often a weak link between farmers, extension systems, research institutions and market (Wubeneh & Sanders, 2006).

4.4.5 Knowledge and skills on weed control

Weeds compete with crops for water and soil nutrients and should be controlled on the farm. Knowledge and skills in their control would help in improving crop productivity. Table 20 provides results on farmers' knowledge and skills on weed control as acquired through the various extension approaches.

Table 20:
Knowledge and Skills on Weed Control (n=396)

Exten	•		Som	ewhat	No	Not sure		Very little			Total	
App			Know					Know Kno			OW	
	f	%	f	%	f	%	f	%	f	%	f	%
FFS	1	2.2	34	73.9	4	8.7	2	4.3	5	10.9	46	100
FA	8	7.6	54	51.4	27	25.7	16	15.2	0	0	105	100
OFR	2	3.6	30	54.5	10	18.2	13	23.65	0	0	55	100
CE	2	1.1	114	60.0	19	10.0	7	3.7	49	25.8	190	100
Total	13	3.3	232	58.6	60	15.2	38	0.5	54	13.6	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The findings show that many farmers (58.6%) had knowledge and skills on weed control. Knowledge and skills on weed control was highest among farmers exposed to FFS (73.9%); On-Farm Research (54.5%); those exposed to Focal Area approach (51.4%); while those exposed to Conventional extension had 60 percent. Overall however, a majority of farmers (58.6%) had had knowledge and skills on weeding.

4.4.6 Knowledge and Skills on Crop Spacing

Optimal crop spacing provides the adequate plant population and should be observed to ensure minimal crop competition for nutrients, water and sunlight. Famers' Knowledge and skills on crop spacing is therefore important ingredient for improved farm productivity. Table 21 shows the expressed knowledge and skills on crop spacing.

Table 21:
Knowledge and Skills on Crop Spacing (n=396)

Extension	Extension Very Approach know		Son	newhat	Not	Not sure		Very little		No		Total	
Approach			Know				Know		Know				
	f	%	f	%	f	%	f	%			f	%	
									f	%			
FFS	3	6.5	27	58.7	13	28.3	3	6.5		0	46	100	
FA	8	7.6	50	47.6	30	28.6	17	16.2		0	105	100	
OFR	2	3.6	31	56.4	9	16.4	13	23.6		0	55	100	
CE	1	0.7	78	54.5	31	21.7	80	23.1		0	190	100	
Total	14	7.4	186	47.0	83	21.0	113	28.5		0	396	100	

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The results show that 54.4 percent of the participants fell in the category of very knowledgeable and knowledgeable while about 45.6 percent had little or no knowledge on crop spacing. Findings show that farmers exposed to Farmer Field Schools had the highest knowledge and skills (58.7%) on crop spacing. Overall, 54 percent of the farmers had knowledge and skills on crop spacing.

4.4.7 Knowledge and Skills on Crop Post- Harvest Handling Techniques

Post harvest operations for cereal grains follow a chain of activities starting in farmers' fields and leading eventually to cereals being supplied to consumers in a form they prefer. During post harvest operations there are often considerable losses of both cereal quantity and quality. The losses result from two main factors: (i) grain scattering, dispersal or crushing, at harvesting, handling, processing and during transportation and, (ii) grain is subjected to bio deterioration by insects or pathogenic organisms. In most cases, post harvest losses start from the field and are transferred along the chain after harvest, to the store and to the processor/and or consumer (Adisa, 2013) . Among the major causes to loss of grain are

moulds, mycotoxins and storage insect pests. Table 22 shows the Knowledge and skills on crop post harvest handling techniques per extension approach.

Table 22:
Knowledge and Skills on Crop Post- Harvest Handling Techniques (n=396)

Exten	Very know		Very Somewhat		No	Not sure		Very little		No Know		Total	
App			Kno)W			Kn	ow					
	f	%	f	%	f	%	f	%	f	%	f	%	
FFS	1	2.2	21	45.7	14	30.4	10	21.7	0	0	46	100	
FA	1	1.0	56	53.3	27	25.7	18	17.1	3	2.9	105	100	
OFR	2	3.6	28	50.9	10	18.2	14	25.5	1	1.8	55	100	
CE	1	0.3	71	17.2	28	7.1	39	9.8	51	26.8	190	100	
Total	5	1.3	176	44.4	79	19.9	81	20.5	55	13.9	396	100	

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional

Findings reveal that on crop post harvest techniques, Farmers exposed to Focal Area approach had some knowledge and skills (53.3%), under the somewhat knowledgeable category; Farmers exposed to On- Farm Research (50.9%); Farmers exposed to Farmer Field Schools (45.7%) and Conventional Extension (17.2%). With regard to post-harvest storage, simple technologies with small investments can make a big difference. Small holder farmers with limited access to dry and sanitary storage and cold chain facilities often suffer post harvest food losses that can range from 20 per cent to more than 30 per cent of their crop yields. Furthermore, without crop storage systems, farmers are usually compelled to sell their entire crop immediately at the time of harvest when market prices are much lower than levels possible several months after harvest (Kader & Rolle, 2004).

4.4.8 Use of Commercial Chemicals for Storage of Crops

Use of commercial chemicals is a common practice in the control and treatment of diseases and pests in crops. Assessment was particularly done on the knowledge and skills on the use of commercial chemicals in controlling insect pests mainly weevils and Greater Grain Borer

in Maize and Beans. Table 23 shows the findings on the knowledge and skills on the use of commercial chemicals in the storage of crops.

Table 23:
Use of Commercial Chemicals for Storage of Crops (n=396)

Exten	Ve	ery	Som	ewha	No	t sure	Ver	y little	No	Know	Tota	al
App.	kr	ow	t Kr	ow			Kno	ow				
	f	%	f	%	f	%	f	%	f	%	f	%
FFS	0		22	47.8	12	26.1	11	23.1	1	2.2	46	100
FA	1	1.0	40	38.1	34	32.4	25	23.8	5	4.8	105	100
OFR	3	5.5	23	41.8	8	14.5	21	38.2	0	0	55	100
CE	1	0.5	82	43.2	26	28.9	28	19.6	53	27.9	190	100
Total	5	1.2	167	42.2	80	20.2	85	21.5	59	14.9	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Results show that 43.4 percent of the participants had some knowledge and skills, while about 56.4 percent had little or no knowledge and skills on the use of commercial chemicals.

4.5 Knowledge and Skills on Livestock Production

Livestock production is useful in the provision of meat, milk and hides and skins among other products. Appropriate technologies to improve dairy production and household food security are crucially needed and that smallholder dairying is clearly a positive activity in a food security programme (Mbagaya, Odhiambo & Oniang'o, 2004). Knowledge and skills on various aspects helps to boost livestock productivity among farmers. In the research the knowledge and skills on livestock feeding, disease control, breeding management and population statistics were studied.

4.5.1 Knowledge and Skills on Livestock Feeding

Productivity of livestock depends among other factors on feeding management. The knowledge and skills on livestock feeding is therefore important in enhancing the type and quality of feeds as well as the actual activity of feeding which includes the feeding regimes, watering timeliness, herd hygiene among other parameters. Table 24 shows the knowledge and skills on livestock feeding.

Table 24:

Knowledge and Skills on Livestock Feeding (n=396)

]	Knov	vledge l	evel					
Exten	Vei	y	Som	ewhat	No	t sure	Vei	ry little	No	Know	To	tal
App	kno	w	Kno	W			Kn	ow				
	f	%	f	%	f	%	f	%	f	%	f	%
FFS	2	4.3	15	32.6	19	41.3	9	19.6	1	2.2	46	100
FA	8	7.6	44	41.9	32	30.5	19	18.1	2	1.9	105	5 100
OFR	1	1.8	30	54.5	6	10.9	18	32.7	0		55	100
CE	4	2.8	56	39.2	30	21.0	52	36.4	48	0.7	190	100
Total	15	3.8	145	36.6	87	22.0	98	27.4	51	12.9	396	5 100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Results indicate that 40.4 percent of the farmers are knowledgeable (very knowledgeable and knowledgeable) in livestock feeding techniques, while about 60 percent have little or no knowledge. On Farm research approach had the highest knowledge and skills on livestock feeding (54.5%). Overall only 36.6 percent of the respondents had the knowledge and skills on livestock feeding under the somewhat knowledgeable category.

4.5.2 Knowledge and Skills on Livestock Disease Control

Livestock diseases affect not only the state of health of the animals but also the ability to digest and convert feeds into the desired products including milk ,beef ,wool, hides and skins among others. Knowledge and skills on diseases is therefore a useful component in reducing

or controlling livestock diseases. Table 25 gives the findings on the knowledge and skills on livestock disease control.

Table 25:
Knowledge and Skills on Livestock Disease Control (n=396)

					Know	ledge le	vel					
Exten	Vei	ry	Son	1e	Not	sure	V	ery	No	Know	Tota	al
App	kno)W	wha	ıt			little	Know				
			Kno	w								
			f	%	f	%	f	%	f	%	f	%
	f	%										
FFS	1	2.2	14	30.4	18	39.1	11	23.9	2	4.3	46	100
FA	1	1.0	27	25.7	29	27.6	26	24.8	22	21.0	105	100
OFR	21	38.2	6	10.9	24	43.6	4	7.3	0	0	55	100
CE	2	1.1	30	15.8	36	18.9	64	33.7	58	30.5	190	100
Total	25	6.3	77	19.4	107	27.0	105	26.5	82	20.7	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Overall, only 25.7 percent of all the respondents were very knowledgeable and somewhat knowledgeable, while 74.3 percent had little or no knowledge and skills on disease control. On the extension approaches, farmers who had participated in the On-Farm Research had the highest knowledge and skills on livestock disease control (38.2%), followed by Farmer Field Schools (30.4%) and lastly Focal Area (25.7%). Farmer who had participated in Conventional Extension had the lowest knowledge and skills (15.8%).

4.5.3 Farmers Knowledge and Skills on Livestock Breeding Management

Knowledge and skills in livestock breeding is an important tool in ensuring that there is replacement of existing old stock but also serves as a means of improving or maintaining the genetic make-up of future cows. Table 26 shows the knowledge and skills on livestock breeding management.

Table 26:
Knowledge and skills on Livestock Breeding Management (n=396)

Extension Approach	Ve kn	•	Son wha	at	No	t sure	Ver little Kno	e	No	Know	Tota	al
	f	%	f	%	f	%	f	%	f	%	f	%
FFS	1	2.2	20	43.5	9	19.6	15		1	2.2	46	100
							32.6	5				
FA	5	4.8	29	27.6	31	29.5	37		3	2.9	105	100
ra							35.2	2				
OFR	0	0	22	40.0	8	14.5	24		1	1.8	55	100
OFK							43.6	5				
CE	2	1.1	31	16.3	40		67		50	26.3	190	100
	8	2.0	102	,	21.	1	35.3	3	55	13.9	396	100
Total			25.8	3	88		143					
					22.	2	36.1					

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Overall the Knowledge and skills on livestock breeding is fairly low among the farmers (2%) and (25.8%) in the very knowledgeable and knowledgeable categories, implying that 72.2 percent of the farmers had little or no knowledge and skills at all.

4.6.6 Comparison of influence of extension approaches in respect to farmers Knowledge and Skills on Experiments

Findings in Table 65 show that in all the four farmer categories a majority of them have not conducted own experiments. The findings are consistent with other studies which point to the fact that as with poverty-focused farmer participatory research programmes conducted elsewhere, the very poorest were usually too preoccupied with survival and solving day-to-day crises to commit themselves to a programme of participatory agricultural experimentation over several seasons (Martin and Salmon, 1996; Kassaye et al., 1998).

Results also showed that 100 (29.3%) are knowledgeable on how to carry out own experiments on crop/livestock varieties, while 153(44.9%) are not knowledgeable with another 26(7.6%) being completely not knowledgeable. The results are contrary to studies by Rusike, Twomlow, Freeman and Heinrich (2006) that information generated in the experiments (trials) enables farmers to revise their subjective beliefs about the profitability of the new technology and to decide whether or not to continue using it and what resources to allocate to it. Similarly the results revealed that 147 farmers (43.2%) are not Knowledgeable on fertilizer trials. Only a small percent 28.2 and 4.1 are knowledgeable and very knowledgeable respectively. For indigenous technical knowledge (ITK) findings showed that 124 farmers (36.8%) have Knowledge and skills on experiments related to; while only 88 (26.1%) are knowledgeable on the same. The results confirm studies by Duveskog et al. (2002) that local innovations can be as effective, if not more, as research generated technologies in improving livelihoods of rural people. Other studies have shown that through group interactions, FFS participants sharpen their decision-making abilities, and are empowered by learning leadership, communication, and management skills (Van Defliert 1993). FFS have remained separate activities implemented in addition to the regular agricultural extension activities. The FFS brings together concepts and methods from agro ecology, experiential education and community development. As a result, hundreds of rice

farmers in countries such as China, Indonesia, Philippines and Vietnam were able to reduce the use of pesticides and improve the sustainability of crop yields.

4.6 Knowledge and Skills on Farmer's Own Experiments

This section provides findings of knowledge and skills on farmers own experiments. The specific experiments investigated included: new crop/livestock varieties, use of fertilizers and Indigenous Technical Knowledge (ITK). Studies have shown that farmers carry out experiments sometimes by evaluating the performance of different technological options in a similar environment by conducting controlled experiments that compare techniques, referred to as adaptive experiments (Rhoades & Bebbington, 1991).

4. 6.1 Experiments Involving New Crop/Livestock Varieties

Farm experimentation involved assessing the knowledge and skills of farmers in conducting simple comparisons, for example, comparing maize varieties H614, H628, H512, local varieties and so on. Table 27 shows the results of knowledge and skills on experiments involving crop/livestock varieties.

Table 27:

Experiments Involving Crop/Livestock Varieties (n=396)

Extension	Ve	ery	Sor	newh	Not s	ure	Ver	y little	No	Know	Tota	ıl
Approach	kn	ow	at I	Know			Kn	ow				
	f	%	f	%	f	%	f	%	f	%	f	%
FFS	1	2.2	15	32.6	17	37	10	21.7	3	6.5	46	100
T.4	2	1.9	31	29.5	24		39	37.1	9	8.6	105	100
FA					22.9							
OED	0	0	10	18.2	13		30	54.5	2	3.6	55	100
OFR					23.6							
CE	0	0	24	12.6	47		62	32.6	57	30.0	190	100
CE	3	0.7	80	20.0	24.7		141		71	17.9	396	100
Total					101		35.6	5				
					25.5							

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Finding in Table 28 show that about 20 percent of the farmers had some knowledge and skills on crop and livestock varieties experiments, while over 80 percent had very little or no knowledge and skills. Farmers exposed to both FFS and FA showed better ability to conduct research.

4.6.2 Knowledge and Skills on Experiments Involving the Use of Fertilizers

Assessment was done on the knowledge and skills involving fertilizers included the use of applying varying rates of fertilizers. For example, chicken manure combined with DAP; compost combined with DAP at varied rates; and Farm Yard Manure used solely with topdressing of CAN. Table 28 shows the results of knowledge and skills on fertilizers experiments.

Table 28:

Experiments Involving Fertilizer Trials (n=396)

Extension Approach	Ver kno	•	Son wha Kno	at	Not	sure	Ver Kno	y little ow	No	Know	Tota	al
	f	%	f	%	f	%	f	%	f	%	f	%
FFS	6	13.0	7	15.2	21	45.7	9	19.6	3	6.5	46	100
FA	2	1.9	36	34.3	23	21.9	36	34.3	8	7.6	105	100
OFR	1	1.8	12	21.8	11	20.0	26	7.3	5	9.1	55	100
CE	1	0.5	21	11.0	48	25.3	67	35.3	53	27.9	190	100
Total	10	2.5	76	19.2	103	26.0	138	34.8	69	17.4	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

The results show that 21.7 percent of the farmers had knowledge and skills on experiments involving fertilizer trials, while about 78.3 percent had little or no knowledge.

4.6.3 Knowledge and Skills on Experiments Involving ITK

Experiments assessed under ITK involved the use of plant extracts, ash of certain tree species and their effectiveness in controlling insect pests like stalk borer in maize and vegetables.

Results in Table 29 show the Knowledge and skills on carrying out experiments involving Indigenous Technical Knowledge (ITK) by extension approach.

Table 29:
Knowledge and Skills on Experiments about ITK (n=396)

Extension	Ve	ry	Son	newh	Not	sure	Ver	y little	No		Tota	al
Approach	kne	ow	at I	Know			Kno	ow	Kn	owledg		
	f	%	f	%	f	%	f	%	e		f	%
									f	%		
FFS	1	2.2	26	56.5	7	15.2	8	17.4	4	8.7	46	100
FA	6	5.7	32	30.5	24	22.9	30	28.6	13	12.4	105	100
OFR	2	3.6	11	20.0	14	25.5	26	47.3	2	3.6	55	100
CE	6	3.2	18	9.4	48	25.3	53	27.9	65	34.2	190	100
Total	15	3.8	87	22	93	23.5	117	29.5	84	21.2	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Results show that only 29.6 percent were knowledgeable on experiments involving ITK, while 74.2 percent had no knowledge. However when a comparison was made among the extension approaches, Farmer Field Schools had the highest (56.5%). The results agree with Wiebers (1993) that participatory training and hands-on experimentation are a key principle of FFS and the purpose of the training is to make the graduates confident-pest experts, self-teaching experimenters and effective trainers of other farmers.

4.6.4 Influence of Own Experiments on Farm Productivity

Farmers are concerned with developing solutions that work under their particular conditions by conducting experiments on their farms. It has been documented that many 'improved'

technologies being promoted by many agricultural research centres actually originate from farmers (Sounder, 1980). Table 30 shows the influence of own experiments on farm productivity as a result of knowledge and skills on conduct of field experiments.

Table 30:
Influence of Own Experiments on Farm Productivity (n=396)

FA 43 41.0 14 13.3 48 45.7 105 100 OFR 10 19.6 17 33.3 24 47.1 51 100	Extension	Increa	sed Rei	mained	Dec	reased	Tota	1
FFS 8 76.1 4 8.7 7 15.2 46 100 FA 43 41.0 14 13.3 48 45.7 105 100 OFR 10 19.6 17 33.3 24 47.1 51 100	Approach		Cor	nstant				
FA 43 41.0 14 13.3 48 45.7 105 100 OFR 10 19.6 17 33.3 24 47.1 51 100		f	% f	%	f	%	f	%
OFR 10 19.6 17 33.3 24 47.1 51 100	FFS	8 70	6.1 4	8.7	7	15.2	46	100
	FA	43 4	1.0 14	13.3	48	45.7	105	100
CE 51 26.8 24 12.6 111 58.4 190 10	OFR	10 1	9.6 17	33.3	24	47.1	51	100
	CE	51 2	6.8 24	12.6	111	58.4	190	100
Total 112 28.3 59 14.9 190 48.0 396 10	Total	112 2	28.3 59	14.9	190	48.0	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Results in Table 30 show that 28.2 percent of the farmers had their farm productivity increased as a result of conducting experiments; 14.9 percent remained constant while 48 percent had a decrease. The results are consistent with empirical studies of the impact of FFS on human and social capital development which has often shown increased productivity associated with experimentation among FFS farmers (Davis, 2003).

A similar study by Ramaswamy and Latif for Bangladesh notes that FFS farmers had 8-13 percent rice yields higher than their non- FFS counterparts. Similarly, high impacts on farm profits had also been reported in studies conducted in Vietnam, Ghana, Cote d' Ivore and Burkina Faso (Kenmore, 1997). The Food and Agriculture Organization (2000) cites increases in profits by 40 percent in Sri Lanka, 30 percent in Thailand and 10-25 percent in China due to FFS. The results also concur with a study on FFS in Kenya which showed that

food self-sufficiency and security in the village is achievable when all key players in the agricultural sector work hand in hand with the farmers to address these issues and that yield increases of maize from 5 to 19 bags have been recorded as a result of the FFS Extension approach (Mweri, 2001).

4.7 Knowledge and Skills on Agricultural Support Services

Marketing of agricultural produce and products is critical to increasing agricultural productivity and commercialization of enterprises so that farming is perceived as a business. Generally, marketing chains for the different commodities are long, not transparent and consist of many players making them inefficient and unresponsive to producer needs. Table 31 shows some of the credit sources that were available to the farmers in the study area.

Table 31:
Sources of Credit Available to Farmers (n=396)

Source	F	%
Cooperatives	120	30.3
Banks	50	12.6
Group Savings	198	50.0
None	28	7.1
Total	396	100

Although a study by Wangia (2001) demonstrated that credit to farmers is an important instrument in improving productivity through enhancing of adoption of improved agricultural technologies by smallholder farmers, the results from this study indicate that 50 percent of the respondents source credit from group savings. This is followed by Cooperative societies (30.3%).

Respondents reported that the use credit to purchase farm inputs especially fertilizer, seeds and chemicals especially insecticides for storing grains. Studies have shown that farmers who use chemical/synthetic farm inputs are significantly more indebted, especially in developing countries (Eyhorn *et al.* 2005; Shah *et al.* 2005). For example, in Central India, cotton farmers bought inputs with loans at annual interest rates between 10-15 per cent (from cooperative societies) to over 30 per cent (from private money lenders). By contrast, those

engaged in organic agriculture were far less likely to take loans owing to lower production costs and greater use of on-farm inputs (Eyhorn, Mader & Ramakrishnan, 2005)

4.7.1 Knowledge and Skills on Credit Facilities

Credit is one key factor in farm production and knowledge and skills on the type of credit, sources and availability are critical for farmers. Findings in Table 32 show the knowledge and skills on credit facilities in the study.

Table 32: Knowledge and Skills on Credit Facilities (n=396)

Exten	Vei	ry	Som	ewhat	Not	sure	Ver	y little	No		Tota	al
App	kno	ow	Kno	W			Kno	owledg	Kn	owledge		
	f	%	f	%	f	%	e		f	%	f	%
							f	%				
FFS	3	6.5	30	65.2	9	19.6	4	8.7	0	0	46	100
FA	8	7.6	60	57.1	21	20.0	15	14.3	1	1.0	105	100
OFR	1	1.8	20	36.4	15	27.3	18	32.7	1	1.8	55	100
CE	2	1.1	82	43.2	26	13.7	30	15.8	50	26.3	190	100
Total	14	3.5	192	48.5	71	17.9	67	16.9	52	13.1	396	100

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Results in Table 31 show that Farmers Field School farmers had the highest knowledge and skills 65.2%) on credit facilities. Overall the results indicate that 52 percent of farmers had knowledge and skills on credit facilities, while 42 percent had little or no knowledge. Although the knowledge level as per the findings was high, study has shown that access to credit remains a key constraint in farm productivity.

According to GoK (2010) access to bank credit by farmers is still a major challenge to agricultural development despite the fact that Kenya has a relatively well-developed banking system given that risks associated with agribusiness coupled with complicated land laws and tenure systems that limit the use of land as collateral make financing agriculture unattractive to the formal banking industry. The cost of bank credit and the limited number of banks in rural areas are some of the factors that make it difficult for farmers to access bank credit.

4.7.2 Knowledge and Skills on Marketing of Farm Produce

A study has shown that in the majority of developing countries, poor rural people are both sellers of food commodities and buyers of foodstuffs, at different times of the year. Typically, they sell immediately after harvest, usually at very low prices, to meet their immediate cash requirements, and buy food in the months prior to the following harvest, usually at higher prices, to meet their food needs (IFAD, 2010b). Knowledge and skills on marketing is therefore an important element in farm productivity. Table 33 shows results on knowledge and skills on marketing of farm produce.

Table 33:

Marketing of Produce by Extension Approach (n=396)

Exten App	Ve	ry know	Son wha		Not	tsure		ry little owledg	No Kn		Tota	al
	f	%	f	%	f	%	e f	%	e f	%	f	%
FFS	6	13.0	20	43.5	10	15.2	8	21.7	2	4.3	46	100
FA	3	2.9	58	55.2	25	23.8	18	17.1	1	1.0	105	100
OFR	1	1.8	17	30.9	19	34.5	17	30.9	1	1.8	55	100
CE	2	1.1	59	31.1	42	22.1	38	20.0	49	25.8	190	100
Total	12	3.0	154	38.9	96	24.2	81	20.5	53	13.4	396	100
Tutal	12	3.0	134	30.9	90	∠ 1 .∠	01	20.3	33	13.4	390	

Key: FFS- Farmer Field Schools; FA- Focal Area, OFR-On Farm Research; CE-Conventional Extension

Focal Area approach is had (55.2%); Farmer Field Schools (43.5%); On- Farm Research (30.9%) and Conventional Extension (31.3%) of farmers were in the somewhat knowledgeable category. Findings agree with other studies which indicate that Extension, as an essential part of an agricultural knowledge and information system, should take into account not only the status of other services to farmers, but also that of the markets, prices and infrastructure (Ro'ling, 1995). Review study by Tegemeo Institute revealed that in the year 2004, about 39 percent of farmers sought credit nationally (Kibaara, 2006).

The results show that 3 percent and 38.9 percent and of the farmers had knowledge and skills on marketing of produce in the very knowledgeable and somewhat knowledgeable categories, while 57.1 percent of the farmers had little or none on marketing of produce. The results concur with Scoones and Thompson (1994) who documented that a large proportion of small-holder farmers are not able to engage with profitable markets for agricultural products, nor effectively engage with local agricultural service providers.

4.8 Analysis of Hypotheses

In comparing the influence of the three extension approaches, four hypotheses were derived from objective as stated herein:

All the hypotheses I, II, III and IV were tested using independent t- test at probability $\alpha = 0.05$ significance level.

4.8.1 Test of Hypothesis I

Ho₁ There is no statistically significant influence of Farmer Field Schools

Approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

Table 34 presents the results of a comparison between Farmer Field Schools and conventional extension regarding the influence on acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region, Kenya.

Table 34:
t-test for the comparison of Farmer Field Schools and Conventional Extension

Source	Means	n	df	Std. Error	t	Sig. (2-
		(236)		Difference		tailed)
FFS	2.7823	46	2	.06951	-1.587	0.014
Conventional	2.9053	190		.03788		
Extension						

From the Results in Table 36, $p \ge 0.014$ is less than alpha < 0.05. This indicates therefore that, there is a significant difference in the means of farmers exposed to FFS and Conventional Extension approaches. The null hypothesis was therefore rejected. This implies that Farmer Field Schools approach significantly influences the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya. The findings mean that when a comparison was made between farmers exposed to FFS and Conventional Extension, those exposed to FFS had more knowledge, skills and productivity that those of Conventional Extension.

The findings mean that farmers exposed to FFS had more knowledge on farm operations including: the use of fertilizers and manures, soil testing, the choice of type and varieties of seeds to plant, weed control and crop spacing. The results also mean that farmers exposed to FFS had higher knowledge and skills on credit facilities, had higher family farm incomes and higher farm productivity as compared to those exposed to Conventional Extension approach. On experiments farmers exposed to FFS had higher knowledge and skills involving crop/livestock varieties as well as livestock breeding.

On experiments the findings mean that farmers exposed to Farmer Field Schools had the higher knowledge and skills on experiments involving crop/livestock varieties and Indigenous Technical Knowledge (ITK) as compared to those exposed to Conventional Extension.

4.8.2 Test of Hypothesis II

H_{O 2}: There is no statistically significant influence of Focal Area Approach on the acquisition of knowledge and skills for improved farm productivity and food security in the Lake Victoria region of Kenya.

Table 35 presents the results of a comparison between Focal Area and Conventional Extension regarding the influence on acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

Table 35:

T-test for the comparison between Focal Area and Conventional Extension

Source	Means	n	df	Std. Error	t	Sig. (2-
		(295)		Mean		tailed)
Focal Area	3.0611	105	2	.07809	2.000	0.047
Conventional	2.9053	190		.03788		
Extension						

The results show that $p \ge 0.047$ which is less than alpha, meaning that there is a statistically significant difference in the means of farmers exposed to the Focal Area approach and Conventional approach hence we reject the null hypothesis. This implies that Focal Area extension approach significantly influences the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya. The findings mean that when a comparison was made between farmers exposed to Focal Area and Conventional Extension, those exposed to Focal Area had more knowledge, skills and productivity that those of Conventional Extension. The farmers exposed to Focal Area were more knowledgeable than those exposed to Conventional Extension on farm operations including: ploughing, crop post harvest handling techniques, marketing of produce and experiments involving fertilizers trials.

4.8.3 Test of Hypothesis III

H_{O3} There is no statistically significant influence of On -Farm Research

Approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

Table 36 presents the results of a comparison between On- Farm Research and Conventional Extension regarding the acquisition of knowledge, skills and productivity for household food security.

Table 36:

T-test for the Comparison between On -Farm Research and Conventional Extension

Source	Means	n	df	Std. Error	t	Sig. (2-tailed)
		(245)		Mean		
On -Farm Research	2.8568	55	2	.05273	767	0.44
Conventional	2.9053	190		.03788		
Extension						

From the Results, p=0.44 which is greater than alpha. Meaning, there is a significant difference in the means of farmers exposed to On-Farm Research extension approach and the conventional extension approach; hence the null hypothesis was accepted (failed to reject). This implies that On-Farm Research extension approach does not necessarily influence the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya. Although the findings show farmers exposed to On-Farm Research approach had higher knowledge on certain farm operations such as livestock feeding, livestock management and control of livestock diseases, when farmers On-Farm Research were compared to those exposed to Conventional Extension the former did not have statistically higher knowledge and skills than the latter.

4.8.4 Test of Hypothesis IV: Multiple comparison

H_{O4} There is no statistically significant influence of Farmer Field Schools, Focal Area and On-Farm Research Approaches combined on the acquisition of knowledge and skills for improved farm productivity and food security in the Lake Victoria region of Kenya.

An independent t-test was done to find out the statistical significance when all the three approaches were combined against conventional extension approach.

Table 37:

T-test for the comparison between the three approaches combined and Conventional Extension

Source	Means	n	df	Std. Error	t	Sig. (2-
		(396)		Mean		tailed)
More than One	2.4975	206	2	.08237	-5.025	.000*
approach			2		-3.023	.000
Conventional	2.9053	190		.03788		
Extension						

From the results in Table 37 it can be seen that (p=0.000). This p value is less than 0.05 (p=0.000), meaning the difference is strongly significant, which implies that there is a statistical significance difference between means of all the three approaches combined and Conventional Extension. The null hypothesis was therefore rejected. This implies that all the three approaches combined significantly influences the acquisition of knowledge and skills for improved productivity and household food security in the Lake Victoria region of Kenya.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the findings of the study, conclusions and recommendations of the study. It has been organized to offer a precise summary of the objectives, design, population, and data analysis, summary of key findings, conclusions, recommendations and suggestions for further research.

5.2 Summary of the Study

The study had the following objectives:

- i). To determine the status of changes in food production under the influence of Farmer Field Schools, On-Farm Research and Focal Area extension approaches in the Lake Victoria region of Kenya.
- ii) To determine the influence of Farmer Field Schools extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- iii) To determine the influence of Focal Area extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.
- iv) To determine the influence of On-farm Research extension approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

v). To determine the influence of Farmer Field Schools, Focal Area and On-Farm Research Approaches combined on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

The research adopted a cross sectional design. This design involves collecting data from a predetermined and specific population, allows the researcher to collect data at one point in time, thus enabling the respondents to describe a phenomenon, in this case selected alternative extension approaches and their effect on agricultural knowledge, skills and household food production. It was carried out in three Sub- Counties in the Lake Victoria region basin of Kenya, namely: Bondo, Nyamira and Rachuonyo. The Sub- Counties were purposively selected since they were representative of the larger Lake Victoria Region of Kenya. A sample size of 396 small-scale farmers was selected using the probability formula by Mugenda and Mugenda (2003). A face – to face administration of the questionnaire was done to collect data from the sampled farmers in the study area. Data was analyzed using both descriptive and inferential statistics.

The key findings and conclusions of this study are based on the synthesis of narratives and responses from the study respondents and analysis of the Research Question and the hypotheses:

Research Question: What are the changes in food production under the influence of Farmer Field Schools, On-Farm Research and Focal Area extension approaches in the Lake Victoria region of Kenya?

Hypothesis I: There is no statistically significant influence of Farmer Field Schools

Approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

Hypothesis II: There is no statistically significant influence of Focal Area Approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

Hypothesis III: There is no statistically significant influence of Farmer Field Schools Approach on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

Hypothesis IV: There is no statistically significant influence of Farmer Field Schools, Focal Area and On-Farm Research Approaches combined on the acquisition of knowledge and skills for improved farm productivity and household food security in the Lake Victoria region of Kenya.

In general findings of this study revealed that all the three extension approaches had contributed to the improvement in farm productivity to some extent as follows:

Those FFS participants had the highest percent (76) of the participants having increased incomes, while Conventional Extension had the highest number with decreased incomes (60.5%) over the last five years. The findings show that 63.04 percent of the farmers exposed to Farmer Field Schools had their yields increased; followed by Focal Area (45.7%); On -Farm Research (20%). Within the 10 year period The findings show that 63.04 percent of the farmers exposed to Farmer Field Schools had their yields increased; followed by Focal Area (45.7%); On -Farm Research (20%); while conventional Extension (26.8%). Most of the Conventional Extension participants (57.9%) had their yields reduced.

Findings revealed that: first that farmers exposed to Focal Area Extension approach had the highest (56.2%) knowledge and skills on ploughing. Secondly, Farmer Field Schools contributed most to the acquisition of knowledge and skills on the use of fertilizers and manures manure (69.6%) compared to the other two Extension approaches. Thirdly, farmers exposed to Farmer Field Schools had highest knowledge and skills on soil testing (63%) as compared to the other two approaches; Fourthly, farmers exposed to Farmer Field Schools had the highest knowledge and skills on the choice of type and varieties of seeds to plant (58.7%) as compared to the other two approaches; fifthly, on weed control results showed that farmers exposed to Farmer Field Schools was highest (73.9%) as compared to the other two approaches; Sixthly, for knowledge and skills on crop spacing, farmers exposed Farmer Field Schools was highest (58.7); seventhly, on crop post harvest handling techniques farmers exposed to Focal Area approach had the highest knowledge and skills (53.3%) as compared to the other two approaches; and lastly, farmers exposed to On- Farm Research had

the highest knowledge and skills on the use of commercial chemicals towards the storage of crops.

Findings revealed that on livestock feeding: firstly, farmers exposed to On- Farm Research had the highest knowledge and skills (54.5%) as compared to the other two approaches; Secondly, farmers exposed to On- Farm Research had the highest knowledge and livestock for the management and control of livestock diseases; Thirdly on livestock breeding management Farmer Field Schools had the highest knowledge and skills (43.5%) as compared to the other two approaches.

On Experimentation, the research showed that participants exposed to Farmer Field Schools had the highest knowledge and skills (32.6%) on experiments involving crop/livestock varieties; secondly that farmers exposed Focal Area had highest knowledge and skills (34.3%) on experiments involving fertilizers trials; thirdly, that farmers exposed to Farmer Field Schools had the highest (56.5%) knowledge and skills on experiments involving Indigenous Technical Knowledge (ITK) as compared to the other two approaches.

Findings revealed that knowledge and skills on marketing of produce was highest (55.2%) among participants exposed to Focal Area approach; and secondly farmers exposed to Farmer Field Schools had the highest knowledge and skills on credit facilities as compared to the other two approaches.

5.3 Conclusions

The conclusions of this study are derived from the findings the research Question and the four hypotheses as follows:

- a) Farmer Field Schools had the highest number of respondents with the highest income as compared with the other two approaches, followed by Focal Are and lastly On Fram research and that over the last five and 10 years FFS participants had a majority (76.1%) of the farmers having increased incomes.
- b) The results indicate that there was a statistically significant influence of Farmer Field Schools on knowledge and skills at alpha 0.05 (p < 0.05), meaning that the null hypothesis was rejected. The study concludes that Farmer Field Schools:

- i) Contributed most to the acquisition of knowledge and skills on the use of fertilizers and manures manure, soil testing, choice of type and varieties of seeds to plant, weed control and crop spacing and crop post harvest handling techniques.
- ii) Contributed most to improvement in farm productivity.
- iii) Contributed most to family farm incomes
- c) The hypothesis test yielded an alpha value of 0.05 (p < 0.05), meaning that the null hypothesis was rejected. This leads to the conclusion that Focal Area approach exposure of farmers to statistically knowledge, skills and productivity for household food security in the Lake Victoria region of Kenya.

The study concludes that Focal Area approach:

- i) contributed most to the acquisition of knowledge and skills on marketing of farm produce; use of Inorganic Fertilizers; crop postharvest handling technologies; use of commercial fertilizers
- ii) Contributed highest to knowledge and skills on experiments involving crop/livestock varieties and experiments involving fertilizer trials.
- d) Findings on this hypothesis showed that alpha value was 0.05 (p < 0.05), meaning that hypothesis was accepted.

The study concludes that:

- On-Farm Research approach does not contribute significantly to the acquisition of knowledge and skills for improved farm productivity in the Lake Victoria region of Kenya.
- ii) On- Farm Research approach contributed most to knowledge and skills on livestock based technologies: including feeding, livestock for the management and control of livestock diseases.
- e). Findings on the use of a combination of all the three selected approaches showed that alpha value was $0.000 \ (p < 0.05)$, meaning that the hypothesis was rejected. That findings

show that when all the farmers were exposed to a combination of all the three Extension approaches there was a highly significant difference in the means.

The study concludes that a combination of the three alternative approaches influences acquisition of knowledge and skills for farm productivity and household food security in the Lake Victoria region of Kenya.

5.4 Recommendations

The conclusions of this study form a basis of making the following recommendations.

- i) The Ministry of Agriculture should mainstream Farmer Field Schools approach in its national extension programmes. This is because the approach proved to be useful in contributing to the acquisition of agricultural knowledge and skills regarding farm operations, contributed to farm experimentation and also improved farm productivity.
- ii. Kenya Agricultural Research Institute, Other Research Organizations, NGO's, Universities and other private Extension providers should use Farmer Field Schools in technology generation, verification, validation and dissemination of proven agricultural technologies as well as other research outputs to farmers. This is because Farmer Field Schools approach enhances experimentation skills of farmers. The ability of farmers to carry out own experiments on their farms will enable them make good production decisions, including what, when , how and whom to plant for on the farm thereby improving their farm productivity
- iii. The Ministry of Agriculture should use Focal Area approach for disseminating agricultural technologies because it ensures a concentration of extension personnel and resources in a given area and that it contributes to knowledge and skills in agricultural technologies for improved farm productivity. The use of Focal area approach not only creates synergies from the multidisciplinary service providers but also provides efficiency and effectiveness technologically and and in terms of resource utilization.
- iv. On -Farm Research proved that it enhances knowledge and skills in such activities such as ploughing and livestock production, it may be recommended that it be

used for such technologies, nonetheless use of the approaches singly may not be very productive in the acquisition of knowledge, skills and productivity for household food security as evidenced from the findings of this study.

5.5 Suggestions for Further Research

The following are the suggestions for further research

- i) There is need for further research on the influence of Conventional Extension approaches in Kenya. Such a study would take an inventory and analyze the various success factors attributed to the Conventional Extension approaches and also their contribution to the overall agricultural production. Such a study is necessary due the fact that during this study the Conventional Extension respondents showed high responses in some activities which they reported to have acquired from Conventional Extension other than the three approaches under investigation.
- ii) There is also need for further research on studies to measure the relative impact of Farmer Field Schools, On-Farm Research and Focal Area approaches on the yields of a named crop like Maize. Using a model this study would measure the actual yield attributed to the approaches. Such a study would be carried out in varied agro ecological zones and would be useful in documenting the merits of each approach.

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APPENDICES

APPENDIX A: QUESTIONNAIRE

This instrument had been designed to capture relevant information regarding household food production in the study Sub- Counties. The research was purely for academics purposes (PhD, Degree of Egerton University). No financial or material gain is expected to be realized by the researcher from this study. The information gathered from this research was treated with utmost confidentiality. To ensure confidentiality of the information provided, the respondents were not indicated their names in the form.

A.	SECTIO	ON 1: GENI	ERAL INFOR	MATION	[
Da	te of	intervie	w	Pro	vince	Sub-	County	y
Div	vision				Location			Sub-
loc	ation		Village	2	Date			
В.	RESPO	NDENTS'	SOCIAL – EC	CONOMIC	C PROFILE			
	1. Sex	of responde	nt. (1)-Male	(2). –Fer	nale			
	2. Age	of responde	ent					
		a. R	Relationship of	responder	nt to the house	hold head (1.)	- Self	(2)
		Husband	(3) – wife (4)	1) -Parent	(5)-child	(6) Gra	ındchild	(7) -
		Others						
	3. Edu	cation level	of the respo	ndent				
	(1)-None	(2) - Primary	(3) -See	condary (4) -	Post secondar	y.	
	4. Farı	n size in ac	eres (1) Owned		(2) -Leased	d		
	5. Lan	d tenure syst	tem: (1)- owne	d with title	e deed (2)- ow	ned without ti	tle deed	
	(3)- Leased	(4) -communal	(5)-oth	ers.			
	6. Size	of family	(1) - above 10) persons	(2) 5-10 perso	ons (3) Below	v 5 person	ıs
	7. Hov	v many fan	nily members d	irectly dep	end on your fa	mily owned fa	rm?	
	8. Wh:	at is your inc	come /year fron	n this fami	ly farm?			
	(1) Less than I	Ksh. 5000.00	(2) Ksh.5,	000.00-10,000	.00 (3) Over	ksh.10, 00	00.00

9. Has your income from this farm increased or decreased over the last 5 years

(i	 (i) increased (ii) remained the same (iii) decreased a. If decreased, what reasons do you give for the decrease? (i) Loss of crop yields (ii) reduced acreage under crop (iii) poor market (iv) other specify. 											
В	B. SECTION II: FARM PRODUCTION											
	10. Have you participated in any Extension approach in your area?(i) No(ii) Yes											
	11.	How long	did you particip	oate in	the ext	ension approa	ach? -		_			
	a. Which Extension approaches have you participated in and what activities did you undertake? TICK <i>appropriately</i>											
		Nature			Wh	at is it doing	g?					
		Name of	Field		О	Tra		Learn		Oth		
	Extens	ion	day/ farm	n-	Farm	ining/	ing	how to	ers			
	approa	ich	demonstration	trials	S	Capacity	use	new		(Sp		
						building	tech	nology	ecify)			
		1.Farmer										
	Field So	chools										
		2.Focal										
	Area ap	proach										
		3. On-										
	Farm R	esearch										
	,	4										
	Conven	ntional										
	Extensi	on										
1:	2.	Which Ex	tension approac	h has l	nelped	you to impro	ove yo	our farm p	roduction	on?		
TI	ICK one		. 1				•	1				
	a.	Farmer Fi	eld School ()									
	b.	On- farm	, ,									
	c.		a Approach ()									
	d	d Conventional Extension ()										

13. T	o what extent	has the Ext	ension appr	oaches a	above help	ped to	improve	e your food
produ	ction?							
	(i)Very much	(ii) much	(iii) not s	ure (iv) Not mı	ıch	(v) No	t at all
14. W	hat do you think	can be don	e to improve	e your fo	od produc	tion sta	tus? (Li	st in priority
order))							
	i			ii				
	iii			iv				
15. W	hat food crops d	o you grow	on your farn	n? Rank t	them with	no. 1, tl	ne most	important in
house	hold food produc	ction?						
	i			ii				
	iii			iv				
	i) Lack of seed and diseas (2006-201	es iv) Other	ck of knowl s (Specify)				-	
	Type of crop							
	Maize							
	Cassava	ı						
	Vegetab	ol						
	es							
	Beans							
	Sorghur	n						
	Others							
	(spe	e						

How many times do you plant the above (Item 18) crops in a year? (i) Once (ii) Twice

(iii) More than twice

cify)

17. What	factors are responsible for	the trend i	n your cro	p production	n over the yea	ars?
(i)	Lack of rains (ii) Lack	k of adequa	ate husban	dry skills	(iii) Poor	seeds (iv)
	Pests and diseases specify				(v)	others
	do you think can be done		•	_		
iii	٠					
	which ONE Extension on to most? Tick ONE Farmer Field School		do you at	tribute imp	provement in	your farm
ii.	On- farm research	()				
iii.	Focal Area Approach	n ()				
iv.	Conventional Extens	ion ()				
C. KN	OWLEDGE and SKILL	S ON LAN	ND PREPA	ARATION		
20. How	much Knowledge and	skills do	you have	on the fo	ollowing reg	arding land
preparation	on on your farm? Tick Of	NE as appro	opriate acc	ording to th	e key provide	ed below the
table.						
K	EY: 1-Very knowledgeable	e; 2-Somev	vhat Know	ledgeable;	3-Not Sure;	4-Very little
K	nowledge; 5- No Knowledg	ge				
	Knowledge and	1	2	3	4	5
	.1.211 13					

Knowledge and skills on land	1	2	3	4	5
preparation					
Tractor					
Ox -drawn plough					
Hand Digging					
Tractor					
Ox -drawn plough					
Hand Digging					
Tractor					

21) Where did you acquire the Knowledge and skills on ploughing? $\textbf{Tick}\ \textbf{ONE}$

i. Farmer Field School	()			
ii. On- farm research	()			
iii.Focal Area Approach	()			
iv.Conventional Extension	()			
22. What do you use to plough your far. (iv) Other specify			wn plough (i	ii) Hand
23 How long have you used the	above me	ethod of	ploughing	(item 25)?
24. Have you sometimes changed to a diffe				yes
25. If yes from which method to another?				
26. How much does it cost to plough 1 (one	e) acre of land	l using the f	ollowing me	thods?
Method of plough	ing			Cost per acre ksh.
Tractor				
Ox -drawn plough				
Hand ploughing				
27. Are there skills you have	gained from	the projec	t you were	
ploughing				methods?
Explain				
D: KNOWLEDGE and SKILLS ON F	ERTILIZEI	R USE		

28. How much knowledge do you have on the following regarding use of fertilizer on the farm? Tick as appropriate according to the key provided below the table.

KEY: 1-Very knowledgeable; 2-Somewhat Knowledgeable; 3-Not Sure; 4-Very little Knowledge; 5-No Knowledge

Knowledge and	1	2	3	4	5
skills on					
fertilizer use					

Farm yard			
manure (Animal			
manure)			
In organic			
fertilizer			
(DAP,CAN,			
NPK,UREA)			
Green Manure			
Compost Manure			
Other (Specify)			
Farm yard			
manure (Animal			
manure)			

29. Where did you acquire the Knowledge and skills on fertilizer use? Tick ONE
i) Farmer Field School ()
ii) On- farm research ()
iii) Focal Area approach ()
iv) Conventional Extension ()
30. Do you use commercial fertilizers or manures on your farm? 1-NO 2-yes
1-10 2-yes
31. If No , why? (i) Lack of money to purchase fertilizers (ii) Lack of knowledge on type of
fertilizer (iii) Lack of animal manure (iv) Other (specify)

If **yes** what type of fertilizer or manures do you use? TICK

TYPE OF FERTILIZER	Tick	How much per acre/Wheelbarrow
Farm yard manure (Animal manure)		
In organic fertilizer		
(DAP,CAN, NPK,UREA)		
Green Manure		
Compost Manure		
Other (Specify)		

32. What is your view about the use of fertilizers? -----

33. Are there skills you have gaine	ea from the pro	oject you were in regarding use of fertilizers	<i>s</i> :
Explain			
34. Do you test your soil?	1-No	2-Yes	
If No why?			
If yes, where do you do the	e soil testing?		
35. How much do you pay for the	soil testing per	sample?	
36. Where did you acquire the Kno	owledge and sk	kills on soil testing? Tick ONE	
i) Farmer Field School	1()		
ii) On- farm research	()		
iii) Focal Area approac	ch()		
iv) Conventional Exte	ension ()		

E: KNOWLEDGDE AND SKILLS ON FIELD OPERATIONS (CROP HUSBANDRY)

37. How much knowledge do you have on the following regarding field operations on the farm? Tick as appropriate according to the key provided below the table.

KEY: 1-Very knowledgeable; 2-Somewhat Knowledgeable; 3-Not Sure; 4-Very little Knowledge; 5- No Knowledge

Agricultural			
Knowledge/Skills			
When and how to			
plough			
Weed control			
How to space			
crops			
Harvesting			
techniques			
Post harvest			
management			
Type and variety			
of seeds to plant			
Amount and type			
of fertilizer to use			

38. Why do	38. Why do you think you don't have enough knowledge on agricultural production on the													
areas shows	n abo	ve?	(i) L	ack	of	inte	rest in	agric	cultural	practio	es (ii)	Lack	of ex	tension
provider	(iii)	I	did	not	go	to	schoo	l to	learn	these	techi	niques	(iv)	Other
specify														
39. Where d	lid you	ı ac	quire	the I	Knov	vledg	ge and	skills	on field	d opera	ions?	Гick О	NE	
	i.		Farr	ner F	ield	Scho	ool ()						
	ii. On- farm research ()													
	iii. Focal Area approach ()													
	iv.		Oth	er									(S	pecify)
40. What ca	ın be d	lone	to in	nprov	e yo	ur a	gricultı	ral pı	oductio	on skills	s?			
(1	List th	em)) i											
	ii													
41.	Have													Officer
visit	visited your farm? (i) No (ii) Yes													
42. Do you	42. Do you get agricultural extension services readily? (i) No (ii) Yes													
43.	What	do	you	think	can	be	done t	o ma	ke you	access	agrici	ultural	advice	e more
read	43. What do you think can be done to make you access agricultural advice more readily?													
Expl	lain													

F. KNOWLEDGDE AND SKILLS ON CROP POST HARVEST HANDLING

44. How much knowledge do you have on the following crop post harvest management on the farm? Tick as appropriate according to the key provided below the table.

KEY: KEY: 1-Very knowledgeable; 2-Somewhat Knowledgeable; 3-Not Sure; 4-Very little Knowledge; 5- No Knowledge

8				_			
Knowledge/Skill	S						
When to harvest							
How to harvest							
How to dr	У						
(Appropriate							
Moisture level)							
How to store	e						
crop							
Which chemical	S						
to apply fo	r						
storage							
How to apply	У						
chemicals and	i						
storage conditions	S						
45. Where did you acquire the Knowledge and skills on crop post harvest? Tick ONE							
i) Farmer Field School ()							
ii) On- farm research ()							
iii) Focal Area approach ()						
iv) Conventional Extension	iv) Conventional Extension ()						
46. What do you do with your crops after harvesting?							
(i) Sell it all (ii) sell some and store some (iii) stores all of it							
47. Do you have a store? (i)	47. Do you have a store? (i) No (ii) yes						
48. Where do you sell your crops? (i) Local market (ii) Co-operative society							
(iii) National Cereals and Produce Board (iv) Middlemen							
(v) Other (specify)							
49. What methods do you	use to pr	eserve you	r crops from	pests like we	evils, Greater		
Grains Borer (Osama) (i) C	hemicals	(ii) ITK	(iii) other spe	ecify			
50. Have you ever suffered losse	es due to j	post harves	t handling (i)	No (ii) Yes			
51.Do you think the losses may	51.Do you think the losses may result to food insecurity? (i) No (ii) Yes						

Agricultural

52. Suggest ways to prevent post harvest losses.

	. How much Knowle		•		•	n on the farm?
	ck as appropriate acco	_	• •			4 17 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
	EY: 1-Very knowleds		Somewhat I	<i>Xnowledgeabl</i>	e; 3-Not Sure	; 4-Very little
Kn	owledge; 5- No Knov	vledge				
Δ	gricultural	1 2	3	4	5	
	nowledge/Skills			•		
	eeds of livestock to					
ke						
	eding					
Br	reeding					
Di	sease control					
54. H	ow many animals do	you keep or	n your farm	?		
	LIVESTOCK TY	PE	N	<u>C</u>		
55. W	There did you acquire	the Knowle	edge and sk	ills on Livesto	ock production?	Tick ONE
i.	Farmer Field Schoo	1 ()				
ii.	On- farm research	()				
iii.	Focal Area approach	h ()				
iv.	Conventional Exten	sion ()			
H FII	ELD EXPERIMENT	TATION S	KILLS			
56. H	ow much skill do yo	u have on f	field experii	mentation on	the farm? Tick	as appropriate
accord	ling to the key provid	ed below th	e table.			
KEY:	1-Very knowledged	able; 2-Son	newhat Kn	owledgeable;	3-Not Sure;	4-Very little
Knowl	ledge; 5- No Knowled	lge				
	Agricultural Knowledge/Skills	1	2	3	4	5
	New crop variety					

G. LIVESTOCK PRODUCTION KNOWLEDGE AND SKILLS

iii.____

/livestock

spp

testing			
Fertilizers/manure			
trial			
Indigenous			
knowledge trial			
New crop variety			
/livestock spp			
testing			
Other (Specify)			

57. I	Have you ever	carried out an	y research tri	al (experiment) on your farm?	'(i)No
	(ii) Yes					

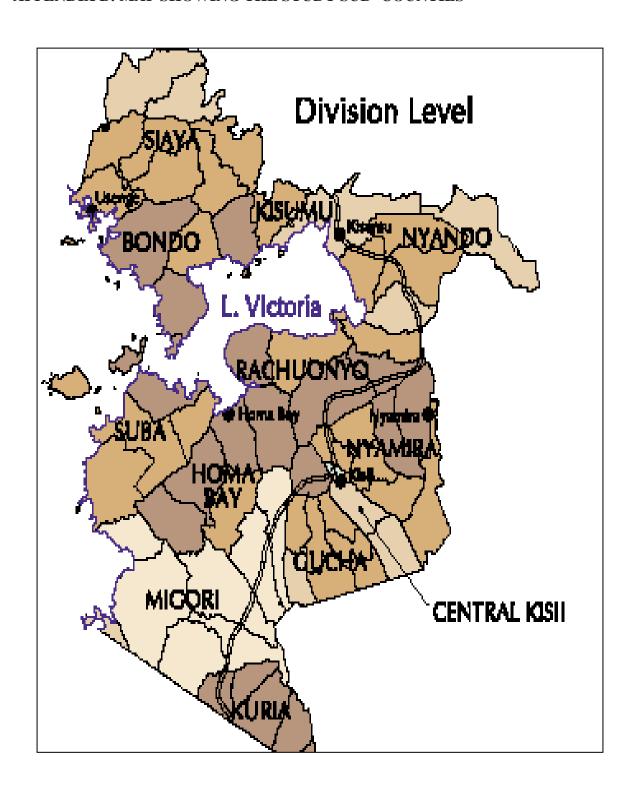
58. If yes, what type of experiment did you conduct on your farm?

Type of research	Type	of	Lesson learnt/
	crop/species	of	preferred treatment
	Livestock		
New crop variety /livestock			
spp testing			
Fertilizers/manure trial			
Indigenous knowledge trial			

	Indigenous knowledge tria	ıl					
59. Where did you acquire the Knowledge and skills on 'Experimentation'? Tick ONE							
	i) Farmer Field School	()					
	ii) On- farm research	()					
	iii) Focal Area approach	()					
	Iv) Conventional Extension	on ()	1				
	did this Research/ Extensionsed (ii) Remained the same		•	our crop/ li	vestock pe	rformance?	
61. Do	you think you can do your o	own 1	esearch?	(i) No	о (ii) Yes	
62. Give your suggestions about research trials on the farm/Extension services.							
	i						

	 How much knowledge do ppropriate according to the keep 	you mave	On the gove	ricultural c	upport carvi	ces? Tick
ար		v provide	_		apport servi	ccs: Tick
	KEY: 1-Very knowledgeab	• -			ole: 3-Not S	Sure: 4-V
	little Knowledge; 5- No Kno		101111011 1111	0,,,,,,,,,	, 0 1,00 2	
	Agricultural	1	2	3	4	5
	Knowledge					
	Credit					
	Input sources (Seeds,					
	fertilizers, chemicals)					
	Market of produce					
	Other sources of					
	information on agri.					
	production					
Wher	re did you acquire the know	ledge &	skills on a	ıgricultural	support ser	rvices? T
E	,			.8		
	i. Farmer Field So	chool ()			
	" O E D	arch ()			
	ii. On- Farm Resea)			
	ii. On- Farm Rese	roach (,			
What	iii. Focal Area App	xtension	()			

APPENDIX B: MAP SHOWING THE STUDY SUB- COUNTIES



APPENDIX C: RELIABILITY RESULTS

Cronbatch's alpha is the most common measure of internal consistency (Reliability). It is most commonly used when there are multiple Likert questions in survey /questionnaire that form a scale and one wishes to determine if the scale is reliable.

The reliability analysis for this study was conducted in SPSS and the results were as follows:

Reliability statistics

Cronbatch's alpha	No. of items
0.878	27

The results show that Cronbatch's alpha was 0.878 which indicates a high level of internal consistency or reliability.

APPENDIX D: RESEARCH PERMIT

PAGE 3 Research Permit No. NCST/RCD/10/012/34 TECHNOLOGYNATION Date of issue NCE AND TECHN11 December, 2012 THIS IS TO CERTIFY THAT: FOR SCIENCE KSH. 2,000 Fee received NCE AND TE Prof./Dr./Mr./Mrs./Miss/Institution Walter Akuno ynational council for science of (Address) Egerton University lence and technolog
P.O. Box 536-20115, Egerton or science and technolog has been permitted to conduct research in Location AND TECHNOL FOR SCIENCE AND TECHNOLO Selected AND THE THOU OF THE TOTAL Province on the topic influence of selected extension intervention methodologies on agricultural production knowledge, skills and household food production in Lake Victoria Region, Kenya TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLO Applicant's Signature National Council for for a period ending: 31 March, 2013. Science & Technolog

You must report to the District Commissioner and Notice NOE the District Education Officer of the area before NO embarking on your research. Francisco do that no ogynational council ENGE may lead to the cancellation of your permit and TECHN Government Officers will not be interviewed with-out prior appointment of FOR SCIENC RESEARCH CLEARANCE ON 3 No questionnaire will be used unless it has been GYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYNATIONA GYNATIONAL COUNCIL FOR SCIENCERMITHNOLOGYNATIONA approved. Excavation, filming and collection of biological EVUING CODIES OF YOUR TIME! TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYNATIONAL ROUND FOR SCIENCE AND TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYNATIONAL ROUND FOR SCIENCE AND TECHNOLOGYNATIONAL ROUND FOR SCIENCE AND TECHNOLOGYNATIONAL ROUND FOR SCIENCE AND TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYNATIONAL ROUND FOR SCIENCE AND TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYNATIONAL ROUND FOR SCIENCE AND TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYNATIO 5. You are required to submit at least two(2)/ four(4) 6. The Government of Kenya reserves the right to TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYNATIONAL COUNCI ENCE AND TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYNATION GPK6055t3mt10/2011 nal council for science and ence and technologynational council for science and ence and technologynational council for science and ence and technologynational council for science and TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYN TECHNOLOGYNATIONAL COUNCIL FOR SCIENCE AND TECHNOLOGYN