EFFECTIVENESS OF PROJECT EXTENSION APPROACH IN DISSEMINATION AND ADOPTION OF SELECTED MAIZE PRODUCTION TECHNOLOGIES AMONG SMALLSCALE FARMERS IN SEME SUB COUNTY, KISUMU COUNTY, KENYA.

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A Thesis Submitted to the School of Postgraduate Studies in Partial Fulfilment of the Requirements for the Award of the Degree Master of Science in Agricultural Extension of the School of Agriculture and Natural Resources Management, Department of Agricultural Education & Extension.

KISII UNIVERSITY

JULY, 2022.

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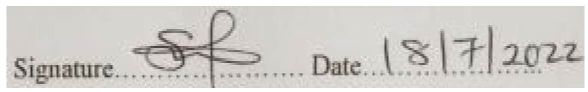

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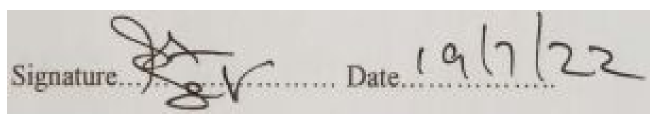

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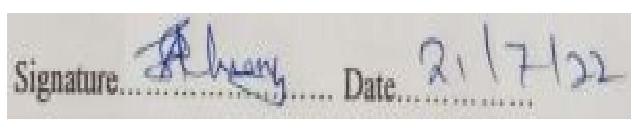

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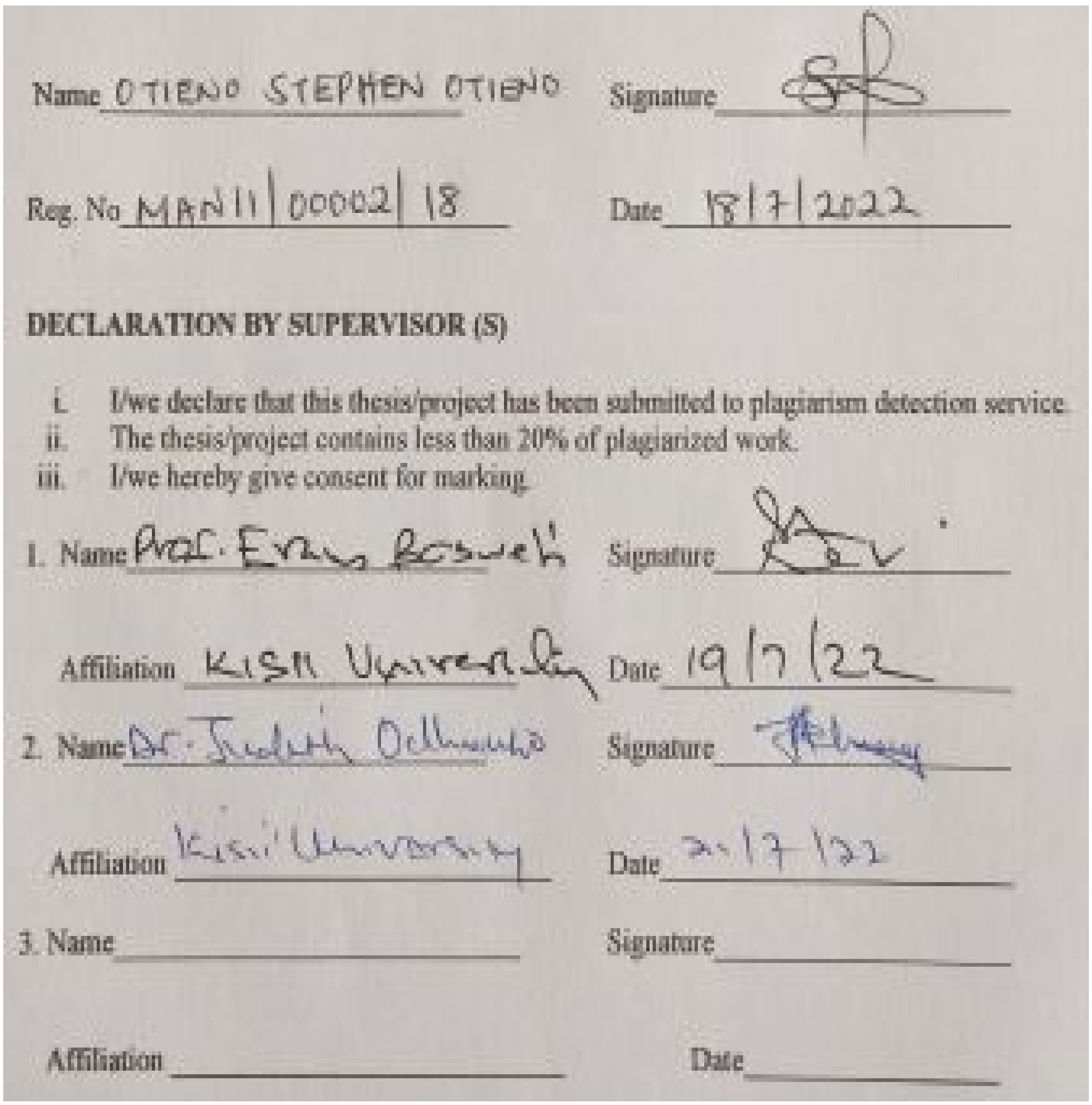

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DEDICATION

To my beloved wife Teresa Atieno, my son Frankline Leo Otieno, my beloved father, George William Otieno, mother Roselida Otieno, and stepmother, Susan Okoth and brothers and sister for their love and support during my study.

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ABSTRACT

Dissemination and use of improved agricultural technologies is an important factor towards attaining improved agricultural production. The purpose of the study was to determine effectiveness of project extension approach in dissemination and adoption, knowledge and skills acquisition, levels of maize production as alternative to conventional extension approach and influence of selected socio-economic factors on adoption among small-scale maize farmers in Seme Sub-County, Kisumu County. Survey research method was used with *Ex post facto* study design and purposive random sampling technique where 180 small scale maize farmers were sampled and interviewed using structured questionnaire. Both descriptive and inferential statistics were used where, descriptive statistics was used to compute percentages, means and standard deviations whereas inferential statistics was used in computing t-test, analysis of variances (ANOVA) and multiple regression analysis. Hypotheses were tested at α 0.05, and data was analysed using Statistical Package for Social Scientists (SPSS). Results indicates statistically significant difference ($P<0.05$) between the approaches regarding adoption of selected maize production technologies, knowledge and skills acquisition and level of maize production. An average of 83.20 percent (R^2 = 0.8320) of the variation in the adoption of selected maize production technologies was explained by some of the selected socio-economic factors. Based on this study, it was concluded that project extension approach is more effective in the dissemination and adoption of selected maize production technologies, knowledge and skills acquisition, and high maize yields as compared to beneficiaries of conventional extension approach. Household income, household size and education levels influence adoption of selected maize production technologies while age, gender and farm size do not. The recommendation drawn this study was therefore, to support dissemination of selected maize production technologies through project extension approach for adoption in many areas in the region by both private sectors, National and County Governments.

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LIST OF ABREVIATIONS

AfDB	African Development Bank
ANOVA	Analysis of Variance
CAN	Calcium Ammonium Nitrate
CBO	Community Based Organization
DAP	Di-Ammonium phosphate
FAO	Food and Agriculture Organization
GoK	Government of Kenya
GDP	Gross Domestic Product
Ha	Hectares
KES	Kenya Shillings
KIPPRA	Kenya Institute for Public Policy Research and Analysis
LSD	Least Square Difference
MoA	Ministry of Agriculture
MoALD	Ministry of Agriculture, Livestock Development
NACOSTI	National Council of Science and Technology and Innovation
NGO	Non-governmental Organization
OAF	One Acre Fund
RA	Research Assistants
SD	Standard Deviation
SRA	Strategy to Revitalise Agriculture

CHAPTER ONE

INTRODUCTION

1.1. Background of the Study

The economy of Kenya is dependent on agriculture, which contributes up to 26 percent of Gross Domestic Product (GDP), as well as 27 percent indirectly through linkages with sectors such as manufacturing, distribution and other service-related (Kenya Institute for Public Policy Research and Analysis (KIPPRA), 2013). In Kenya, more than 80 percent of Kenya's population live in rural areas and entirely depend on rain fed smallholder agricultural practices (Government of Kenya, 2012). This group of farmers accounts for 75 percent of total agricultural produce and 70 percent of total marketed produce in Kenya (Government of Kenya, 2009).

Through agricultural extension which concerned with provision of insight or intel to enable farmers identify their own problems, come up with relevant solutions, training, and updating farmers regarding practicality and scientific innovations related to farm operations and changing their attitude and perceptions positively towards adoption of improved innovations or technologies for the purpose of improved agricultural productivity and attain sustainable development. When successful implemented, agricultural extension results into positive observable outcomes in agricultural productivity hence improved household livelihood (Kibett, Omunyin, & Muchiri, 2005).

An effective extension approach is an instrumental factor for sustainable agricultural development among the small-scale farmers as it enhances effective innovations or technologies delivery for uptake. Hence, by improving, the productive capacity of these smallholder farmers through effective extension systems not only improves their food security and livelihood but also contribute towards national economic growth. Improved productivity, improved rural livelihoods, increased food security and better growth is realized when agricultural extension systems are well designed and implemented (Muyanga & Jayne, 2006; Swanson et al., 2007; FAO, 2015).

Agricultural ‘extension’ is argued as extending relevant agricultural information to people (Swanson et al., 1997). The means of enabling farmers to be knowledgeable and use new agricultural innovations for improved production efficiency, income and welfare is termed as agricultural extension (Purcell and Anderson 1997). Agricultural technologies refer to all types of improved techniques plus practices, which determine rise in the agricultural output (Jayne et al., 2001). According to Karanja (1990) maize is regarded as staple food, source of employment and source of income for majority of rural households in Kenya. Welfare and food security of the farming population are dependent on the productive capacity of maize farmers. More than 70percent of maize area in Kenya is cultivated on farms of less than 20 acres (Karanja 1990).

Basic planning philosophy adopted by an agricultural extension provider is termed as an agricultural extension approach (Leeuwis (2004). Therefore, agricultural extension approach can be defined as procedure within an extension system informs, and guides its structures, leadership, resource allocation and linkages (Anandajayasekeram et al., 2008). In this study, maize production technologies are all types of improved techniques and the practices aimed at increasing maize crop production. Selected maize production technologies included: Improved seed varieties such as DH01,DH02, DH03, DH04,DH05, PAN33,DK8031,SC Duma41,SC Duma43, PHB30G19 among others; Proper spacing's such as 75cm x 25cm (row vs seed spacing) for one seed per hole or 90cm x 60cm for two seeds per hole; Number of maize seeds per hole/hill; Planting either one or two seeds; Fertilizer application such as 123.5 kg/ha DAP at planting, 247 kg/ha urea as top dress and 123.5 kg/ha CAN as top dress; Proper weeding: Weeding two times with an interval of 6-7 weeks; Improved maize storage bags such as PICS storage bag and Maize storage pesticides such as Actellic Super (50 g Actellic Super per 90 kg of maize).

Several extension approaches have over the past period been used in Kenya to enhance dissemination of improved maize production technologies for adoption by smallholder farmers. Such extension approaches include project extension approach and conventional extension approach, which this study did consider. Other extension approaches include:

i. Commodity specialized approach majorly adopted by private agricultural industries, agro-processing industries and government parastatals, or where they contract farmers or purchase raw materials or otherwise called the commodities from the farmers. The main purpose of the extension approach is mainly increased production of the main crop and profitability due to the scale of production of the commodity crop.
ii. Farming Systems Research Development Approach (FSRD); This is implemented through a strong linkage between extension staff and research using a systems approach and considers that innovations which aligns to the needs of farmers, particularly smallholder farmers, is not available and should be invented locally.
iii. Training and Visit extension approach (T&V) focusing on organised rigorous schedule visits to farmers and scheduled frequency of retraining of extension officers and relevant

specialists. It emphasised a close working linkage between research, extension and farmers. The approach is also exhibiting the top–down decision approach, where decisions making are made by government officers at the headquarters and emphasises on disseminating uncomplicated, technically sound, and financially viable technologies, and teaching farmers to make best use of available resources.

iv. Participatory Agricultural Extension Approaches characterized with integration of community mobilization for planning and action with rural development, research and agricultural extension; based on an equal partnership between farmers, researchers and extension agents who can all learn from each other and contribute their knowledge and skills; It aims to strengthen rural people's problem-solving, planning and management abilities; It promotes farmers' capacity to adopt and develop new and appropriate technologies/innovations.

v. Cost Sharing Approach anchored on the fact that; programmes local ownership is improved through local participation by contributing part of the programme costs and assumes that cost-sharing with local people, who do not have the means to pay the full cost, will promote programme ownership and that they are more likely to meet local situations.

vi. Educational Institution Approach focusing on transfer of technical knowledge and uses educational institutions which have technical knowledge and some research ability to provide extension services for rural people. Implementation and planning are often controlled by those who determine the school curricula.

This study focused on determining effectiveness of project extension approach in dissemination and adoption of maize production technologies as used by One Acre Fund organization as compared to conventional extension approach used by Kisumu County Government.

1.2. Project Extension Approach.

In this approach, the outside resources for a specific period are concentrated on a location and focuses on improving livelihood of the targeted population with the hope that adjacent populations will learn from the benefiting group. Active participation of target group individuals just like in participatory agricultural extension approach is very key. It always uses group extension methods such as demonstrations. Demonstration of techniques and methods that could be extended and sustained after the project period is always the focus of this approach.

One acre fund organization is a social enterprise operating in Kenya reaching approximately 408,000 small-scale farmers by 2019 and non-profit in nature. The main aim of the program as illustrated in appendix 1 is to enhance agricultural productivity for poverty reduction among smallholder farmers on staples food crops such as maize which are grown on a widely grown by the target population and presents a greater opportunity for higher yield increments through supplying of improved farm inputs and training.

The organization uses project extension approach to train farmers of modern agricultural practices for various crops including maize. Through their market-based model, small scale farmers receive complete package of services aimed at doubling incomes per planted acre. The model comprises of; loans inform of farm inputs with flexible repayment system; delivery of inputs to farmers they serve; Training of farmers on modern agricultural technologies for example grain storage technologies and capacity building farmers about maximizing profits despite dynamic forces in the market. Most households in Kenya regard maize as a major food and source of income and employment for rural households. Productive capacity of maize farmers' influence food security and welfare of the farming population. The program has been working with small scale farmers in their respective farmer groups in the area since the long rains 2015 to enhance household food nutrition and security through maize production as well as income generation through sales of surplus produce. Further, the program also provides other agricultural products (e.g., nutrient rich vegetables and legumes) and relevant innovations or technologies in other sectors such as clean energy. This study targeted smallholder farmers who were beneficiaries of the program between the years of 2015 to 2018.

1.3. Conventional Extension Approach.

Conventional extension approach is also known as Ministry-based general extension approach and based on the premise that technologies, innovations, and information are suitable to the local farming conditions are available. However, smallholder farmers are not making full utilization of the improved technologies due a feeling of lack of inclusivity in planning, and information to improve their farming situation. In this approach most decisions on the management and major controls of the approach are controlled at the government headquarters. This makes the extension approach more centralized, and government controlled.

In this top-down approach, all planning levels including strategic planning of resources allocation is undertaken at government headquarters making it a top–down approach. Improvement in national production and adoption rate of recommended technologies are regarded as the success indicators. This approach has been widely criticised for not being efficient and effective by not achieving its objectives of; effectively improving adoption rates and increasing national production. High levels of bureaucracy and hierarchical procedures experienced in this approach is considered as the cause of its inefficiency (Swanson et al., 2007). This approach utilises the "top down" model in transfer of agricultural innovations (TOT), which conforms to conveying superior technologies into the traditional practices or systems. The farmers are regarded as recipients of "expert" decisions, either adopters or rejectors of technologies or improved practices, and not the innovators of either improved practices or technical knowledge. In this study conventional extension approach, is fundamentally a ministry operated service, was the system in existence before inception of project extension approach in Seme Sub-County by One Acre Fund Organization. This study targeted smallholder farmers who benefited from this extension approach through trainings conducted by Ministry of Agriculture extension staffs of Kisumu County between the years 2015 to 2018.

1.4. Statement of the problem

In Kenya, maize is a staple food to many rural households. Availability and accessibility of agricultural extension services is vital for adoption of improved agricultural technologies as it bridges the gap of lack of years of formal education (Yaron et al., 1992). Extension services avail avenues for the acquisition of knowledge about new technologies and important information meant to promote adoption of technologies. Effectiveness of an agricultural extension approach is crucial during the process of disseminating improved agricultural technologies among small-scale farmers for adoption.

The Ministry of Agriculture in Kisumu County for a long period has adopted conventional extension approach for disseminating selected maize production technologies among small-scale farmers for adoption, knowledge and skills acquisition and improvement of levels of maize production in terms of yields. However, this approach has succeeded minimally in dissemination or transferring and adoption of selected maize production technologies in the study area. One Acre Fund project was introduced in the area, in the year 2014 and adopted project extension approach as an alternative approach to the existing conventional extension approach.

It was for this reason therefore there was need to carry out a study to compare the two approaches in terms of their effectiveness in dissemination and adoption of selected technologies, knowledge and skills acquisition, levels of maize production and influence of selected socio-economic factors on the adoption of technologies in study location.

1.5. Significance of the Study

Information captured is important to various agricultural stakeholders such as extensionists, policy makers, farmers, development agencies and researchers in influencing, enlightening, decision making and formulation of extension methodology and extension policies to enhance private sector inclusion in dissemination of selected maize production technologies. Small-scale farmers are also expected to note relevancy of the project extension approach and fully participate in such programs to enable them to realise improved maize yields and adoption of selected technologies.

1.6. Purpose of the study

To determine effectiveness of project extension approach as an alternative agricultural extension approach to conventional extension approach in dissemination and adoption selected maize production technologies among small-scale farmers East Seme Location in Seme Sub-County.

1.7. General Objective

The broad objective was to compare effectiveness of project extension and conventional extension approaches in terms of dissemination of selected maize production technologies for adoption, knowledge and skills acquisition, levels of maize production in form of yields and influence of selected socio-economic factors on adoption of the technologies

1.8. Specific Objectives

The following are the specific objectives of study:

1. To determine effectiveness of project extension approach as compared to conventional extension approach on level adoption of selected maize production technologies.
2. To determine effectiveness of project extension approach as compared to conventional extension approach on selected maize production technologies knowledge and skills acquisition.
3. To determine level of maize yields as a result of adoption of selected maize production technologies disseminated through project extension approach as compared to conventional extension approach.
4. To assess the influence of selected socio-economic factors on adoption of selected maize production technologies.

1.9. Hypotheses of the Study

The following null hypotheses were tested at 0.05 alpha level.

H_{o1} There is no statistically significant difference between effectiveness project extension approach as compared to conventional extension approach on level of adoption of selected maize production technologies.

H_{o2} There is no statistically significant difference between project extension approach as compared to conventional extension approach on selected maize production technologies knowledge and skills acquisition.

H_{o3} There is no statistically significant difference on level of maize yields as a result of adoption of selected maize production technologies disseminated through project extension approach as compared to conventional extension approach.

H_{o4} There is no statistically significant influence of selected socio-economic factors (Age of farmers, education level, gender, household income, farm size and household size) on adoption of selected maize production technologies.

1.10. Assumptions.

The study assumed that targeted farmers provided correct information to all the research questions, from this study. It is also assumed that information obtained being useful to the government and private agricultural extension service providers.

1.11. Scope of Study

The scope was to determine effectiveness of project extension approach as compared to conventional extension approach in terms of its effectiveness on adoption, knowledge and skills acquisition, level of maize production and determine how selected farmers' socio-economic factors influence adoption of selected maize production technologies among small-scale farmers in Seme Sub-County.

1.12. Limitations

While undertaking this study several limitations were expected. For example, during the interview session, some respondents were not willing to respond thereby the researcher and enumerators had to transverse wider area to reach a significant number of farmers. Some farmers also expected to be paid something to participate in the interview.

1.13. Concept Framework

This is a representation of study variables and denotes how dependent variables of the study is influenced by the independent variables. An illustration of effectiveness of project approach in dissemination and adoption of selected maize production technologies is presented in Figure 1. The main independent variable in the framework is dissemination of selected maize production technologies through project extension approach and conventional extension approach. The independent variables effects to dependent variables could be seen in terms of adoption of selected maize production technologies, knowledge and skills acquisition regarding selected technologies and level of maize production in terms of yields. Selected socio-economic factors for the study were formulated as moderator variables. These variables were studied on how they are influencing adoption of selected maize production technologies.

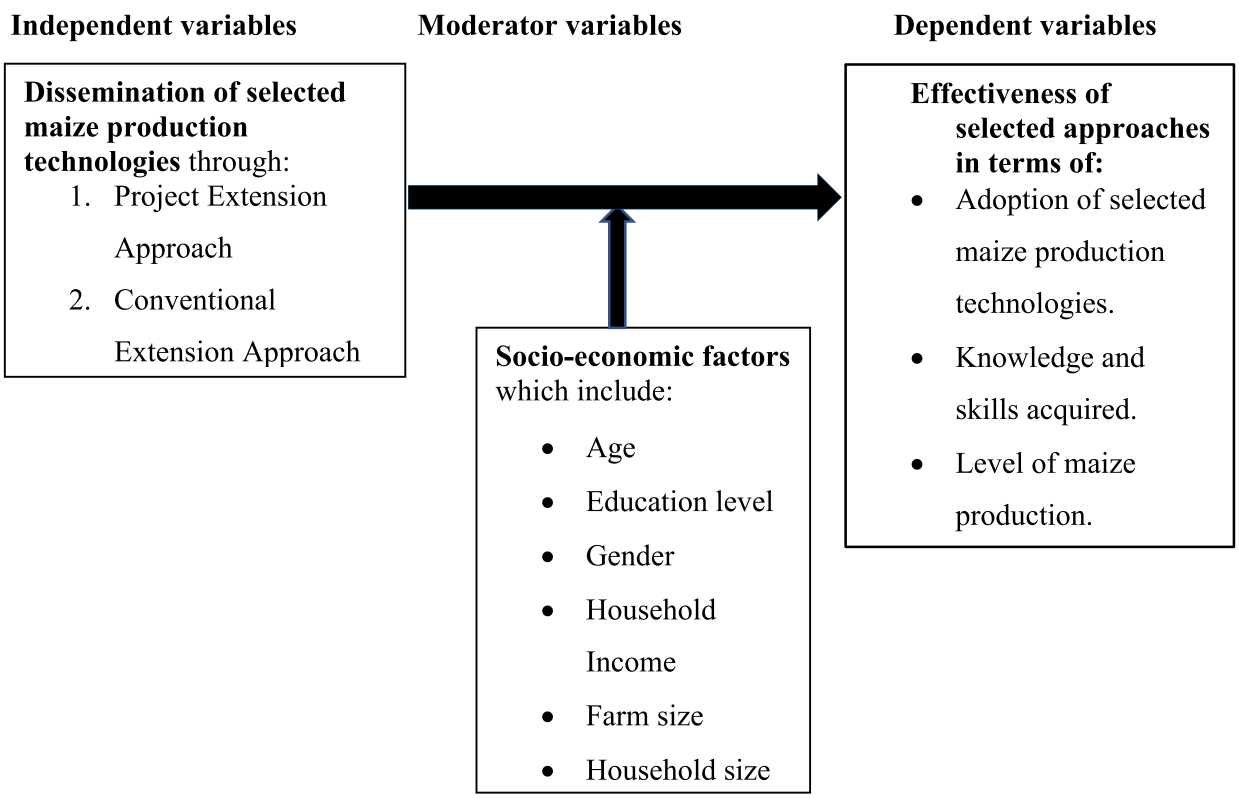

Figure 1: Conceptional framework of the effectiveness of maize production technology model showing the dependent, independent and moderator variables.

1.14. Definition of operational of terms

Adoption: Denotes a state where a small-scale maize farmer makes decision to practice selected maize production technologies or selected technologies are put into practice by farmers.

Diffusion: Refers to the process of spreading selected maize production technologies from source of innovation to its users.

Dissemination: Translates to transferring of selected maize production technologies by either of the selected extension approaches.

Effectiveness: Operationalized in terms of level of adoption, knowledge and skills gained and level of maize production.

Hectare: Denotes land and of farm size under use by the farmer.

Influence: The action or process effects on action, behaviour, opinions of another thing or other people.

Maize: A large plant that yields large grains used for their nutrition value.

Fertilizers: A chemical or natural substance added to the soil to increase soil fertility such as Di-Ammonium Phosphate, Calcium Ammonium Nitrate and Urea

Production: Is the action of making or manufacturing something from inputs.

Productivity: Denotes farm income and production per unit area related to maize production.

Conventional extension approach: In context of this research is a Ministry of Agriculture operated extension service.

Project extension approach: In the context of this research, is an extension approach that outside resources for a specific period are concentrated on a location and focuses on improving livelihood of the targeted population with the hope that adjacent populations will learn from the benefiting group.

Small-scale farmers: Farmers owning not more than two hectares of farm under maize.

CHAPTER TWO

LITERATURE REVIEW

2.1. Introduction

This section introduces history of agricultural extension in Kenya and importance, extension approaches, adoption process, dissemination and diffusion of innovations concept, knowledge and skills acquisition, level of maize production, influence of selected socioeconomic factors on dissemination and adoption of maize production technologies.

2.2. History of Extension Services

Following existence of less productive technologies that farmers were using, agricultural extension services started in Kenya in the late 1940's. According to McMillan et al., (2001) with the changing theories of development, agricultural extension in Kenya has undergone evolution. State–provided early extension services with specific early extension models to disseminate new technologies for adoption among farmers. Through top-down approach, extension agents ensured information originating from Ministry of Agriculture are extended to farmers hence not accountable to most of farmers needs due to lack of inclusion during the development of the disseminated technologies (Nambiro et al., 2010).

According to Collinson et al. (2000) to reinforce technology transfer, government focused on the poor farmer's needs by advancing new presentation thereby leading to the inception of farming system approach. Its distinctive feature was its pattern of linkages consisting of the extension, research as well as farmers. For gaining synergy effects, extension service should only be done by relevant agents and stakeholders providing valuable inputs (Muyanga and Jayne, 2006). New ideas developed by researchers focusing on agricultural productivity improvement in form of high quantity and quality gains is termed as technology.

2.3. Importance of Agricultural Extension

Evidence indicate that improved agricultural productivity, increased food security, improved rural livelihoods, and pro-poor economic growth is as a result of a well designed and implemented agricultural extension systems (Muyanga & Jayne, 2006; Swanson et al., 2007; FAO, 2015). Agricultural extension provides farmers with information on improved and better farming systems through their extension agents are considered social workers since they are responsible for ensuring that the farmers livelihood is improved (Kimaro et al., 2010).

Extension is important for agricultural growth, which in turn propels economic growth of most nations. Agriculture provides more than eighty percent of food consumed in Africa and Asia and accounts for more than ninety percent of livelihoods in these continents (Committee on World Food Security, 2013). To address the increasing food demand in the world as a result of the growing population, agricultural production techniques must keep evolving and become more efficient especially among the smallholder farmers (Ton et al., 2015). Strategy to Revitalise Agriculture (SRA) elaborates significance of extension in poverty eradication in Kenya and noted ineffectiveness of the public extension service is seen to have resulted into reduced growth in agricultural sector in Kenya (GoK, 2006). Perceived perception of private sector being well organised in extension delivery than public sector led to inclusion of the private sector in extension services in developing countries (Rivera et al., 2001; Alex et al., 2002; Katz, 2002).

According to Muyanga and Jayne (2006) working with private sector having actors for example, Non- governmental (NGO's), faith-based organisations, Community-based (CBO's) and private company's participation in agriculture have contributed to emergence of private agricultural extension system and privatisation. Innovations or technologies delivery by extension agents is crucial since it contributes to positive change in target groups attitudes and perception. In this comparative study between selected approaches, importance of extension delivery in dissemination and adoption of technologies will be noted. Extension delivery by One Acre Fund program as well as the Ministry of Agriculture of Kisumu County is regarded to be crucial towards availing the needed information related to selected maize production technologies to farmers for adoption with an ultimate goal of improving levels of maize productivity.

2.4. Extension Approaches

An "extension approach" according to MOALD, (2001) is a means or strategy of overseeing extension. According to Maunder (1973), extension can be termed as a continuous process of delivering important information to beneficiaries, assisting in getting relevant skills, knowledge and attitude to utilise information or techniques for their own benefit. Various approaches have been used, but this research focused on project extension approach and conventional extension approach.

2.5. Project Extension Approach

In this approach, efforts are focused on the necessities of the beneficiaries and donors, therefore consensus of the general stakeholders is necessary before and during projects implementation (Abibatu, 2016). Livelihood improvement of the targeted population is its focus and hope that innovations diffusion will occur to the adjacent populations in the target area. This approach also needs the participation of the target group members just like the participatory agricultural extension approach.

It always uses group extension methods such as demonstrations. It is one of the extension methods involving inclusion of community members at large suitably while diagnosing matters related to entire community (for example low agricultural productivity). Dissemination of knowledge and skills can occur in meetings to expound matters related to technologies such maize production. In this approach, trainings are best carried out on individual farms with two kinds of demonstration; a) method demonstrations involving showing farmers how task or activity is executed. It is regarded as an effective method as beneficiaries can hear, see, practice and interrogate while demonstration is ongoing; b) result demonstrations which involves farmers being shown the results of a concluded practice with intention to awaken farmer's interest in uptake and can utilised in comparing older practices or techniques with latest ones. One Acre Fund organization employs these methods to enhance dissemination of selected maize production technologies to small-scale farmers for their adoption.

2.6. Conventional Extension Approaches

In this approach decision making on management and control of the approach operations is fully centralised to the government hence top-down planning approach. In this approach, technologies and information is assumed to be suitable for the local farming situations are available, but they are not made into fully use by the small-scale farmers. Remarkable achievements here are rated based on the levels of adoption of recommended technologies and production improvement (Swanson et al., 2007).

According to Zuubier (1984), all extension services have five important tenets for: (i) an intervention; (ii) uses communication for change; (iii) voluntary change; (iv) operates through organised procedures and outcomes; and (v) it is institutionalized. In Kenya, extension services are a public sector operated service through the Ministry of Agriculture but currently devolved to

County Governments. Devolving Ministry of Agriculture to the County government has aggravated management challenges and low inclusion of other stakeholders.

According to Moris (1994), Government Ministry operated extension service has the following characteristics or broad functions which is still in practice at the County governments for examplea: (i) territorial hierarchy from the ministry headquarters and operated from a Ministry's office (ii) extension advisory services rely upon residential staff in their area of work or station; (iv) extension services financed through public funds (i.e. mainly payment of staff salaries); (v) the extension service focus upon annual campaigns and blanket recommendations; (vi) technology is derived from official research stations; (vii) extension services in most instances are vulnerable to bad packages (i.e. inappropriate messages).

The success of this approach is attributed the rate of technology adoption and the improvement in the national production. Meanwhile, extension personnel implementation of this approach is large in numbers therefore resulting into high cost of operation. The approach has received many critics for not being efficient and effective in attaining their objectives of; effectively improving rate of technology adoption and improving the national production. Numerous studies indicate that this approach is has not been successful (Venkatesan and Schwartz, 1992; Bindlish and Evenson, 1993; Morris, 1994).

The inefficiency of the approach is as a result of its bureaucratic procedures and hierarchical structures which services are anchored on, this also affects its effectiveness. The hierarchical and bureaucratic process results to distortion of extension information. The hierarchical and bureaucratic process inhibit information transfer and farmers may be exposed to outdated or irrelevant technologies and information due to delays and challenges.

2.7. Adoption process

According to Rogers et al., (2003) the decision to entirely use as a better available action is termed as adoption whereas rejection is decision of not adopting an innovation. Roger (2003) termed diffusion as a means of relaying techniques among the category of a social system through certain channels over time. He further noted that, characteristics of diffusion of innovation include innovation itself, communication channels, time and social structure. For this study, the term innovation is viewed as an idea, practice, or project that is regarded to be latest by a small-scale farmer. Interrelated units considered while solving a problem for a common goal is termed as social system.

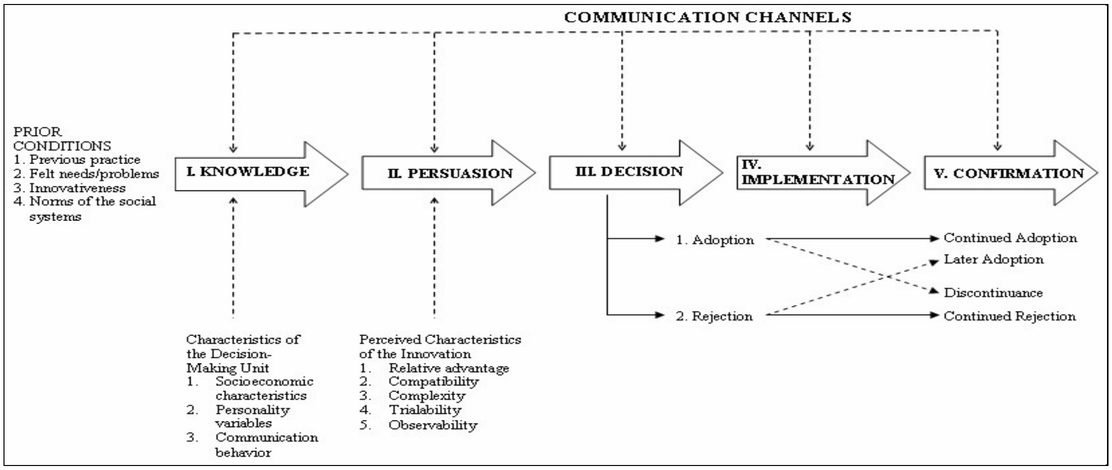

Figure 2: A Model of Five Stages in the Innovation-Decision Process.
(Source: Diffusion of Innovations, Fifth Edition by Everett M. Rogers.

According to Rogers (2003) innovation-decision process which focuses on limiting uncertainty about advantages and disadvantages of innovation has five phases following each other chronologically; knowledge, persuasion, decision, implementation and confirmation as illustrated in Figure 2. The knowledge phase recipients' focuses on learning about presence of the technology and relevant information on; what, how, and why. According to Rogers (2003) at this phase, the recipient seeks to assess "what the technology is and how and why it works". At the persuasion phase the recipient, forms a negative or positive attitude towards technology or innovation.

During decision phase the recipient decides whether to adopt or reject the technology or innovation, and this is fully dependant on the following technology characteristics; observability, compatibility, relative advantage and trialability. Adoption is the application of an innovation as best course of action available whereas rejection means not to adopt. Innovation rejection can be categorised in two ways; active rejection where recipient tries technology and decides about adopting it, and eventually decides not to adopt it, while passive rejection entails recipient rejecting the technology or innovation at all costs.

Implementation phase entails an individual practicing the innovation or technology. Lastly, for the confirmation phase an individual seeks evidence for supporting his or her decision. At this stage the attitude of an individual is very important. Depending on the support availed for technology's adoption recipient attitude, later adoption, or discontinuance happens. The aspects of discontinuance happen in two means; First technology is rejected by an individual and adopt a superior technology replacing it. Therefore, this kind of discontinuance decision is termed as replacement discontinuance. For disenchantment discontinuance, recipient rejects the technology or an innovation since technology's performance did not satisfy him or her.

There are three main patterns that explain innovation or technology uptake decisions making. Initially is "innovation diffusion model" denoting acquisition of information of a technology or an innovation. This is a key determinant factor in the uptake decision making, hence improving communication through the use of farm visits to plot trials, on-farm demonstrations can enhance the innovation uptake decision making. Secondly, "economic constraint model" that suggest economic constraints is also a key determining factor of adoption decisions since this can lead to limited access of these factors of production reduces farmers' capability for adoption of new innovations. Lastly, "adoption perceptions paradigm" that realised characteristics of perception regarding specific technology is vital in its adoption and here the farmers' subjects the perception to their current socio-economic conditions thus determining their adoption decisions (Adesina and Zinnah, 1993).

In this study, selected maize production technologies include improved seed varieties, recommended number of maize seeds per hole, proper maize spacing's, recommended fertilizer application, proper weeding, improved maize storage bags and storage maize pesticides. Adoption of these technologies, knowledge and skills acquisition and improved maize yields among small-scale farmers is believed to have been influenced by effectiveness of selected approaches in dissemination and adoption of selected maize production technologies.

This study primarily focused on determining effectiveness of project extension approach in dissemination and adoption of selected maize production technologies among small-scale farmers as compared to conventional extension approach and its effectiveness on knowledge and skills acquisition, level of maize production and influence of selected socio-economic factors on adoption of selected maize production technologies.

2.8. Adoption of Improved maize Production Technologies

Agricultural innovations or technologies are entire types of upgraded techniques plus practices, that determine rise in the agricultural productivity or output (Jayne et al., 2001). Embracing of improved agricultural technologies has led to the success of green revolution in Asia continent. The decision to adopt such technologies are determined by very many determinants (socio-economic factors, institutional factors, and technology characteristics). Uptake of new technologies like improved maize varieties and fertilizer is core to poverty reduction and agricultural growth (Tura et al., 2010).

Uptake of agricultural innovations is an important trigger for economic prosperity for poor countries (Nkonya et al., 1997). In Mexico, uptake of improved maize varieties among farmers has led to household welfare improvement (Becerril and Abdulai; 2010). For Western Kenya, uptake behaviours of farmers are determined by input costs such as fertilizer and maize seeds, off farm income, access to credit, perceived yield and risks (Mose, 1997).

In a separate study, it is noted that farmer's socio-economic characteristics do influence technology adoption (Etoundi and Dia, 2008). According to Doss et al., (2003) during his study on adoption of maize and wheat technology in Eastern Africa noted that lack of or inadequate information about technologies by the farmers and benefits of these technologies are some of the reasons for not adopting improved technologies.

Most research on uptake of agricultural innovation such as Mureithi et al., (2000), Mulugeta (2001) and Ransom et al., (2003) have concentrated on farmers' attributes as key determinants influencing the uptake or dismissal. Their research overlooked effectiveness of extension approaches towards dissemination or transfer and uptake of agricultural technologies by intended beneficiaries. For example, this study regarded comparing effectiveness of project extension approach and conventional extension approach in dissemination and adoption of selected maize production technologies,

This study considered socio-economic characteristics of small-scale farmers such as education level, household size, age, household income, gender and farm size to determine how they influence adoption of selected maize production technologies. In this study, selected maize production technologies are use of improved maize seeds varieties, recommended maize seeds per hole/hill, proper maize spacing's, recommended fertilizers application, proper weeding, use of improved storage bags and use of maize storage pesticides.

2.9. Dissemination and Diffusion of Innovations

Dissemination

This refers to transfer of agricultural technologies from a source to recipients. According to McDermott, (1987), dissemination involves informing farmers of the new technology, helping them figure out how to fit it into their farming systems. Quraish, (1996) recommended that for dissemination process to be successful or effective there should be: exchange of knowledge between all stakeholders, which include farmers, extensionists, researchers, and agriculture related professionals and institutions.

Diffusion of Innovations

Diffusion is a process of transferring new ideas through a defined channel from the point of creation to its probable end users or adopters. According to Berdegue et al., (2005) innovation concept has different definitions and meanings to various people since it is socially constructed. Rogers et al., (2003) perceived technology as practice regarded latest by other adopting unit or individual while anything successfully new into a social process or economic is termed as innovation (Spielman, 2009).

Several characteristics of innovation or technology like its complexity, observability, compatibility, trialability and relative advantage influences whether such a new technology or technologies will be adopted or not (Roger, 2003). Relative advantage is the extent to which a technology or an innovation is regarded being better than the idea it supersedes. Compatibility is the consistence degree to which a technology is with former experiences, existing values and needs of potential adopters. The degree to which an innovation or a technology is seen to be relatively difficult to interpret and practice is termed as complexity. Trialability is the degree to which a technology or an innovation can be experimented more than once. Lastly, observability is the extent to which the results of a technology or an innovation are visible to adopters and non-adopters (Rogers, 2003).

2.10. Role of Extension in Dissemination of Technologies

Extension services accessibility is vital in promotion and uptake of agricultural production-based techniques since it helps to resolve negative impact following years of inadequate formal education in decision making related to uptake of technologies (Yaron et al., 1992). Acquisition of useful information that promote adoption of technologies is depends on the extension service accessibility. The uncertainty concerning the technology's performance is reduced by the information access through extension service provision; this may change the assessment of an individual to objective from purely subjective over period, hence facilitating adoption.

Extension delivery in this study area has been availed through conventional extension approach as well as private extension approach. Emergence of private extension approach in extension services delivery was triggered by then ever-increasing need for demand driven services informed by observations made following positive impacts of various agricultural projects that were being undertaken by other agencies in the neighbourhood locations such as the Millennium Village Project in Gem Sub-County.

2.11. Knowledge and Skills Acquisition

Levels of knowledge and skills of a farmer regarding a technology or an innovation is crucial in understanding uptake behaviour. Knowledge concerning an innovation or a technology, its elements and predictable outcome promotes its use or uptake. Decision making concerning adoption by farmers is dependent on availability of adequate information about a technology and is coupled with knowledge transfer, outcome demonstration and the predictable risk reduction ability. Agricultural extension enables farmers access relevant information. According to Rogers, (1962), access to information is supported by Innovation-diffusion model which explains adoption decision of a technology and reduced uptake problems of an innovation or a technology by potential users.

Several researchers have supported the notion that extension services influence uptake or utilization of agricultural innovations or technologies. Dorfman (1996), Adesina and Baidu -Furson (1995) in Burkina Faso, Makokha et al., (1999) in Western Kenya and Gerhart (1975) in Kakamega realised that attendance to agricultural innovation's demonstrations by farmers such as on-farm demonstrations and home visit influences decision making for the innovations' acceptance as a result of created perceptions regarding the technologies being demonstrated.

Noonan and Goddard, (1995) in their survey among wheat growers in Australia indicated that, information from local trials have more credibility as compared to field days and trials conducted further from their locality. The rate of technology adoption increases because of demonstration of the technology. In Ethiopia, it was noted that after introduction of demonstration and training extension system, adoption of wheat varieties and improved maize resulting to high yields was realised with majority who took part in demonstration programmes adopting the improved innovations.

According to Rogers, (1971) early adopters of techniques are individuals with higher social status, more educated while "laggards" are individuals who still cling to their past practices and take a lot of time to change their mind-set regarding new concepts or ideas in their midst. Youthful or middle age groups of farmers possessing formal education might be adopters of new technologies. Application of modern farm inputs are more efficient with educated farmers since they are willing to try out new innovations and motivated to utilize complex agricultural technologies (Misiko.,1976).

Uptake of agricultural innovations and education levels have a significant relationship as opposed to gender and farm size, which showed no relationships (Ndiema et al. 2002). Karanja et al. (1998)

also noted that, use of fertilizers is influenced by education level at post-secondary as educated individuals have better ability to assess the difference an innovation or a technology has on productivity. However, none of the reviewed studies looked into the effectiveness of project extension approach as compared to conventional extension approach in knowledge and skills acquisition regarding selected maize production technologies in the area of study.

2.12. Role Agricultural Extension in Knowledge and Skills Transfer.

Competency of extension workers is instrumental in success of programmes in extension since they aid in the transfer of new techniques and providing technical assistance needed to the farmers (Neda, 2009). Earlier the purpose of extension agents was perceived only as transferring new technologies to farmers from the research centres. Extension personnel play other vital such as provision of enough and relevant information to rural people, helping farmers make informed decision by providing the required information (Van de Ban and Hawkins, 1996).

According to Schwartz and Kampen, (1992) the ability of extension system to reach their goals is termed as effectiveness. Hence, effectiveness in agricultural knowledge transfer denotes the ability of extension system to attain its goals. Effectiveness can also be used as an indicator for measuring programme worthiness (Cornea and Tepping, 1997). According to Bennett, (1977) indicators such as number of contact farmers who adopt a given practice, total crop output, frequency of extension workers visits and spreading levels of key practices are used to determine or measure the effectiveness. However, none of these reviewed studies has studied effectiveness of project extension approach as another approach that can replace or readjust conventional extension approach in the dissemination of maize production technologies among of small-scale maize farmers in study area for adoption.

2.13. Level of Maize Production

According to Morris (2001), white maize is an important part of meal in sub-Saharan Africa and Central America and maize production is connected to technology in the global perspective. In the global arena maize production are grouped into white and yellow maize production (Meyer et al., 2006). The two maize categories are similar genetically and biologically. According to Meyer et al., (1998) white maize production is common in the developing world occupying roughly 40 percent of lowland tropical maize area. Also grown in sub-tropical/mid-altitude and tropical highland environments.

Approximately 40 percent of world's maize harvest is produced in United States. Other leading maize producers globally are China, Brazil, Mexico, Indonesia, India, France and Argentina. According to FAOSTAT 2008, North America recorded the largest production of maize with about 38.8percent of the global output followed by Asia (28.5percent); South America (11.2percent); Europe (11.1percent); Africa (6.9percent); Central America (3.4percent); and Oceania (0.07percent).

Between 16th to 18th centuries, Portuguese introduced maize crop in Africa and making it become one of Africa's most staple foods. According to FAO/WFP 2004/2005, Kenya alongside Ghana, Mozambique, Angola, Zimbabwe (a maize exporter until the late 1990s) were the top importers whereas South Africa, Tanzania, Uganda, Zambia and Swaziland were top exporters of maize in sub-Saharan Africa. In Kenya, the major counties that are suitable for maize production are Trans Nzoia, Uasin Gishu, Bungoma, Nandi counties with an area of about 1.5 million hectares and producing about 26 million bags of maize annually.

Adoption of agricultural technologies or innovation by farmers have the potential of improving agricultural production. For example, recommended fertilizers application contributes to larger extent sustained crop productivity. In this study, the recommended maize agronomic practices included use of improved maize varieties, recommended fertilizers application such as D.A.P or Nitrogenous fertilizers, such as C.A.N, spacing of 75cm by 25cm for a seed per hole or 90cm by 60cm for dual seeds, weeding twice per season and post- harvest handling techniques such as the use of hermatic bags and maize storage pesticides. Positive interactions between applied technologies, climatic, pest and disease and soil conditions may greatly improve maize yields.

According to Kolawole (2014), crop production is also influenced by the time and rate of fertiliser’s application. In the past 50 years, there is a dramatic increase in agricultural production following use of chemical fertilizers and high yielding seed varieties (Mwabu et al., 2007). Fertilizer’s application reduces soil nutrients deficiencies, but excess use decreases the soil fertility following adverse change in soil pH levels (Crawford et al., 2008). Proper spacing of plants within a row can change the amount of light available for the plants; with reduced light and nutrients competition from the plants, increment in total crop yield can be realized (Nielson, 2001).

According to Spasojevic (2014) maize plant, physiological process and morphology of a maize plant are modified by weed competition, which in turns affects their light use efficiency and physiological processes relevant for their productivity such as chlorophyll and carotenoids contents. Maize yields are greatly affected by weeds in the field. They compete with maize crop for moisture, space, light and nutrients and consequently interfere with normal growth of maize. Weed control is therefore vital for maize production and if not correctly checked yield loss can be up to 39.8percent (Oudejans, 1991).

Application of recommended number of maize seeds per hole, is likely to increase its levels of production due to reduced nutrients, water and light competition between the plants in the same hole. Post-harvest handling of maize produce has a remarkable influence on the food nutrition security at household levels, through utilization of hermatic bags and use of maize storage pesticides like actellic gold dust, the grain quality is maintained for a long time due to reduced exposure to loss causative agents such as moisture contamination and weevil attack.

2.14. Influence of Socio-Economic Factors on Dissemination and Adoption of Maize Production Technologies.

According to Rogers, (2003) specific socio-economic factors of an individual positively correlate with uptake of innovation and therefore enhancing transfer of knowledge while others are not. For example, farmers having a higher socio-economic power are seen to be faster adopters of technologies. Farmers with high income level can facilitate extension workers to undertake their tasks more in areas compared to individuals having low levels of income (Mlozi, 1994). According to Rogers (2003) in US on diffusion innovation he noted that farmers owning large size of farm tends to be early adopters as opposed to small sized farm owners. Ekpere, (1976) realised that there is more opportunity and flexibility to new practices use by farmers possessing large scale farms size they can deal with uncertainty and risks of adoption. Similarly, Ohajianyo et al., (2003) noted that education among fisheries enabled them to search and get information concerning improved practices needed by them.

Similar observations were also made by Nweke (1981) on his study on agricultural progressive or smallholder farmers in Nigeria, he observed educated farmers are positive regarding new innovations and have capability to undertake evaluation of information concerning new innovations and make appropriate decisions. Farmer’s age, perception of technology profitability, farm size and farm characteristics determines promotion and adoption. Large farm size the farmer experiences reduced binding related to land and financial constraints. The accessibility of resources and services is dependent on gender of household head who makes decisions (Nkonya, 1997). Sain, (1999) noted that farm asset accessibility does enhance continued use of improved technologies.

2.15. Theoretical Framework

The theoretical framework consists of the concept of dissemination and diffusion of innovation, innovation- decision process and research results closely related to this research. This section has underlying theories supporting dissemination and adoption maize production technologies. The theory of innovation- decision process was used in this study. Innovation-decision process is an information seeking and processing activity focusing on reduction of the uncertainty about merits and demerits of innovation or technology. The process comprises of five stages: knowledge, persuasion, decision, implementation, and confirmation. This theory perceived technology as practice, or an idea regarded latest by other adoption unit or individual (Rogers et al.,2003). While anything successfully new into a social process or economic is termed as innovation (Spielman, 2009). The innovation or technology adoption decisions making has three main patterns which include; "innovation diffusion model" denoting the relevancy of access to information about a technology or an innovation for innovation uptake decision making; "economic constraint model" suggesting the role of economic constraints among farmers in adoption decisions making; "adoption perceptions paradigm" recognising the importance of attributes perception of specific technology by farmers before adoption with farmers' subjecting their perception to their current socio-economic conditions thus determining their adoption decisions (Adesina and Zinnah, 1993).

2.16. Literature Gap

This section has presented a summary of gaps after literature review on history of extension, importance of extension, extension approaches, project extension approach, and conventional extension approach, adoption process and adoption of maize production technologies, knowledge and skills acquisition, maize yields and selected socio-economic factors. Moreover, gaps regarding absence of a study on dissemination and diffusion of selected maize production technologies, knowledge and skills acquisition, level of maize production in form of yields, influence of selected socio-economics factors in dissemination and adoption or uptake of maize production technologies guided this study.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

This chapter presents a detailed research methodology adopted. Features of the research methodology employed include research design, study area, target population, sample size and sampling procedure. This chapter comprises also of data collection instruments, validity and reliability, data collection procedures, data analysis methods and summary table of data analysis.

3.2. Area of Study

This study was undertaken in Kisumu County with a population of 1,155,574 and land area of 2,085 sq. km according to 2019 National Census Report and in particular Seme Sub County whose population stands at 121,667 according to National census of 2019 and an area of 268 Sq. Km with four wards namely, East Seme, North Seme, West Seme and Central Seme as shown Figure 3. East Seme Location which borders Kisumu West to the East, Rarieda to the West and Lake Victoria to the South. The area lies on a GPS position of Latitude. -0.0833°S, Longitude. 34.5167°E with elevation of 1,300m. According to the 2019 National Census Report the population distribution in East Seme having population size of 19,605 is distributed across the three sub locations as follows: Kaila (4,681), Koker-Kajulu (7,111) and Kit Mikayi (7,813). It experiences an average temperature of 22.9^{0}C and average rainfall of 1,321mm annually with January being the driest month and April being the month which receives the highest amount of rainfall. The area under maize production is averagely 8,000 ha in long rains and 3,500 ha in short rains. According to Kisumu County-Ministry of Agriculture, maize yields in the area averages to 2,250 kg/ha during the long rains and 1,800 kg/ha in short rains.

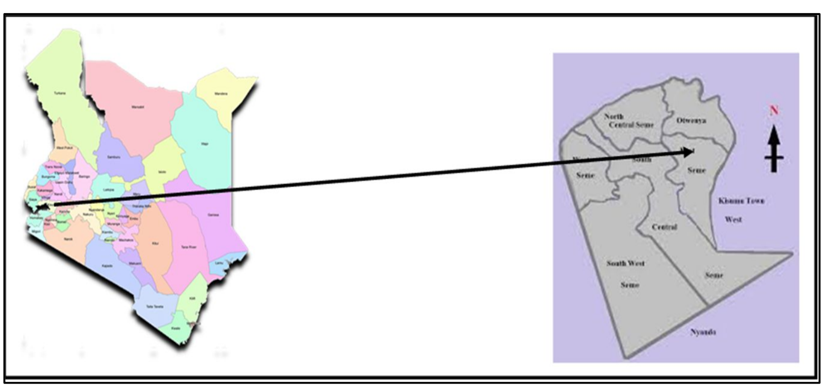

Figure 3: Map of East Seme Location. Source: IEBC map 2009

3.3. Research Design

The conceptual framework which a research study is carried out with guidelines on data collection and analysis is termed as research design (Mugenda and Mugenda, 2003). A survey research method with *Ex-post facto* research study design was used. According to the design as was noted by Kathuri & Pals (1993), Ellis-O'Quinn (2012) and Wiersma (2009) relates to exploring the impact of ''a naturally occurring treatment after the treatment has occurred''. This study determined the effectiveness of project extension approach in dissemination and adoption of selected maize production technologies as compared to conventional extension approach. Additional studies such as Kothari, (2012) and Ingleby, (2012) observed this kind of design is applicable when determining the cause-and-effect relationship between past actions.

According to Cohen et al., (2007) cross-sectional survey studies are kind of observational studies, which analyses data collected at a specific time and point. Cross-sectional survey was also employed as structured questionnaires and observations were collectively applied to collect and verify information from sampled respondents on effectiveness of the approaches in dissemination and adoption of selected maize production technologies.

3.4. Target Population

An entire group that an investigator is focused at or the category upon which a conclusion is drawn from is termed as target population Mugenda and Mugenda (2003). The study targeted 142 small scale farmers who were project beneficiaries based on One Acre Fund Field Report for a period of 4 years before opting out. The study also targeted beneficiaries of conventional extension approach from the extension services of Ministry of Agriculture under Kisumu County Government over the same duration.

3.5. Sample Size Determination

According to Kothari (2004), a sub-set of entire population applied for generalisation of the target population is termed as sample size. Whenever the study population is below 10,000 a researcher is allowed to pick good presentation of sample size between 10-30 percent of target population and use *t*-test during data analysis (Mugenda, 2013).

Using Cochran's sample size formula of:

$N_0 = (Z^2pq)/e^2$

Where N_0 denotes sample size, Z denotes z-value in a Z table, e denotes recognised level of precision (i.e., the margin of error), p denotes the estimated proportion of the population which has attribute in question and q denotes 1-p.

In this case,

N_0= (1.96^2*0.2*(1-0.2)/ 0.05^2= 246

Due to low targeted population for this study, the following formulae was used to modify the sample size:

N= n_0/ (1+ (n_0-1/N). Where N is the new adjusted sample size, n_0 is Cochran sample size recommendation.

Sample size was calculated as follows:

246/ (1+ (245/142) = 90

Total sample size of 180 small scale farmers was studied as shown in Table 1 (90 small scale farmers from each extension approach).

Table 1: Respondents sampled per the corresponding villages.

Name of Village	Population Size (N)	Sample Size (n)
Oluti	105	68
Ombo	44	28
Lunga	42	26
Malela	38	24
Gul	25	16
Kaila	24	14
Magina	4	4
Total	**284**	**180**

n=180

3.6. Sampling Procedure.

Sampling procedure refers to selection of a part of a population as a representative for determining attributes entire population (Frankel &Wallen, 2004). Cochran, (1963) formula was applied to determine sample size of 180 small scale farmers utilised. Purposive random sampling technique was utilised to get respondents from purposively selected villages. Purposive sampling was preferred as the study only targeted beneficiaries of the extension approaches. In addition, random sampling was done in order to select the actual beneficiaries of the approaches to serve as respondents, this was done to avoid biasness in respondents' selection.

3.7. Survey Questionnaire

According to Abawi, (2013) data collection tool comprise a series of questions used for information capturing is called survey questionnaires. Structured questionnaires having both closed and open-ended statements and questions were applied as data collection instruments to collect relevant data needed to meet study objectives as indicated in appendix 2. The questionnaires were designed to capture interval, ordinal and nominal data as per the objectives of the study, for both descriptive and inferential statistical analysis. Likert scale which is a psychometric scale commonly used to scale responses, the levels of agreement to some questions was typically in five points: (1) Very Low; (2) Low: (3) Moderate: (4) High: (5) Very High.

3.8. Validity of the Instrument

Validity is explained as the preciseness, meaningfulness and appropriateness of specific inferences that are selected on research results (Frankel &Wallen, 2004). It is the degree to which results obtained from the data analysis represent the phenomenon under the study. Content validity was a concern in this study. According to Kothari (2004) content validity is defined as extent to which a questionnaire covers the topic under study adequately. Content validity of questionnaire was assessed by two supervisors and fellow students and enumerators in research in relation to specific objectives under this study. Refining of the questionnaire was done under the guidance of supervisors to strengthen its validity.

3.9. Reliability of the Instrument

The precise extent of internal consistency or stability of questionnaire over period of time is referred as its reliability. Southwest Rata in Seme Sub-County was selected as a pilot study area since project extension approach was introduced into the area in the same year as East Seme Location and the area was easily accessible by the enumerators and researcher. Test-retest method was used to ascertain reliability. Thirty small scale farmers followed by another interview of a similar numbers of small-scale farmers after two weeks was conducted. Through correlating the scores instrument reliability was confirmed.

The tool's reliability was explored using Cronbach's alpha coefficient. Mugenda (2003), argued a lowest threshold level of approval of a questionnaire for social research study is tagged at 0.7 coefficient alpha. Scores were computed gave a reliability coefficient of 0.7063. Readjusting item's length and exclusion of unclear questions were employed to improve the reliability of the questionnaire. The tool's validity was checked through discussion with supervisors to ensure all included items captured the research objectives.

3.10. Data Collection Procedures

Upon research proposal approval, inception note from university and license from Ministry of Science and Technology through National Council of Science and Technology and Innovation (NACOSTI) were obtained as shown appendix 3. The local administrators for the study areas were informed, and additional authorization letters were provided. Through survey methodology, physical interviews were conducted for data capturing from sampled respondents. Translation into local language was done in cases where farmers were not competent in English.

3.11. Recruitment and Training of Research Assistants

Three enumerators were mobilised to aid in data collection based on the following criteria: agriculture field experiences, research work including participatory methodologies For quality data collection the research assistants (RAs) were trained and on-training pre-test conducted was .The topics that were covered in the training were: focus on study background ; rapport establishment with targeted respondents; confidentially as well as ethics in research.

3.12. Data Analysis

Descriptive and inferential statistics were used for data analysis and null hypotheses tested 0.05 alpha level of significance. Coding was done to the data collected and analysed by using the Statistical Package for Social Sciences (SPSS) version 20 software. Analysed data were presented descriptively using frequencies, percentages, means, and standard deviation. Independent sample *t*-test which is a parametric test was used to compare the sample means for the two set of categories, that is beneficiaries of the two approaches under study. The method was used for determining any statistical significance difference between selected extension approaches in dissemination and adoption of selected maize production technologies, knowledge and skills acquisition, levels of maize production in form of yields in East Seme Location.

During the analysis, project and conventional extension approaches were the independent or explanatory variables while levels of adoption of selected maize production technologies, knowledge and skills acquisition, levels of maize production in form of yields were the dependent variables under consideration. The method was used as it assumed independence of the observations belong to only one category, no significant outliers in the two groups, data from each group is normally distributed and homogeneity of variances in each category.

One way- Analysis of variance (ANOVA) a parametric test used to compare the means of two or more independent groups in order to determine whether there is statistical evidence that the associated population means are significantly different. The method was used to determine statistically significant differences between mean scores of the three groups: pre and post project extension approach participation and conventional extension approach beneficiaries. The three groups served as independent variables while selected maize production technologies, knowledge and skills acquisition, levels of maize production in form of yields were the dependent variables. Furthermore, post hoc analysis was undertaken to uncover specific differences between the three groups means when an analysis of variance (ANOVA) F test is significant.

The adoption level determination formulae used:

$$Y= d_1 + d_2 + d_3 + d_4 + d_5 + d_6 + d_7$$

Where, Y is adoption of maize production technologies, d_1 improved maize seed variety, d_2 recommended number of seed per hole, d_3 recommended maize spacing, d_4 recommended fertilizer application, d_5 proper weeding, d_6 improved maize storage bags and d_7 maize storage pesticides.

Contribution for each socioeconomic factor on adoption for the selected techniques was determined through multiple regression analysis. In addition, a linear model was applied to determine line of best fit and significance of β coefficient of the socioeconomic factors was tested at α level of 0.05. Total percentage of variations in levels of adoption of selected maize production technologies is realised following inclusion of the socioeconomic factors in the model is presented by square of correlation coefficient (R^2) with a high R^2 being most instrumental at predicting selected maize production technologies. These technologies included improved maize seed varieties, number of maize seeds per hole, proper maize spacing's, recommended fertilizer application, proper weeding, post-harvest technologies such as improved maize storage bags for weevil control and maize storage pesticides for example Actellic gold dust.

The model has the following independent variables household size, age of respondents, educational level, farm size, household income and gender while the dependent variable was adoption of selected maize production technologies as an entire package. This model helps in showing predictions regarding influence of selected factors on adoption and making informed decisions regarding the importance of variables during dissemination of selected technologies for adoption.

Multiple correlation coefficient helps in showing combined relations between a dependent and a series of independent variables and is denoted by R as the square root of the ratio of the regression sum of total squares. It is always positive and less than one.

Kothari (2012) noted that: If Y is the dependent variable and P1, P2......are the independent variables, then the multiple regression equation will be: $Y= \beta0+ \beta_1 P_1+ \beta_2 P_2 ......+ E$

Where: β0 is a constant and β1 + β2 .... are referred to as Beta in Table 21 and are the partial regression coefficients.

The square of the multiple correlation coefficient R^2 represent the fraction of the variation in y, accounted for by its joint association with the variates P1, P2........ The coefficient is therefore a measure of the joint association of all these variates with the dependent variate Y and tells us how much of variation in Y could be accounted for by reference to these variates (Mondal, 2014). The value of R^2 is generally multiplied by 100 and expressed in terms of percentage. In this study the multiple regression was generate as follows:

$Y = \beta0 + \beta1P1+ \beta2P2 + \beta3P3+ \beta4P4 + \beta5P5+ \beta6P6 + \epsilon$

Where: Y is the dependent variable, while P1, P2........P6 are the independent variables

The definition of variables formulated for the model was as follows:

Y= Adoption of selected maize production technologies as a package.

β0 = Constant term and β1, β2...... β6 = are the partial regression coefficients

E= Epsilon term

P1 = Household size; P2 = Age of respondents; P3 = Education Level; P4 = Farm size; P5 = Household Income; P6= Gender

3.13. Ethical Considerations

Note of introduction from university plus a permit from Ministry of Education for introduction were obtained. All information captured from respondents were confidentiality handled and only used academic purpose.

3.14. Operationalization of Variables

According to Mugenda and Mugenda (2006) it is the definitions of operations employed in measuring study variables and includes objectives, variable types, indicators, scale of measure, and statistical test has indicated in Table 2.

Table 2: Summary of Statistical Tests used in Data Analysis for the Study

Null Hypothesis	Independent variable	Dependent variable	Method of analysis
H_{o1}. There is no statistically significant difference between project approach as compared to conventional extension approach effectiveness on levels of adoption of selected maize production technologies.	Project extension approach or Conventional extension approach.	Adoption of selected maize production technologies.	Descriptive analysis- mean and frequency Inferential analysis- *t*-test and One way-ANOVA
H_{o2}. There is no statistically significant difference between project approach as compared to conventional extension approach on selected maize production technologies knowledge and skills acquisition.	Project extension approach or Conventional extension approach.	Knowledge and skills acquisition	Descriptive analysis- mean and frequency Inferential analysis- *t*-test and One way-ANOVA.
H_{o3}. There is no statistically significant difference on level of maize yields as a result of adoption of selected maize production technologies disseminated through project approach as compared to conventional extension approach.	Project extension approach or Conventional extension approach	Maize production in terms of yields.	Descriptive analysis- mean and frequency Inferential analysis- *t*-test and One way-ANOVA
H_{o4}. There is no statistically significant influence of selected socio-economic factors (Age of farmers, education level, gender participation, household income, farm size and household size) on adoption of maize production technologies.	Age, Education level, Gender, Income, Farm size and Household size.	Adoption of selected maize technologies	Descriptive analysis- mean and frequency Inferential analysis- Multiple regression

3.15. Chapter Summary

The chapter has discussed the methodology used and further presented research design, location of study, targeted population, sample size determination, sampling procedure, survey questionnaire, reliability and validity of the instrument, data collection procedure, recruitment and training of research assistants, data analysis, operationalization of variables ethical standards.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1. Introduction

This section provides results and discussions on effectiveness of project extension approach in dissemination and adoption of selected maize production technologies among small-scale farmers in Seme Sub-County, Kisumu County.

4.2. Questionnaire Return Rate

During the two weeks of data collection exercise, 180 questionnaires were successfully administered and returned depicting a return rate of 100 percent. Babbie (1990), suggested 60 percent is recommended response rate while 70 percent being impressive. Return rate of 100.0 percent was therefore regarded enough for this research.

4.3. Respondent Distribution by Village

Majority of respondents were from Oluti village at 37.2 percent followed by Ombo at 15.6 percent, and lastly Magina at 1.7 percent as indicated in Table 3. Differences in numbers of respondents interviewed per village was influenced by several factors such as frequency of training visits by extension officers, proximity to trading centres and geographical positioning of villages location.

Table 3: Respondents Distribution by Village

Name of Village	Frequency	Percent
Oluti	67	37.2
Ombo	28	15.6
Lunga	27	15.0
Malela	24	13.3
Gul	16	8.9
Kaila	15	8.3
Magina	3	1.7
Total	180	100.0

n=180

4.4. Socio-Economic Characteristics of the Respondents.

4.4.1. Gender and Adoption of Maize Production Technologies

According to Lionberger, (1996) findings, women manage most homes when men are in urbans in search for jobs. The findings in this study shows that most of respondents were female at 62.2 percent while male at 37.8 percent as presented in Table 4. Availability of time for women contributed to their dominance in this study. Additionally, most males never participated in the interviews referring enumerators to the females who are considered as farms owners. The results study concurs with the findings made of World Bank (2006) who reported that, women in Kenya provide greatest labour yet key decision makers in farming are men. Female farmers were found to have higher level of uptake for maize production technologies among the beneficiary of project extension approach at 64.8 percent as compared to male at 35.2 percent.

Table 4: Respondents distribution by gender.

Gender	Frequency	Percent
Male	68	37.8
Female	112	62.2
Total	**180**	**100.0**

n=180

4.4.2. Age and Adoption of Maize Production Technologies

The small-scale farmers within an age group of 31 to 45 years old registered the largest number at 51.7 percent followed by 46 to 60 years old at 25.6 percent and 5 percent of the respondents are between ages 61 to 80 years old as shown in Table 5. Age is an important factor in agricultural production since it determines the availability and reliability of the labour needed to thrive the sector. This depicts that maize production is majorly undertaken by individuals aged 31 to 45 years since they avail required labour for land preparation, planting, weeding, top dressing, harvesting and storage. Young farmers are more updated on upgraded technologies and practices and relatively risk takers and adapt to improved farming innovations or techniques since they are ready to realise more productivity from their fields (Abunga et al., 2012). According to Wasula, (2000) and Lionberger, (1996) farm practices adoption is more likely to be observed among the younger farmers compared to the older farmers.

Table 5: Age distribution among respondents.

Age Range (years)	Frequency	Percent
18-30	32	17.8
31-45	93	51.7
46-60	46	25.6
61-80	9	5.0
Total	**180**	**100.0**

n=180

4.4.3. Education Level and Adoption of Maize Production Technologies

Most respondents have primary level of education, with very few having attained higher level of education as indicated in Table 6, according to the results 57.8 percent of respondents have attained primary certificate level of education and the least being university degree level at 4.4 percent. Well-structured education is instrumental in dissemination agricultural innovations by enabling farmers to be effective during techniques application because of sound information gained. It enables farmers to assess the relative benefits and risks before decision making. It deepens their understanding for the uptake of all the technologies as a package. In addition, it improves the ability to evaluate, diagnose and respond to new innovations.

Table 6: Distribution of Levels of Education respondents.

Level of Education	Frequency	Percent
University	8	4.4
Secondary	51	28.3
Polytechnic	17	9.4
Primary	104	57.8
Total	**180**	**100.0**

n=180

Findings concurs with Abebaw & Belay, 2001; Rogers, (2003) which noted that decision-making and uptake of agricultural innovations is enhanced by education. Education level is noted to have a remarkable effect on technologies uptake decision has realised in other studies; Mishra and Park, (2005); Mishra et al., (2009); Fernandez-Cornejo et al., (2001). Farmers with know-how of innovation application are easier to put in into practice. Further, the finding concurs with Nkonya et al. (1997) in research done in Northern Tanzania on uptake of improved maize techniques.

4.4.4. Household Size and Maize Production Technologies Adoption

The findings in this study shown in Table 7 denote most respondents have household size of 5 members at 22.8 percent followed by 6 members at 21.7 and the least being household size of 1 member at 1.1 percent. The household size in the rural is one of the important determining factors for the availability of much demanded labour during various stages of farming. This is an important socio-economic factor during application of various farm practices (Njuguna et al., 2015). However, other studies show that a larger household size may lower the adoption level of improved agricultural technologies since it might imply more cash constrain as a result of meeting other family needs because of large family size, hence leaving little cash for the household use in acquisition of farm inputs and latest practices or technologies (Audu and Aye, 2014; Kudi et al., 2011).

Table 7: Respondents household size distribution.

No. of household members	Frequency	Percent
1	2	1.1
2	4	2.2
3	24	13.3
4	33	18.3
5	41	22.8
6	39	21.7
7	16	8.9
8	11	6.1
9	4	2.2
10	6	3.3
Total	**180**	**100.0**

n=180

4.4.5. Household Income and Adoption of Maize Production Technologies

The rural household income is a vital factor enabling smallholder's farmers acquire needed farm inputs and their utilization. The respondents indicated with higher incomes ability adoption of selected maize production techniques is likely to be faster and at a higher level than farmers with low income due to availability of disposable income. The positive relationship signals: economic intervention strategies such as subsidised farm inputs costs would fasten the adoption of selected technologies by farmers.

4.4.6. Farm Size and Adoption of Maize Production Technologies

Increasing rural population pose a remarkable hinderance to the agricultural productivity due to reduction of farm size available for agricultural production. The results in Table 8 shows the respondents own small land sizes of averagely 0.8097 hectares per household thus influencing their decisions to adopt the techniques fully, partially or not at all. Beneficiaries of project extension approach have relatively greater farm size of 0.7085 hectares under maize production techniques compared to beneficiaries of conventional extension approach with an average of 0.4049 hectares. This translates to 87.5 percent and 50 percent respectively regarding their land size into farm size set be aside for the adoption of the techniques. Some studies show individuals owning relatively large land sizes have higher probability of adopting technologies and conversation of larger percentage of their land size converted to farm size under the techniques than counterparts with small.

According to Feder et al., (1985) farmers possessing large land sizes are assumed to be capable to acquiring and adopting improved technologies because they have the ability to take the risk in case technology failure. Contrary, to this study findings Chukwuji and Ogisi (2006) found out that it is more economical for farmers to adopt techniques such as fertilizer application when cultivating of large farm sizes.

Table 8: Average land and farm sizes in hectares.

Size	Mean	N	Conversion Percentage
Land	0.8097	180	
Project extension approach	0.7085	90	87.5
Conventional extension approach	0.4049	90	50

n=180

4.5. Adoption Levels of Selected Maize Production Technologies.

Testing of effectiveness of project extension approach on adoption levels of selected maize production technologies as compared to conventional extension approach. Time duration which the respondents did attend trainings offered through either of these approaches was determined within the 4 years' periods before opting out. This study realised majority of respondents had attended trainings for 4 consecutive years at 58.3 percent, followed by 3 years at 25.6 percent, 2 years at 9.4 percent and 1 year at 6.7 percent as shown in the Table 9.

Table 9: Frequency of training attendance

Number of years	Frequency	Percent
1	12	6.7
2	17	9.4
3	46	25.6
4	105	58.3
Total	**180**	**100.0**

n=180

Adoption level was determined using formulae:

$Y = d_1 + d_2 + d_3 + d_4 + d_5 + d_6 + d_7$

Where, Y represents adoption of maize production technologies, d_1 is improved maize seed variety, d_2 recommended number of seed per hole, d_3 recommended maize spacing, d_4 recommended fertilizer application, d_5 proper weeding, d_6 improved maize storage bags and d_7 maize storage pesticides.

Respondents were realised to have adopted these technologies or practices at different levels. Finds as presented in Table 10 reveals levels of adoption for each technology component. The findings indicate above average level of adoption for entire package hence sufficient for drawing levels of adoption conclusion. The data was classified as dichotomous; adopters were the respondents who adopt recognised level. This was regarded as the recommended level of adoption. Non-adopters are individuals who adopted three technologies or practices and less, to accepted level. It was regarded as adoption far from the recommended level. This criterion, adoption index level found only 63.9 percent had adopted entire package to recommended level with 36.1 percent having adopted less than the satisfactory level with beneficiaries of project and conventional extension approaches leading at 77.4 percent and 22.6 percent respectively.

Table 10: Adoption Level and Adoption Index of Package Components

Adoption Level	Technology Component	Count	Percentage	Percentage of Adopters	Percentage of Non-adopters	Project extension approach	Conventional extension approach
	d_1	132	73.3				
	d_2	117	65.0				
	d_3	128	71.1				
	d_4	93	51.7				
	d_5	149	82.8				
	d_6	78	43.3				
	d_7	67	37.2				
Total		**180**	**100.0**	**63.9**	**36.1**	**77.4**	**22.6**

Source: Field Work, 2019

The t-test analysis findings shown in Table 11 reveals that there is significant difference between mean scores of beneficiaries of the selected approaches at 0.05 alpha level with (t = 9.401, P <.05) for adoption of improved maize varieties seeds, (t = 12.701, P <.05) for adoption of recommended number of maize seeds per hole, (t = 13.015, P <.05) for adoption of proper maize spacing's, (t = 14.038, P <.05)for adoption of recommended application of fertilizers, (t=3.400, P<.05) for adoption of proper weeding, (t = 11.644, P <.05) for adoption of improved maize storage bags and (t= 11.057, P<.05) for adoption of maize storage chemicals. Therefore, the null hypothesis (H_o) was rejected since in every instance: P-value< 0.05. The results are similar to Yaron et al., 1992, findings which also found out that extension services accessibility is vital in promotion of modern agricultural production innovations or technologies for adoption as its counterbalance the hurdles of lack of years of formal education in overall decision for uptake some agricultural practices and technologies.

Table 11: T-test analysis results for the selected maize production technologies.

Maize production technologies	Extension Approach	N	Mean	SD	t-Value	2-tailed probability
Improved maize seed varieties	Project Extension approach	90	1.0444	.20723	9.401*	.000*
	Conventional Extension approach	90	1.5778	.49668		
Correct number of maize seed per hole	Project Extension approach	90	1.0000	.000	12.701*	.000*
	Conventional Extension approach	90	1.6444	.48136		
Proper maize spacing	Project Extension approach	90	1.0000	.0000	13.015*	.000*
	Conventional Extension approach	90	1.6556	.47785		
Correct fertilizers application	Project Extension approach	90	1.0000	.0000	14.038*	.000*
	Conventional Extension approach	90	1.6889	.46554		
Proper weeding	Project Extension approach	90	1.0222	.14823	3.400*	.000*
	Conventional Extension approach	90	1.1667	.37477		
Improved maize storage bags	Project Extension approach	90	1.2111	.41038	11.644*	.000*
	Conventional Extension approach	90	1.8667	.34184		
Maize storage pesticides	Project Extension approach	90	1.2444	.43216	11.057*	.000*
	Conventional Extension approach	90	1.8778	.32938		

Legend: (*) Significant at the .05 alpha level

n=180

Subjecting the results to *t*-test analysis reveals statistically significant difference between the mean scores for beneficiaries of selected extension approaches on adoption for the selected technologies at the alpha level of .05 with (t = 10.750, P <.05) as presented in Table 12.

Table 12: Summary T-test Analysis Table for selected approaches on adoption of selected maize production technologies.

Categories of beneficiaries	N	Mean	S. D	*t*-value	2-tailed probability
Project Extension approach	90	1.075	.1711	10.750*	.000*
Conventional Extension approach	90	1.639	.4239		

Legend: (*) Significant at the .05 alpha level

n=180

Findings for the analysis of variance done for every technology shows various instances of statistically significant difference and non-statistically significant difference across the three levels: (1- *Before project extension approach participation, 2- After project extension approach participation, 3- Conventional extension approach participation*) as shown in Table 13. For example, adoption results for the following techniques: improved maize seeds, recommended number of maize seeds per hole, proper maize spacing's, recommended fertilizers application, proper weeding, maize storage bags and maize storage pesticides indicates a statistically significant difference between groups of before and after project extension approach participation, after project extension approach participation and conventional extension approach with calculated $P<.05$. However, no significant difference was found between before project extension approach participation and conventional extension approach beneficiaries for the selected techniques with $P>.05$ for respective techniques (in that order) at P values of .063, .124, .111, .105, .187, .205, and .109.

Table 13:Analysis of variance results for the adoption of selected maize production technologies.

Selected maize production technologies	Least Square Difference	(I) Group	(J) Group	Sig.
Improved maize seed varieties	LSD	1	2	.000
			3	.063
		2	1	.000
			3	.000
		3	1	.063
			2	.000
Recommended number of maize seed per hole/hill	LSD	1	2	.000
			3	.124
		2	1	.000
			3	.000
		3	1	.124
			2	.000
Proper maize spacing	LSD	1	2	.000
			3	.111
		2	1	.000
			3	.000
		3	1	.111
			2	.000
Recommended fertilizers application	LSD	1	2	.000
			3	.105
		2	1	.000
			3	.000
		3	1	.105
			2	.000
Proper weeding	LSD	1	2	.000
			3	.187
		2	1	.000
			3	.005
		3	1	.187
			2	.005
Improved maize storage bags	LSD	1	2	.000
			3	.205
		2	1	.000
			3	.000
		3	1	.205
			2	.000
Maize storage pesticides	LSD	1	2	.000
			3	.109
		2	1	.000
			3	.000
		3	1	.109
			2	.000

*. The mean difference is significant at the 0.05 level.

Key

(1- Before project approach participation, 2- After project approach participation, 3- Conventional extension approach participation).

LSD- Least Square Difference.

4.6. Selected Maize Production Technologies Knowledge and Skills Acquisition.

The results in Table 14 shows 66.7 percent of farmers acknowledged selected approaches to have enabled them to acquire knowledge and skills of selected maize production technologies with beneficiaries of project extension approach and conventional extension approach recording 74.2 percent and 25.8 percent respectively. The results also indicate that 31.1 percent noted either of the approaches were not responsible for their knowledge and skills acquisition with conventional extension approach and project extension approaches recording 98.2 percent and 1.8 percent respectively, 2.2 percent of respondents were neutral towards the approaches to having enabled them to acquire knowledge and skills with 100 percent of the respondents are under conventional extension approach.

Table 14: Frequency distribution on effectiveness of the approaches on knowledge and skills acquisition.

			Project Extension Approach	Conventional Extension Approach
Response	**Frequency**	**Percent**	**Percent**	**Percent**
Yes	120	66.7	74.2	25.8
No	56	31.1	1.8	98.2
Neutral	4	2.2	0	100
Total	**180**	**100.0**		

n=180

The *t*-test analysis findings in Table 15 presents a statistically significant difference between mean scores for beneficiaries two approaches across all selected technologies at 0.05 alpha level regarding knowledge and skills acquisition for selected maize production technologies with (t = 14.508, $P < .05$) for adoption of improved maize varieties seed, (t = 22.346, $P < .05$) for use of recommended number of maize seed per hole, (t = 17.351, $P < .05$) for proper maize spacing's, (t = 24.496, $P < .05$) for correct use of fertilizers, (t =

13.202, $P < .05$) for proper weeding, ($t = 15.147$, $P < .05$) for use of improved maize storage bags and ($t = 12.664$, $P < .05$) for adoption of maize storage pesticides.

Table 15: Results on Knowledge and Skills Acquisition for Selected Maize Production Technologies.

Selected Maize production technologies	Extension Approach	N	Mean	SD	t-Value	2-tailed probability
Improved maize seed varieties	Project	90	4.044	.4952	14.508*	.000*
	Conventional	90	2.622	.7872		
Correct number of maize seed per hole	Project	90	4.122	.3294	22.346*	.000*
	Conventional	90	2.433	.6369		
Proper maize spacing	Project	90	4.122	.3294	17.351*	.000*
	Conventional	90	2.522	.8104		
Correct fertilizers application	Project	90	4.178	.3845	24.496*	.000*
	Conventional	90	2.267	.6325		
Proper weeding	Project	90	4.178	.3845	13.202*	.000*
	Conventional	90	3.078	.6907		
Improved maize storage bags	Project	90	3.711	.8900	15.147*	.000*
	Conventional	90	2.122	.4454		
Maize storage pesticides	Project	90	3.589	1.027	12.664*	.000*
	Conventional	90	2.122	.3917		

*The mean difference is significant at the 0.05 alpha level

n=180

The *t*-test analysis results shown in Table 16 reveals instance of statistically significant difference between mean scores for beneficiaries of the two approaches on knowledge and skills acquisition at the alpha level of .05 with (t = 17.102, $P < .05$).

Table 16: Summary T-test analysis results for knowledge and skills acquisition.

Categories of beneficiaries	N	Mean	S. D	*t*-value	2-tailed probability
Project Extension approach	90	3.922	.4936	17.102*	.000*
Conventional Extension approach	90	2.452	.6298		

*The mean difference is significant at the 0.05 alpha level.

n=180

Results from analysis of variance for knowledge and skills acquisition for selected maize production technologies indicate various instance of statistically significant difference and non-statistically significant difference across the three levels: *(1- Before project extension approach participation, 2- After project extension approach participation, 3- Conventional extension approach participation)* as shown in as shown in Table 17. The results indicates that acquisition of knowledge and skills has statistically significant difference for the following techniques; improved maize seeds, use of recommended number of maize seeds per hole, proper maize spacing's, recommended fertilizers application, proper weeding, use of improved maize storage bags and maize storage chemicals between groups of before and after project extension approach participation, after project extension approach participation and conventional extension approach with calculated $P < .05$ at $P < .00$. However, the findings show no significant difference found between before project extension approach participation and conventional extension approach beneficiaries for the selected techniques with calculated $P > .05$ for respective techniques (in that order) at P values of .061, .098, .221, .496, .316, .106, and .333.

Table 17:Analysis of variance results for knowledge and skills acquisition for selected maize production technologies.

Selected maize production technologies	Least Square Difference	(I) Group	(J) Group	Sig.
Improved maize seed varieties	LSD	1	2	.000
			3	.061
		2	1	.000
			3	.000
		3	1	.061
			2	.000
Recommended number of maize seed per hole	LSD	1	2	.000
			3	.098
		2	1	.000
			3	.000
		3	1	.098
			2	.000
Proper maize spacing	LSD	1	2	.000
			3	.221
		2	1	.000
			3	.000
		3	1	.221
			2	.000
Recommended fertilizers application	LSD	1	2	.000
			3	.496
		2	1	.000
			3	.000
		3	1	.496
			2	.000
Proper weeding	LSD	1	2	.000
			3	.316
		2	1	.000
			3	.000
		3	1	.316
			2	.000
Improved maize storage bags	LSD	1	2	.000
			3	.106
		2	1	.000
			3	.000
		3	1	.106
			2	.000
Maize storage pesticides	LSD	1	2	.000
			3	.333
		2	1	.000
			3	.000
		3	1	.333
			2	.000

*. The mean difference is significant at the 0.05 level.

Key

(1- Before project approach participation, 2- After project approach participation, 3- Conventional extension approach participation).

LSD- Least Square Difference

4.7. Levels of Maize Production.

Improvement of agricultural productivity in the rural areas is important in achieving household food nutrition and security. To achieve improved agricultural production, uptake of new agricultural innovation or practices is instrumental. In this study adoption of selected maize production technologies noted to have resulted into improved levels of maize production with 69.4 percent of respondents acknowledging yields improvement. Beneficiaries of project extension approach have recorded the highest positive yield response at 64.8 percent compared to conventional extension approach beneficiaries at 35.2 percent. This concur with Nin et al., (2003), who noted agricultural productivity growth in the developing world is as a resultant of the uptake of improved agricultural production innovations. However, 22.2 percent of interviewed farmers found out that yields have not changed with beneficiaries of project extension approach and conventional extension approaches at 12.5 and 87.5 percent respectively. Meanwhile, 8.3 percent of interviewed farmers disagreed with any aspect of approaches to having changed levels of maize production with project extension approach beneficiaries at 26.7 percent and conventional extension approach at 73.3 percent as indicated in Table 18.

Table 18: Respondents distribution regarding influence of selected extension approaches on level of maize production.

			Project Extension Approach	**Conventional Extension Approach**
Response	**Frequency**	**Percent**	**Percent**	**Percent**
Yes	125	69.4	64.8	35.2
No	40	22.2	12.5	87.5
Neutral	15	8.3	26.7	73.3
Total	**180**	**100.0**		

n=180

The beneficiaries of project extension approach recorded highest maize yields at an average of 498.3 kg as compared to beneficiaries of conventional extension approach at 298.1 kg per half hectare as shown in Table 19. Results also indicate a statistical significance difference between selected approaches at 0.05 alpha level (t = 6.228, P < .05).

Table 19: T-test analysis results for selected extension approaches on levels of maize production.

Categories of beneficiaries	N	Mean	Std. Deviation	*t*-value	2-tailed probability
Project Extension approach	90	498.2778	262.21310	6.228*	.000*
Conventional Extension approach	90	298.0556	155.73078		

Legend: (*) Significant at the .05 alpha levels
n=180

Further, ANOVA test results shows there was significant differences at F = 60.656, p = .000 on the levels maize yields realised following adoption of maize agronomic practices disseminated through selected extension approaches as shown in Table 20.

Table 20: ANOVA Results on Maize Yields.

Scores	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4384611.296	2	2192305.648	60.656	.000
Within Groups	9650188.333	267	36143.027		
Total	14034799.630	269			

Further ANOVA results indicates an existence of a statistically significant difference between the clusters of respondents inform of maize yields realised with calculate P-value at 0.000 and 5 percent level of significance (P< 0.05) between groups before and after project extension approach participation. Similarly, beneficiaries of project extension approach and conventional extension approach results shows a statistically significance differences with a calculated P-value of .000 at 5 percent level of significance. However, no statistically significance difference in level of maize yield between before project extension approach participation and conventional extension approach beneficiary with calculated *P*-value of .089 at 5 percent level of significance (*P*>.05) as presented in Table 21.

Table 21: Post hoc analysis results for farmers categories on levels of maize production.

	(I) Group	(J) Group	Sig.
LSD	1	2	.000*
		3	.089*
	2	1	.000*
		3	.000*
	3	1	.089*
		2	.000*

*. The mean difference is significant at the 0.05 level.

Key:

(1- Before project approach participation, 2- After project approach participation, 3- Conventional extension approach participation).

I&J- Farmer's category.

LSD- Least Square Difference**.**

Income earned among respondents as a result of sale of harvested maize greatly differ with beneficiaries of project extension approach showing a higher average of KES 2,815.0 as compared to beneficiaries of conventional extension approach at an average of KES. 490.0 as shown in Table 22, the difference is attributed to maize yield difference noted between the categories of extension approaches. Findings in Table 22 indicates statistically significant difference between the group on levels of income earned at 0.05 alpha level ($t = 3.550$, $P < 0.05$).

Table 22: T-test Analysis on Income earned as a result of maize sales.

Categories of beneficiaries	N	Mean	Std. Deviation	*t*-value	2-tailed probability
Project Extension approach	90	2815.556	6108.732	3.550*	.000*
Conventional Extension approach	90	490.556	1134.071		

Legend: (*) Significant at the .05 levels

n=180

Similarly, ANOVA results highlighted in Table 23 shows beneficiaries of the project extension approach having statistically significant difference on income earned before and after they participated in the approach with a calculated *P*-value of .000 and 5 percent level of significance ($P < 0.05$) as well as beneficiaries of the project extension approach differ significantly with beneficiaries of conventional extension approach with calculated *P*-value of .000 at 5 percent level of significance ($P < .05$). However, levels of income earned is not statistically significant different between before project extension approach participation with beneficiaries of conventional extension approach as calculated *P*-value of .932 at 5 percent level of significance ($P>.05$).

Table 23: ANOVA results for income earned as a result of maize sales by beneficiaries of selected extension approaches.

	(I) Group	(J) Group	Sig.
LSD	1	2	.000*
		3	.932*
	2	1	.000*
		3	.000*
	3	1	.932*
		2	.000*

*The mean difference is significant at the 0.05 alpha level.

Key:

(1- Before project approach participation, 2- After project approach participation, 3- Conventional extension approach participation)

I&J- Farmer's category.

LSD- Least Square Difference

4.8. Influence of Socio-Economic Factors on Adoption of Selected Maize Production Technologies.

4.8.1. Socio-Economic Factors

Household size, age, educational level, household income, farm size, and gender were the socio-economic factors considered in this study with an aim to predict how they influence adoption of selected maize production technologies among small scale farmers in East Seme Sub-Location. The results further presented the contribution of socio-economic factors being significant (F = 19.044, R^2=0.832, P <.000). High variations in adoption of selected maize production technologies are contributed by explanatory variables like household size, household income and education levels since their $P < .05$. Findings in Table 24 further shows age, farm size and gender were of less significance to having caused variations in adoption of selected techniques since their $P > .05$.

Table 24: Multiple Regression Analysis Results.

Model n =180	R^2 Square	Beta	t-value	Sign
Dependent variable: Adoption of selected Maize Production Technologies (Constant)			3.328	.001*
Household size		.004	-.285	.046*
Age		.057	-.558	.113*
Education Level		.062	.830	.037*
Farm size		-.143	-.834	.140*
Household income		.076	.562	.029*
Gender		.311	1.322	.356*
R^2 squared	**0.832**			
F= 19.044 ***P*<.000**		**Adjusted R ^{2} = .789**		

The findings of the regression analysis in Table 24 above depicts multiple regression equation:

$$Y = \beta0 + \beta1\ P_1 + \beta2P_2 + \beta3P_3 + \beta4P_4 + \beta5P_5 + \beta6P_6 + \epsilon$$

The multiple regression equation as per the substitution of equation above was given as:

$$Y = 3.328 + 0.004P_1 + 0.057P_2 + 0.062P_3 - 0.143P_4 + 0.076P_5 + 0.311P_6 + \epsilon$$

The results show household size influences adopting of selected technologies amongst small scale farmers, number of individuals at the household provides reliable source of labour vital for uptake of agricultural innovations and practices. Households with large individuals is realised to have adopted relatively more technologies as compared to households with low numbers of individuals. Levels of disposable income at household levels is essential factor in uptake of agricultural innovations it enables farmers to acquired essential resources for technologies adoption. In this study, farmers with relatively more incomes are seen to have adopted more selected maize production technologies as they were able to buy various inputs needed for technology adoption.

Significance influence of education level on uptake of selected maize production technologies as shown in the results, depicts the importance formal education in fastening uptake of selected maize production technologies due to effective use of information gained. Education improves managerial ability, hence strengthening capacity to assess, diagnose and react to new insights. It also equips individuals with know-how of how to pick carefully from a pool of available innovations or practices. These results share similarity to Amudavi (1993) in which education was realised to greatly boost technology practising.

Despite many studies have showing age being an important socio-economic in the uptake of agricultural innovations, finding of this study contradicts such findings. Gender had no significant influence on adoption despite female being most of the respondents in this study at 62.2 percent. Most of the respondents did indicate, that individual willingness to adopt maize production technologies are not dependent on the gender in as much that they did recognize that there can be a slight correlation between gender and adoption of some technologies. This study concurs with a study by Ndiema et al. (2002) who realised no significant relationship between uptake of improved seed varieties and gender.

The size of land is often regarded as an important factor when deciding on whether to uptake agricultural innovations or not, as it determines the farm size which a farmer can have under agricultural technologies. In this study, the results shows that small scale farmers in this area doesn’t make a decision of whether to adopt selected maize production technologies based on their farm sizes.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Summary

The study was undertaken in Kaila Sub location within East Seme Location guided by the purpose of determining effectiveness of project extension approach as an alternative agricultural extension approach to conventional extension approach in dissemination of selected maize production technologies for adoption by small scale farmers. Selected socio-economic factors were studied on how they influence adoption of selected maize production technologies. Concepts or aspects of dissemination, communication, transfer, and adoption of technologies were reviewed with the aim of understanding, conceptualizing, and explaining the theoretical basis of these processes and linking them to reality.

Literature review for this study was anchored on research topic, concerned with dissemination and adoption of selected maize production technologies among small-scale farmers in East Seme Location. In this study, recommended maize agronomic practices included use of improved maize seed varieties, planting with D.A.P and top dressing with C.A.N, weeding two times per crop season, spacing of 90 cm by 60 cm in case of two seeds per hole or 75 cm by 35 cm in case of one seed per hole, and post- harvest handling techniques such as hermatic bags and maize storage pesticides.

Major findings of the study indicate that beneficiaries of project extension approach were better off in terms of level of adoption of various selected maize production technologies, knowledge and skills gained and level of maize production in terms of yields realised as compared to conventional extension approach beneficiaries. This was proved in the three hypotheses tested, which all showed a statistical significance difference in their mean scores. Similarly, findings from analysis of variance clearly indicates significance differences between the three groups of pre and post project extension approach participation and conventional extension approach beneficiaries. Same computation confirms similarity between category of farmers before project extension approach participation and beneficiaries of conventional extension approach regarding adoption of selected technologies, knowledge and skills gained, and level of maize production.

The selected socio-economic variables were subjected to multiple regression analysis as a further test of their importance in predicting their influence on adoption of the selected maize production technologies. The finding showed that education level, household income and household size contributed highly to the variation observed in the adoption of selected maize production technologies. Age, gender, and farm size were, however, of less significance in predicting the adoption of selected maize production technologies.

5.2. Conclusion

The following conclusions are made:

1. Project extension approach is more effective in dissemination of selected maize production technologies for adoption as compared to conventional extension approach: Project extension approach beneficiaries showed greater levels of adoption for the selected maize production technologies as a package as compared to conventional extension approach beneficiaries. This therefore shows that project extension approach has sound methodologies for dissemination of selected maize production technologies for adoption among small scale farmers.
2. Project extension approach is more effective in enabling small scale farmers gain knowledge and skills regarding selected maize production technologies as compared to conventional extension approach. This, therefore, shows that methods used within the project extension approach enables sound knowledge and skills transfer.
3. The levels of maize production in terms of yields among beneficiaries of project extension approach is high as compared to counterparts in conventional extension approach. This shows that due to adoption of the technologies disseminated through project extension approach for adoption by small scale farmers enabled them to realise better maize yields.
4. Some socio-economic factors influenced uptake of selected maize production technologies while others do not. Factors like education level, household income and household size are best predictors for the uptake of selected maize production technologies among small scale farmers while other factors such as gender, age and farm size do not influence the adoption of selected maize production technologies.

5.3. Recommendations

i. Support project extension approach interventions

Findings in this study indicates there is need to support interventions targeting promotion of modern agricultural technologies and innovations related to selected maize production technologies through project extension approach by both private sectors. There is a need for both National and County Governments to avail favouring environment for inclusion of private sector led extension servicer's delivery. This can be done through formulation of enabling policies.

ii. Replication of project extension approach in new areas

This study finding validates the need of encouraging replication of project extension approach incorporating input supply model as well as trainings into new areas to aid dissemination of improved agricultural technologies targeting maize production for adoption. This will possibly result into an increase in maize production.

iii. Strengthening conventional extension approach

The findings indicate there is need for Ministry of Agriculture to evaluate effectiveness of conventional extension approach in dissemination of selected maize production technologies and strengthen various methodologies currently under application.

iv. Collaboration between the approaches

Robust knowledge management across the approaches needs to be encouraged to fasten exchange of lessons learnt regarding the process of dissemination and adoption of selected maize production technologies, this will enhance restructuring and refinement of methods and tools involved in the approaches to suit the context (small scale farmers).

5.4. Further Research Suggestions

This study recommends further research in the area on:

i. Underlining factors that hinder small scale farmers in the area towards adoption of maize storage chemicals.
ii. The sustainability and cost effectiveness issues of project extension approach in dissemination and adoption of selected maize production technologies.
iii. Knowledge transfer of agricultural innovation through project extension approach should be examined purposely to ascertain uptake and inclusion into the County extension programme.

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APPENDICES

APPENDIX 1: ONE ACRE FUND ORGANIZATIONAL VISION.

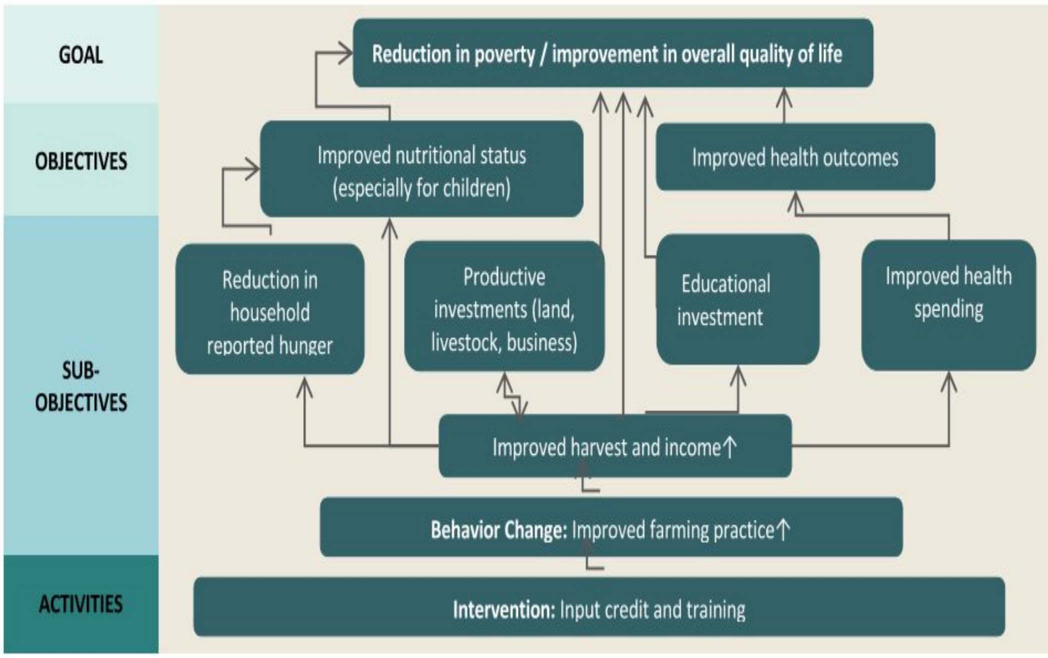

Figure 4: One Acre Fund Impact Report 2016

APPENDIX 2: HOUSEHOLD QUESTIONNAIRE

Guidelines

This tool aims capture data on '**Effectiveness of project extension approach in dissemination and adoption of selected maize production technologies among small-scale farmers in Seme Sub-County, Kisumu County**. The information collected will be used solely for research as intended for this study and will remain confidential.

Section 1: Demographic Data.

a) Respondent name…………………………………………….

b) Name of Village…………………………………………………
c) Tick where appropriate
   Gender: Male [ ] Female [ ].

d) Indicate your age bracket range:
   18-30 years [ ] 31-45 years [ ] 46-60 years [ ] 61-80 years[ ]

e) Kindly indicate your highest level of education attained.
   College/University [ ] Secondary education [ ] Polytechnic [ ]

   Primary education [ ] Never went to school [ ]

f) Household size …………………

Objective1: To determine the effectiveness of project approach as compared to conventional extension approach on levels of adoption of selected maize production technologies.

Answer appropriately.

a) Are you a member of a group working with One Acre fund organization? Yes [**1**] No[**2**]
b) If **Yes**. How many seasons have you worked with the One Acre fund organization? ....
c) If **Yes** to OAF membership, do you normally attend OAF training? Yes (1) No (2)
d) If **NO** to OAF membership, do you normally attend MoA training whenever held? Yes (1) No (2)
e) Do you agree that your adoption levels of maize production technologies has improved due to any of the above approaches? Mark where appropriate. Yes (1) No(2) Neutral (3)
f) Among the selected maize production technologies **(7)** trained on, kindly indicate any or more you have adopted. Yes (**1**) No(**2**) Neutral (**3**).

Technologies	Before OAF Participation	After OAF Participation	None- project beneficiaries
Use of improved maize seed			
Number of seeds per hole			
Proper maize spacing's			
Correct use of fertilizer			
Proper weeding			
Use of improved storage bags			
Use of storage pesticides			

Objective 2: To determine effectiveness of project approach as compared to conventional extension approach on knowledge acquisition of selected maize production technologies.

a) Do you agree that either project or conventional approach has improved your level of knowledge regarding selected maize production technologies? Yes (1) No (2) Neutral (3)

b) Kindly rate your level of knowledge regarding the selected maize production technologies. Tick where appropriate.

NO.	Maize Production Technologies	1- Very low [ ] 2. Low [ ] 3. Moderate [ ]. 4. High [ ] 5. Very high [ ]														
	Category	Before OAF(Participation)					After OAF (Participation)					Non- Beneficiary (conventional approach)				
1	Use of improved maize seed	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
2	Number of seeds per hole	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
3	Proper maize spacing's	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
4	Correct use of fertilizer	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
5	Proper weeding	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
6	Use of improved storage bags	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
7	Use of storage chemicals	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

Objective 3: To determine the level of maize productivity as a result of dissemination of selected maize production technologies through project approach compared to conventional extension approach.

a) Has the level of maize productivity changed as a result of dissemination of selected maize production technologies through project approach or conventional approach? Yes (1) No(2) Neutral(3)
b) How has it changed? Increased (1) Decreased (2) Neutral (3).

Factors	**Before participation (beneficiary)**	**After Participation (Beneficiary)**	**Non- project participant**
Number of 90kg bags.			
Yields (Kg)			
Income (Ksh) as a result of sales from maize grains harvested.			

Objective 4: To determine the influence of selected socio-economic factors on adoption of selected maize production technologies.

Tick where appropriate.

i. What size of land do you own in (ha) ………………?
ii. What is your farm size under maize production technologies? (ha)....................
iii. Do you agree that socio-economic factors influence levels of adoption of selected maize production technologies? Yes ( ) No ( ) Neutral ( ).
iv. Kindly indicate whether the selected socio-economic factors influence the levels of adoption of selected maize production technologies by marking where appropriate: Yes (1) No (2) Neutral (3).

Technologies	**Household Size.**	**Age**	**Educ. levels**	**Farm size**	**Income**	**Gender**
Use of improved maize seed						
Number of seeds per hole						
Proper maize spacing's						
Correct use of fertilizer						

Proper weeding						
Use of improved storage bags						
Use of storage chemicals						

APPENDIX 3: RESEARCH PERMIT

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: **601358**

Date of Issue: **25/September/2019**

RESEARCH LICENSE

This is to Certify that Mr.. Stephen Otieno of Kisii University, has been licensed to conduct research in Kisumu on the topic: Effectiveness of project approach in dissemination and adoption of maize production technologies. A case of One Acre Fund among small scale farmers in Seme Sub-County, Kisumu County. for the period ending : 25/September/2020.

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Director General

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

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APPENDIX 4: WORK PLAN

Action/Month 2019	Sept 2019	Oct 2019	Nov 2019	Dec 2019	Jan 2020	Feb 2020	May 2021	Nov 2021	Dec 2021-May 2022	Jul 2022
Post graduate Proposal submission	X									
Pre-testing		X								
Data collection		X	X							
Data entry				X						
Data analysis				X						
Thesis writing and presentation					X	X				
Thesis submission							X			
Thesis defence								X		
Thesis corrections									X	X
Final Thesis submission										X

APPENDIX 5: KISII UNIVERSITY RESEARCH PERMIT

KISII UNIVERSITY

Telephone: +254 773452121

Email: research@kisiiuniversity.ac.ke

P O BOX 408 – 40200
KISII
www.kisiiuniversity.ac.ke

OFFICE OF THE REGISTRAR RESEARCH AND EXTENSION

Ref: KSU/R&E/03/5/Vol.1/71 **Date:** 20th September, 2019

The Head, Research Coordination
National Council for Science, Technology and Innovation (NACOSTI)
Utalii House, 8th Floor, Uhuru Highway
P. O. Box 30623 – 00100
NAIROBI - KENYA.

Dear Sir/Madam

RE: OTIENO STEPHEN OTIENO MAN11/00002/18

The above mentioned is a student of Kisii University currently pursuing a Master's degree in Agricultural Extension in School of Agriculture and Natural Resource Management. The topic of his research is, **"Effectiveness of Project Approach in Dissemination and Adoption of Maize Production Technologies: A Case of One Acre Fund among Small Scale Farmers in Seme Sub-County, Kisumu County."**

We are kindly requesting for assistance in acquiring a research permit to enable him carry out the research.

Thank you.

for Prof. Anakalo Shitandi, PhD
Registrar, Research and Extension

KISII UNIVERSITY
SEP 2019
REGISTRAR RESEARCH & EXTENSION

Cc: DVC (ASA)
Registrar (AA)
Director SPGS

APPENDIX 6: PLAGIARISM REPORT

EFFECTIVENESS OF PROJECT EXTENSION APPROACH IN DISSEMINATION AND ADOPTION OF SELECTED MAIZE PRODUCTION TECHNOLOGIES AMONG SMALLSCALE FARMERS IN SEME SUB COUNTY, KENYA

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