FACTORS THAT DETERMINE FARMERS' ACCESS AND UTILISATION OF THE INFORMATION AND COMMUNICATION TECHNOLOGY PROVIDED BY THE DEPARTMENT OF AGRICULTURE IN BAHATI DIVISION, NAKURU NORTH DISTRICT, KENYA

JAMES WACIURI WANJOHI

A Thesis Submitted to the Graduate School in Partial Fulfillment of the Requirements for the Award of the Degree of Master of Science in Agricultural Extension of Egerton University

EGERTON UNIVERSITY

NOVEMBER 2015

DECLARATION AND RECOMMENDATION

Declaration

I declare that this thesis is my original work and has not been presented for the award of a degree in any other university.

……. …….

James Waciuri Wanjohi Date
EM12/2321/09

Recommendation

This thesis has been submitted with our approval as university supervisors

……. ……..**....**

Prof. Christopher A. Onyango Date
Department of Agricultural Education and Extension,
Egerton University.

……. ……..**.....**

Dr. David M. Amudavi Date
Director, Biovision Africa Trust,
Coordinator, Biovision Farmer Communication Programme,
icipe - Africa Insect Science for Food and Health,
Nairobi, Kenya.

COPYRIGHT

DEDICATION

This thesis is dedicated to my late parents, Moses Wanjohi and Shelmith Wangeci, who though they did not live to witness this achievement, taught me that the best kind of knowledge to have is that which is learnt for its own sake. It is also dedicated to my family who were a great source of motivation and inspiration and whose support and encouragement helped me soldier on to the end.

ACKNOWLEDGEMENT

I thank the almighty God whose love, mercy and protection saw me through this study. I also thank Egerton University for giving me the opportunity to learn in the institution. I also express my appreciation to the Ministry of Agriculture, Livestock and Fisheries for according me a study leave to pursue this study, the Agriculture extension staff in Bahati Division, for the support they accorded the study by introducing me to the farmers and the division at large and the extension staff in Dundori Division who exhibited exemplary cooperation with the researcher during the piloting of the study. The two teams enabled smooth access to background information, data and facilitated the research conclude successfully. Further, I acknowledge the cooperation and sacrifice of the farmers and village leaders in Bahati Division who participated in this study. I wish to thank my supervisors Prof. Christopher A. Onyango and Dr. David M. Amudavi, for their intellectual contribution, insightful criticisms, sage advice, guidance and commitment to this study. Finally, I acknowledge my family for the understanding and being there for me and encouraging me when I seemed to despair. May God bless you all in a mighty way.

ABSTRACT

Limited access to accurate and timely information by farming communities is perceived as a major drawback in the development of agriculture in Kenya. Subsequently, the Ministry of Agriculture, Livestock and Fisheries (MoALF) has promoted the integration of Information and Communication Technologies (ICTs) to improve farmers' access to information and rapidly transform the delivery of agricultural extension services to them. The initiatives promoted include; mobile telephony, web based network and National Farmers Information Service (NAFIS) as channels of delivering extension messages to farmers. Since the introduction of ICT based information channels in provision of agricultural extension services in 2000, no empirical study has been conducted to assess how the farmers' access and utilise them and also examine the factors influencing these outcomes. The purpose of this study therefore was to assess selected factors that influence access and utilisation of the MoALF's used ICTs in order to inform strategies of widening use of ICTs in agriculture. A cross sectional survey with expost-facto design was adopted. Correct sampling was done to allow generalisation to other people, times and contexts and hence giving it external validity. A total of 110 respondents from 4 locations of Bahati Division, Nakuru North Subcounty, Nakuru County. were selected and interviewed. A questionnaire with closed and open-ended questions was used to collect data while secondary information was used to supplement the responses that had gaps. The questionnaire was subjected to scrutiny by professionals in the Department of Agricultural Education and Extension to assess the content, construct, criterion and face validity. Analysis was conducted using Statistical Package for Social Sciences (SPSS) version 17.0 software. Descriptive statistics used for analysis included modal distribution, means, standard deviations, frequencies and percentages. Chi Square statistical tests were applied for testing relevant hypotheses and inferences interpreted at 0.05 level of significance. The study revealed that farmers in this area relied on MoALF extension agents for agricultural information provided during field days, trade fairs, shows, office visits among other platforms. They also preferred information availed through mass media such as radio and televisions. Radio and mobile phones were common in most households though not used for acquisition of agriculture related information. Farmers in the study area received agricultural related information weekly, monthly and only a few on daily basis. There was generally low farmers' knowledge and usage of mainly computer and internet based ICT platforms in the study area. The farmer's age, gender and level of education were not significant determinants to the utilisation of MoALF information platforms. Farmers who had connection to electricity seemed to have been enjoying more services of NAFIS, use of phones and radio to access MoALF services. There was a significant association between distance travelled to access an extension worker and the utilisation of *MoALF website and NAFIS* services unlike the case for radio and mobile. These findings may inform policy makers at the MoALF to review the content and reassess the suitability of these channels as alternative extension delivery avenues. Further, consider involving target users in development of such future initiatives in order to meet and fulfill the potential of communication technology.

TABLE OF CONTENTS

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

LIST OF TABLES

LIST OF FIGURES

ABREVIATIONS AND ACRONYMS

AECT	Association for Educational Communications and Technology
AIN	Agricultural Information Network
AIRC	Agricultural Information Resource Centre
AIS	Agricultural Innovation Systems
CCK	Communications Commission of Kenya
DIS	Diffusion of Innovation Systems
FAO	Food and Agriculture Organisation of the United Nations
FARA	Forum for Agricultural Research in Africa
ICIPE	International Centre of Insect Physiology and Ecology
ICT	Information and Communication Technology
KAINet	Kenya Agricultural Information Network
KARI	Kenya Agricultural Research Institute
KNBS	Kenya National Bureau of Statistics
LH	Lower Highlands
MoALF	Ministry of Agriculture, Livestock and Fisheries
NAFIS	National Farmers Information Service
SMS	Short Message Service
SPSS	Statistical Package for Social Sciences
TV	Television
UH	Upper Highlands
UM	Upper Midlands
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
WAICENT	World Agricultural Information Centre

CHAPTER ONE

INTRODUCTION

1.1Background of the study

Globally, Information Communication Technology (ICT) in agriculture is a key field focusing on the enhancement of agricultural and rural development. It involves application of innovative ways to use information and communication technologies in delivering agricultural information to farmers. The Food and Agriculture Organisation (FAO) of the United Nations for instance, attaches great importance to the use of information, communication and associated technologies in sustainable agricultural development and food security (FAO, 2007). Through the World Agricultural Information Centre (WAICENT) which is the FAO's strategic resource for improving access to valuable documents, statistics, maps, and multimedia resources, FAO aims to foster the management and dissemination of agricultural information in an effort to achieve food security and fight hunger. WAICENT is a web based platform that aims to build the capacities of those who work to eliminate hunger by providing full-text publications and technical documents available through the internet on agriculture, fisheries, nutrition and forestry. Specific subjects include trends in trade, country-specific information, food safety and deforestation, among others.

Advancements in ICT can be utilised for providing accurate, timely, relevant information and services to the farmers, thereby facilitating an environment for more remunerative agriculture (FAO, 2007). The nature of ICTs is diverse, ranging from telephones, radios and TVs to more complex technologies such as internet technologies, mobile telephone, computers and databases. This diversity implies that they can be used by people with varying degrees of skill, although the current trend towards sophisticated applications could be more demanding to the end user.

The primary purpose of ICTs is to provide an enabling environment for the generation of ideas and knowledge, their dissemination and use by various target groups. In globalising agriculture where the need for information becomes most vivid, the smallholders farmers, who still provide a significant portion of the world’s food, need information to advance their work. The ICTs

foster the diffusion and sharing of knowledge enabling open access to information and better coordination of knowledge (Vachara & Walker, 2005). For instance, infonet-biovision (www.infonet-biovision.org) provides an internet-based information platform that promotes and disseminates locally relevant knowledge on sustainable agriculture, health promotion and environmentally safe technologies and approaches. This easy to access, practical and user-friendly information database is targeted at farmers' groups, NGOs and agricultural and health advisers. In order to make use of all possible dissemination channels, a so-called, offline version of the platform is available on CDs drive and can be used on computers without internet access.

ICT can be used to facilitate efficient transaction between manufacturers, distributors and the consumers as evidenced by the initiative by Farmchem, an agricultural input company who in 2010, launched Angaza Mkulima, a customer information website and SMS communication system to provide valuable information to farmers. The network provides a wide variety of information to farmers such as farming tips and strategies, locations of authorized ICT Applications and Agricultural Input Supply Companies. A farmer is required to submit the name and phone number through a simple form on the website or by sending an SMS with the same information for registration. Once registered, farmers gain access (through the website or SMS menu system) to farming tips and strategies for helping them increase their yields and profits. The system also allows farmers to give feedback on products, identify farmer field days near them, locate their nearest authorized retailer, get updates on new products, and order products directly to their nearest dealer

ICTs facilitate the creation of networks and collaborative and interdisciplinary approaches locally, regionally and globally, leading to shared knowledge-bases, online forums and collaborative spaces and consequently problem solving and research diversification (Nyirenda, 2010). A good example is the Kenya Agricultural Information Network (KAINet) (www.kainet.or.ke) which is an information network set up to promote information exchange among stakeholders in the agricultural sector in order to support decision making, promote innovation in agriculture and subsequently improve livelihoods. It aims to modernise and increase productivity of the agricultural sector.

The Kenya Agricultural Information Network (KAINet) aims to establish coherent information management that maximises information collection, storing and sharing within member institutions and the network on a global platform. In doing so, KAINet encourages institutions to develop strategies that define how information flows within each of them. This offers an opportunity to systematically collect all the information from the institutions, standardise, and share it using appropriate web-based tools and methodologies. In this way, KAINet helps increase efficiency in information management thereby reducing duplication and wastage of resources. Thus there are opportunities that ICTs can offer for transforming the agricultural sector such as in contributing to achieving food security which requires new levels of innovation.

The following examples highlight more of the ICT applications that advisory services have used to improve their interactions and technical knowledge sharing with farmers in developing countries. These applications include web services such as "ask the expert," mobile messaging for advice, radio programs to disseminate technical information, and video. Many of these endeavors are fairly new, limiting practitioners' ability to analyse their effectiveness. Another innovation is the M-Farm, a mobile service that aims to improve Kenya's agricultural sector by connecting farmers with one another, through peer-to-peer collaboration that can improve market information and enhance learning opportunities. Based around farmers' traditional needs, such as the need for market price and weather information, M-Farm is a subscription service that also works with larger institutions, such as NGOs and the government, to connect them with farmers

According to African Economic Outlook (2009), as telecommunications technologies continue to be widely embraced regionally, they open new opportunities for the continent. Fiber-optic cables are progressively being laid across the continent to connect these nations to the information superhighway through broadband internet connection. For the past one decade, Kenya has established one of the largest and fastest internet sectors in Africa. Since the use of internet was introduced in Kenya in 1994, the country has experienced phenomenal growth in its use (Ministry of Information and Communication, 2006). Use of mobile telephones on the other hand has spread rapidly, opening new communications channels that include voice and data and thereby enabling people even in the most remote parts of the continent to gain instant access to the internet.

Some of the common problems in adoption of ICT in rural segments are ICT illiteracy, non-availability of relevant and localised contents in the locals' own languages, easy and affordable accessibility and other challenges such as limited awareness and willingness for adoption of new technologies among the rural people (Ministry of Information and Communication, 2006). One critical aspect in the usage of ICTs is that they can, for example, speed up the extension of development services, can be instrumental in strengthening partnerships and in providing a framework for shared learning (Van Audenhove 2003).The advent of ICT in Kenya opens potential for delivery of appropriate extension and key messages in agriculture to farmers and other users. Currently, the capacity of internet, faxes, mobile phones, Television and Radio tools to relay information to users has proved to be key to leapfrogging enormous development.

The use of ICT in agriculture is still evolving compared to its application in other sectors such as transport. Use of ICT innovations in extension service delivery in Kenya is basically hampered by lack of adequate extension personnel, ICT infrastructure and budget support to reach the over 4.5 million farmers located in the expansive administrative units all over the country (Ministry of Agriculture, 2009). Through the Ministry's own Agricultural Information Resource Centre (AIRC), information most demanded by users is assessed, researched, evaluated and repackaged into booklets, leaflets, posters or books and audio-visual to suit users' needs before being disseminated (Ministry of Agriculture, 2009).

Kenya has different regions that are variably endowed in terms of level and quality of telecommunications, access to information, interest and individuals effort among farmers to access ICT. According to the records of past annual reports on agriculture, Nakuru North Subcounty for instance, is considered to have modest infrastructure and is well endowed in extension personnel, weather and the farming conditions. The majority of farmers in Bahati, Nakuru are post primary graduates with adequate awareness on extension messages delivered through their local extension agents. Through the normal extension activities and fora such as field days, farmer trainings, barazas (local gatherings) and farm visits, the MoALF extension staff brief the farmers on the existence and use of the MoALF ICT initiatives as valuable sources of agricultural information. However, being a rural area, there is a likelihood of vast information divide amongst ICT users in the sub-county (Ministry of Information and Communication,

2006). The ICT initiative by the Ministry of Agriculture, Livestock and Fisheries to fill the information gap is one such attempt. For instance, sending a short message about the name of crop and the name of a division where the sender resides to a specific telephone number to get advice on the variety of the crop suitable for that division, one types the text Bahati# Maize and send to 5354 (the number is regularly changed to avoid distortion by dishonest players). In addition, clients can simply dial 020-5100102 from phone handsets and be able to access information on crop varieties, planting spacing, fertilizer use, pests and diseases and their control from the comfort of their homes.

For the farmers who are internet literate, the Ministry has provided a link to interactive pages where a farmer can log in and ask experts to answer or explain technical information needs on agriculture. Further, farmers can call in through the ministry's open telephone lines, 020 2718870/9 and seek any information needs including the prevailing major markets and prices of agriculture produce.

In order to combat "Fake" Agro-Inputs Counterfeit agricultural inputs, KEPHIS, the Kenya Plant Health Inspectorate Service, provides an SMS service to help diligent farmers verify that seed they have purchased is from a licensed input dealer. The farmer sends an SMS containing the dealer's license number to the KEHPIS system and receives an response confirming the agro-dealer's status. The service is available for users of Kenya's main mobile service providers with the farmers only expected to meet the cost of the outgoing SMS. This is an initiative that could interest input supply companies who may wish to track inputs from their factories to the farms destined for use.

Through a platform hosted by www.plantwise.org/knowledgebank, the Ministry collaboratively provide plant health information and service to farmers and extension agents on various crop enterprises. The platform provides common signs of a pest or disease attack on a crop, management of the condition being chemical, cultural or biological including tolerant varieties for free While some of these ICT initiatives are intended to address the needs of the farmers, the socioeconomic factors of intended beneficiaries that would affect their actual usage has not been examined.

1.2 Statement of the Problem

The Ministry of Agriculture, Livestock and Fisheries has initiated the use of ICT as an additional way of enhancing communication of information to the farming community. The ICT initiatives include; hosting the Ministry's website (www.kilimo.go.ke), use of the National Farmers Information Service (NAFIS) (www.nafis.go.ke), interactive radio programmes (*mteja mfalme*) and telephone lines, for Interactive Voice Response. Despite the investments in these initiatives, there has been no study to examine the factorsthat actually determine effective use of the ICT by farmers in Nakuru North Subcounty. This study therefore was carried out to determine and document the factors that influence access and utilisation of the MoALF's used ICTs by farmers of Bahati Division, Nakuru North Subcounty, Nakuru County.

1.3 Purpose of the Study

The purpose of this study was to establish the key factors that determine the use of the Ministry of Agriculture, Livestock and Fisheries provided ICT initiatives in Nakuru North Subcounty and if addressed would inform the wayforward to the policy makers and planners to improve on their use.

1.4 Objectives of the study

The study had the following main objectives;

1) To identify and document the commonly applied source and channel of agricultural information amongst farmers in Nakuru North Subcounty
2) To assess the level of access to and utilisation of the MoALF provided ICT initiatives in Nakuru North Subcounty.
3) To determine the user's socioeconomic factors that determines access to and utilisation of the MoALF ICT initiatives in Nakuru North Subcounty.
4) To determine selected institutional factors that may determine a user's ability to access and utilise the MoALF provided ICT initiatives in Nakuru North Subcounty.

1.5 Hypotheses of the study

H_o1: there is no statistically significant relationship between the utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and age of farmers in Nakuru North Subcounty.

H_o2: there is no statistically significant relationship (independence) between the utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and level of education of farmers in Nakuru North Subcounty.

H_o3: there is no statistically significant relationship between the utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and gender of farmers in Nakuru North Subcounty.

H_o4: there is no statistically significant relationship between the utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and distance travelled to access an extension office to farmers in Nakuru North Subcounty.

H_o5: there is no statistically significant relationship between the utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and access to electricity to farmers in Nakuru North Subcounty.

1.6 Significance of the study

The findings of this study inform the debate on the value of ICT in extension service delivery. The study findings may enable MoALF particularly to develop a more informed policy on its investment and that of the county governments on ICT based information channels that are easily accessible and utilised by staff, farmers and stakeholders. Extension agents will effectively deliver new information and technical innovations required to cope with farmers' challenges and thereby enhance the livelihoods of Nakuru North farmers and farm households through the most preferred information channel revealed by the study.

Moreover, since the introduction of ICT in provision of agricultural extension services in Kenya, no empirical study has been conducted to assess the accessibility and utilisation of the ICT based information in agricultural extension. This study has therefore been timely.

1.7 Scope of the study

This study was conducted only in Bahati Division of Nakuru North Subcounty and thus the study considered some relevant factors informed by literature review in the area of adoption of innovations. The respondents interviewed were head of households. The selected factors were limited to the farmers' socioeconomic characteristics (gender of the user, age of the household head, his/her (educational level), land ownership and on farm and off farm income sources) and institutional factors (connection to electricity, availability of extension services, and distance to an extension office/agent, availability of ICT infrastructure and cost of ICT).

1.8 Limitation of the study

Bahati Division has some parts with road network that is not all weather making them inaccessible with a vehicle. The researcher used motorcycles to reach some respondents where applicable. Some of the respondents were unwilling to fill the questionnaire especially where the household head was away. The researcher used available secondary information and also administered the questionnaire asking for clarifications in order to get the required information or to supplement the responses that had gaps.

Conducting the study at the onset of devolution and reorganisation of government functions called for strict observance of time as some of the platforms would either be temporarily or permanently be off air with the reconstruction of new units' websites, transfer of functions, end of donor support among others. Some respondents would probably have found it hard to recall some platforms or services that are no longer in operation.

1.9 Assumptions of the study

The study made the following assumptions:

i. The respondents would be honest and truthful with the information provided on the use of ICT amongst farming community in Nakuru North Subcounty.
ii. The personal and socioeconomic factors as well as the institutional considerations investigated in this study were critical to influencing access to and use of provided ICT initiatives.
iii. The findings from this sample would be valuable in informing how to strengthen the optimal use of ICT initiatives to deliver information to farmers to the entire country.

iv. The political environment of the general election would not negatively affect data collection during the study.

1.10 Definition of Terms

Agribusiness is a generic term that refers to the business involved in food production, including farming, seed supply, agrochemicals, farm machinery, wholesale and distribution, processing, marketing and retail sales (FAO, 2009). In this study, the term referred to farmer's activities that promote farming as a business.

Agricultural Innovation Systems (AIS) is an interactive and evolutionary approach where new products and processes are brought into economic and social use through the activities of networks of organisations mediated by various institutions and policies (Hall *et al*., 2004). In this study, a system of innovation was considered to involve all the actors and their interactions involved in the production, use of knowledge, and the institutional and policy context that shapes the processes of interacting, knowledge sharing and learning.

Communication channel is the means by which messages get from one individual to another (Rogers, 1995). In the study, communication and information channel were used interchangeably to refer to a medium through which agricultural extension messages are transmitted to farmers.

Diffusion is the process by which an innovation is communicated through certain channels over a period of time among the members of a social system (Rogers, 1995). In this study, diffusion referred to how the use of ICT based information was communicated to the targeted users (farmers).

Farmer group is a collection of farmers interacting with one another towards achieving a common goal (FAO, 2009). In the study, a farmer group referred to a group of individuals formed at the local level and targeted for extension with the purpose of increasing food production, family income and quality of life.

ICT based innovations are new ideas or practices applied in extension service delivery through use of Information Communication Technology (European Commission, 2011). In the study, use of mobile phones services, Ministry web platforms and computers were such innovations.

Information and Communication Technologies (ICTs) are the technologies used in the conveying, manipulation and storage of data by electronic means (The Open University, 2011).

World Bank (2011), defines an ICT as any device, tool, or application that permits the exchange or collection of data through interaction or transmission. ICT is an umbrella term that includes anything ranging from radio to satellite imagery to mobile phones or electronic money transfers. In reference to this study, ICTs referred to databases, programmes, computers, mobile phones and such other technology used by the MoALF ICT based information delivery innovations.

Information technology refers to Information technology that includes software and computer accessories like computer-assisted instruction (CAI), web browsers, hypertext authoring tools, and multimedia software (Swortzel, 2001). In this study information technology was the technology of production, storage, sending, retrieving, managing or communication of information using computers and microelectronics.

Innovation refers to the process of creating and putting into use combinations of knowledge from many different sources (Mytelka & Farinelli, 2000). Rogers (2003), defines an innovation as an idea, practice, or object that is perceived as new by an individual or other unit of adoption. The Ministry of Agriculture, Livestock and Fisheries-led use of mobile phones, mass media, National Farmer Information Service (NAFIS) to deliver extension service was considered as innovations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The following chapter presents the review of the relevant literature on the selected topic with particular focus on use of ICT based information channels in agriculture extension service delivery. The literature reviewed focused on the use and importance of ICT in the agriculture sector, challenges of ICT utilisation and integration in agriculture and the current ICT infrastructure at the institutional level. The chapter concludes with a presentation of both the theoretical and conceptual framework that guided the study.

2.2 Uses of ICTs in Agriculture

Apart from scientists and researchers, the agriculture sector attracts other players and stakeholders including farmers, commodity brokers, buyers, extension workers, policy makers and end-consumers. Each of these stakeholders has varying needs for, and uses of ICTs, all within the common thread of knowledge and information brokerage and sharing. According to the Forum for Agricultural Research in Africa (FARA, 2009) comprehensive inventory of initiatives providing such services, the basic information needs for farmers are market information prices, weather forecasts, transport facilities, information on storage facilities and information related to crop and livestock diseases and general advice related to agriculture. Integration of new Information and Communication Technologies (ICTs) for instance is rapidly transforming the agricultural extension as asserted by Saravanan (2010). Through the use of ICTs, the information can be provided in a variety of ways: SMS, voice, web portal and call centre. The inventory indicates that several of the information services have been developed in order to provide information in a standard way by using question-and-answer services and that the most popular services are audio-or voice-based (Gakuru, Winters & Stepman, 2009).

As argued by Rao (2007), ICT can accelerate agricultural development by facilitating knowledge management. If they take full advantage of ICT, farmers can enhance productivity and generate more income through adoption of new technologies such as new varieties, value addition and seeking market for their products. Soriano and Cheryll (2007), in their study argued that farmers

make well informed decisions about what crops to plant and where to sell their produce and buy inputs if provided with timely access to market information via communication networks. The adoption of modern industrial inputs in agricultural production relies on the information and communication infrastructure (Lio & Liu, 2006).

2.2.1 Selected examples of use of ICT in Agriculture

The following examples highlight some of the ICT applications that extension and advisory services have used to improve their interactions and technical knowledge sharing with farmers in developing countries.

2.2.1.1 Web based agricultural extension applications

These applications include web services like "ask the expert," mobile messaging for advice, radio programs to disseminate technical information, and video. In Sri Lanka, an initiative known as *Cyber Extension* (an ICT initiative for Strengthening Agricultural Extension) demonstrates that a combination of different ICT tools and technologies have been proved effective in disseminating information and knowledge to farmers and extension workers. The approach uses the power of networks, computer communications and interactive multimedia to facilitate information sharing mechanism with revitalisation of agricultural extension cadre and the personnel in the ministry (Wijekoon, 2006).

According to Joseph (2006), e-Choupal which is used by farmers as one of the portals in setting up kiosk networks is the largest initiative among all internet-based interventions in rural India. The ICT enabled extension systems are acting as a key agent for changing agrarian situation and farmers' lives by improving access to information and sharing knowledge. Information Communication Technology based agricultural extension brings valuable opportunities and has the potential of enabling the empowerment of farming communities. Saravanan (2010) re-affirms that experiences on ICTs for agricultural extension initiatives are showing encouraging results and also complementing conventional extension communication methods.

Experience shows that combination of interpersonal communication channels and mass media is the most effective way of reaching farmers and informing them about an innovation. Indeed mass media and interpersonal channels play complementary roles in dissemination of

innovations (Elizabeth, M. & John, A., 2006). The two should therefore be combined to produce communication channels that yield maximum results. Thus, ICT can be used as a type of mass media channel as well as an interpersonal channel being unique in the capacity to embrace one-to-one, one-to-many, many-to-one and many to many communications. According to Akunyili (2010), most ICT users such as government agencies do little with them except to collect, store and present data. The most prevalent use of ICTs in agriculture is to provide farmers with information and advisory services. ICT has great potential to transform the way public extension is organised and delivered which includes interactions with farmers. ICT can also increase women's access to advisory services.

2.2.1.2 Networking stakeholders in Agriculture

In the wake of introduction of ICT and internet during the last three decades, it is increasingly possible to simultaneously attain richness in terms of quality of information and outreach to people who can share information (Richardus, 2011). In Thailand, a multi-lingual Internet portal, Agricultural Information Network (AIN) enables farmers, field officers, policy makers and government to communicate and access relevant and useful agricultural information. ICT has raised the hopes of actors in agricultural innovation systems (AIS) as a diffusion tool to reach and share information, knowledge and resources efficiently and effectively 24 hours and seven days in a week. ICT and the internet have the ability to enable greater information richness and reach (Evans & Wurster, 2000).

2.2.1.3 Financial based ICT uses

According to the World Bank (2009), another application of ICT is E-banking and especially mobile banking (m-banking) which has had a tremendous impact on the socio-economic status of farmers. In developing economies worldwide, initiatives have sprung up to deliver financial services outside the conventional banking services through mobile phones and nonbank retail agents. For instance, easypaisa in Pakistan, G-Cash in the Philippines, and Bancosol in Bolivia provide some form of mobile financial services to the un- and underbanked poor. Through similar innovative schemes such as Airtel Money of Airtel network, YU CASH of Yu and M-PESA of safaricom, farmers in Kenya are able to send and receive money using their mobile

phones. In Malawi, a smart-card-based MAKWACHA system allows people including rural farmers to receive payments and purchase farm inputs electronically (World Bank, 2009). In the Philippines, there are many e-commerce applications, portals and innovative technologies used to provide relevant agricultural information (Mariquita, 2010).

2.2.1.4 Market focused uses of ICT

Farmers usually lack information on demand and supply conditions, prices and quality, a condition which encourages opportunistic behaviour among traders. Consequently, most smallholders incur high prices for inputs and receive low prices for their produce (World Bank, 2004). In response to these problems and in order to spur commercialisation of smallholder agriculture, modern ICTs, such as mobile telephony and web-based applications, have been embraced and old ones, such as television and FM radio, re-designed to facilitate the transfer of market information to farmers. Information in terms of collection, relevance and retrieval supports an organisation's integral functions (Marcella & Knox, 2004). This reflects the MoALF's primary roles of delivery of extension to Kenyans. With the vibrant mobile, wireless, and Internet industries, ICT has found a foothold even in poor smallholder farms and in their activities. The benefits of ICTs accrue not only from the technologies but also from their potential to facilitate technological recombination and change leading to further innovation (UNCTAD, 2008).

Elsewhere, ICTs have also been used in external certification for traceability of agricultural products. A notable example is the Fresh Food Trace web platform of the fruit-and-vegetable export company Fruilema GIE in Mali (Annerose, 2007). Farmers provide updates by use of mobile phones on their activities which are aggregated on the platform and accessed by buyers. Through this way, fruit exporters are able to enhance the traceability of their products and to maintain global certification standards.

2.2.1.5 ICT application in data management in agriculture

Other applications of ICTs in agriculture include data collection, data analysis, geo-spatial applications, decision-support and knowledge-based systems, embedded ICTs in livestock and farm equipment and processes. Findings from a study by Adekunle, Olowu and Ladele (2007), on ICT reinforced maize innovation clusters in Nigeria showed that; the yield of maize more

than doubled to 2.46 tonnes per hectare, farmers' incomes increased from USD1632 to USD2572 per year (158%), use of external inputs and farm size rose by 300percent and 70percent respectively. The above changes were attributed to the use of ICT to engage the innovative capacity of various partners in the commodity value chain including the farmers and rural communities. However, in this case, a community managed information access point including internet was strategically established in area predominantly growing maize unlike a region like Bahati division in Kenya where farmers grow different crops and rear different livestock types. The study did not test the factors that dictated how easy or otherwise it was for the target users to access the innovations. Is it the rich, poor, men, women or youth, literate or illiterate who accessed and ultimately utilised the innovations?

Many of these innovations are fairly new, limiting practitioners' ability to analyse their effectiveness. There is need to investigate the changing roles of the older and newer ICTs and through the growing use of mobile phones with a focus of who is being included or excluded from these developments and initiatives. Arokoyo (2005) noted that a strong extension linkage complimented by flawless information flow and enhanced by the effective use of ICTs will significantly boost agricultural production and improve rural livelihoods in developing countries. This has however not been proved or tested empirically.

2.3 Challenges in Integrating ICT in Agriculture

More than half the population of Africa lives in extreme poverty, with 75percent residing in rural areas and deriving livelihoods directly or indirectly from agriculture (The World Bank, 2011). During the past decade, ICT has been recognised to play a key role in improvement of productivity and reduce costs thus increasingly enhancing agricultural and rural development. Although internet penetration continues to grow across the world, many farmers and rural entrepreneurs lack internet access and/or the skills to take advantage of computers, mobile technology and the internet to provide information relevant to their work. This means that they also generally lack access to accurate and timely information on markets, production processes, crops and livestock disease, as well as access to services such as land registration databases, permits, and information on government regulations (FAO, 2011).

In Kenya, 72% of the total population is agricultural (World Bank, 2008). Smallholder farmers typically comprise the majority of the farming community and most produce small marketable surplus and are geographically dispersed, selling and purchasing commodities in rural markets where prices often vary with the crop season (Bonaglia, Labella & Marshal, 2007). Ali (2011) concurred with argument by Adhiguru, Bierthal and Ganesh, (2009) that farmers not only look for various information sources for carrying out their production and marketing tasks efficiently but also aim to ensure delivery of safe and quality products to the consumers.

The concept of promoting and sustaining rural livelihoods is central to the discussion on ICT and extension. This concept was first promoted by Chambers and Conway (1992) and is now used by many development agencies to orient their policies and their programmes towards improved livelihoods. The approach has been embraced by the FAO to show the link between ICT and rural livelihoods in facilitating the acquisition and exchange of the information by the poor to develop relevant livelihoods strategies, improve communication within and between institutions responsible for making decisions that affect livelihood options and empower poor communities to participate in decision making processes (Batchelor & O'Farrell, 2003). Thus, ICT has great potential to transform the way public extension is organised and delivered - including interactions with farmers. It can also be an entry point for nontraditional actors who see advisory services as an area of intervention and for giving greater emphasis to subjects traditionally deficient in extension services.

Information Communication Technology is an enabler to building an information centered society where all members of the society can create, access, utilise and share information and knowledge (Okello, 2009). However in order to fully realise the benefits of ICTs, there are three broad prerequisites that must be provided: access, capacity (skills) and applications (services) (Nyirenda, 2010). Access refers to both the hardware and the underlying infrastructure. Both must be reliable and affordable; additionally, infrastructure must be ubiquitous. The capacity or skills to use ICTs is the second requirement. These skills are required to varying degrees at several levels along a continuum ranging from basic end-users (e-literacy) to ICT specialists with highly developed technical skills. In the Sri Lankan Cyber Extension quoted case, lack of

awareness on use of ICT tools, manpower issues, administrative problems coupled with attitudes of senior management constrained crucial successful implementation of ICT initiatives.

Lastly, there must be applications and services that are relevant, localised and affordable. Batte, Jones & Schnitkey, (1990) and Warren, Soffe & Astone, (2000), clearly demonstrated that the use of ICT is strongly associated with educational level and age of the farmer. According to Kurtenbach and Thomson (2000), an understanding of the factors associated with ICT adoption in agriculture will enable the development of strategies to promote ICT adoption and increase the efficiency and effectiveness of information use in agriculture sector.

2.4 ICT Infrastructure in Kenya

The use and ownership of ICT facilities such as personal computers and mobile phones by people and offices as well as rural farmers has been on the increase in the recent past with the largest increases in the use of ICT being in mobile telephony. According to Cieslikowsk, Halewood, Kimura, & Zhen-Wei Qiang (2009), subscriptions to mobile telephony in developing countries increased from about 30 percent of the world total in 2000 to more than 50 percent in 2004 and to almost 70 percent in 2007.

The 2009 World Bank statistics report indicated that 48.7 percent of the population of Kenya own and operate a mobile phone, and 10 percent of the population had access to internet in 2009. Several ICT tools used in disseminating agricultural knowledge and technology elsewhere including email, internet, phone, radio, TV, and print are found in Kenya.

At present, Kenya has about 200 000 personal computers for a population of 40 million (Central Bureau of Statistics, Kenya 2010). Availability of computers across sectors shows that the education sector ranks first with 9 000 computers, followed by the banking sector, with 4 800, and the health sector, with 1,050 computers. No known statistic is available for the agriculture sector. Internet availability is low, with regular internet users amounting to less than 4 percent of the population (Central Bureau of Statistics, Kenya 2007). In spite of having the highest internet penetration rates in the region and one of the highest in Africa, Kenya still has a long way to go because only 10percent of the population is ICT literate (Kavulya, 2010).

While internet use has not increased as rapidly as mobile communication, it increased tenfold in developing countries in the same period (Cieslikowsk *et. al*., 2009). Other ICT facilities such as telecast, FM radio and information centers have also increased in number remarkably during the same period.

Public internet access is provided in some libraries and Internet-cafes. An important question is, does the status of the infrastructure have any effect on the capacity of the farmers to access and utilise the MoALF ICT based information channels? Taragola and Gelb (2005) demonstrated that lack of ICT proficiency, lack of ICT benefit awareness, too hard to use, lack of technological infrastructure, cost of technology, lack of training and software availability limit the use of ICT by farmers. This was confirmed through study by Jayathilake *et al*, (2006).

With the booming mobile, wireless, and Internet industries, ICT has found a foothold even in poor smallholder farms and in their activities. The mobile telephone network enjoys good coverage over the entire country with Nakuru North enjoying the services of four (4) major mobile phone service providers (CCK, 2010). However, internet content, an essential component of the national ICT strategy, is developing rapidly.

Though Kurtenbach and Thomson (2000) argue that the two most important limiting factors in developing countries are infrastructure and cost of the technology, other factors cannot be ruled out. For example, the internet is not affordable by the majority of individuals and small businesses, whereas phones and faxes will commonly be used by most businesses. Full computer access in institutions is usually restricted to staff, while computer training and education in universities have only recently begun; therefore, teachers' computer literacy is elementary (Attygalle *et al*., 2006).

As agriculture is becoming knowledge-intensive, the role of ICTs is gaining importance in agricultural information delivery systems and improving exchange of information and knowledge among different stakeholders in agricultural development. An efficient agricultural communication or extension strategy supported with a variety of innovative ICT services ensures the rural and agricultural development.

2.5 Factors Affecting Technology Usage among Farmers

Truong's (2002) study suggests that factors such as the knowledge level of extension workers, methods of organisation and management of extension programs, and local conditions are the drivers for technology adoption. A number of local studies by Hayrol Azril *et al*. (2009) and Abu Samah *et al*. (2009) have agreed with findings by Truong (2002) which accentuated on factors such as education, negative perceptions, lack of capital, small land areas, ineffective infrastructural facilities, and limited capacity of extension workers as the main drivers that lead to low technology adoption. Based on a study conducted by Truong (2008), there are many obstacles to running a successful technology strategy. The main reasons for non-adoption of technology are weak perceptions of technology and low education of farmers, low teaching capacities, limited knowledge among extension workers, disorganisation, geographical conditions, and inadequate resources and funds. Furthermore, farmers should have a certain level of education and be very familiar with application of the technology in order to be motivated to learn the new technology.

Further, Abdullah & Bahaman (2013), added that technology usage must be in line with the financial capacities of farmers, and that farmers with limited financial ability will have little chances to adopt the technology. In addition, they argued that not all farmers are able to adopt technology due to the small number of extension workers they have, and the fact that it comprises many measures that require a high level of knowledge from farmers. Moreover, technologies which contain complicated components also require more time and more labor, making them difficult for farmers to apply (Abdullah & Bahaman, 2013).

Other studies show that use of ICT varies with age and gender with most young people preferring to use mobile phones and computers; women preferred listening to the radio and watching TV while adult males preferred listening to news on both the radio and TV, and watching football matches (Economic and Social Research Foundation, 2008). This suggests that as the ICT infrastructure grows and connectivity and hardware costs decline, the critical constraints are likely to be the development of an appropriate policy and institutional environment for the creation and delivery of information and knowledge (Mwakaje, G.A., 2010).

On gender percepective, some studies argue that women's access to and usage of ICTs have a significant gender divide. A study commissioned by Gender and ICT Network, Reseau Genre *et al.*,TIC (2005), (Mottin-Sylla 2005) reveals that, globally, women's chances to benefit from the advantages of the information society are one third less than men's. This study examines the factors that would influence the adoption of ICT as a technology by the farmers in the study area.

2.6 Innovations transfer and adoption

According to Meera, N., Jhamtani, S. & Rao, D.U.M (2004), a new paradigm of agriculture development is emerging with ICT playing a crucial role in enabling extension workers to gather, store, retrieve and disseminate a broad range of information to farmers. Nkurumah (2006) stated that Information, Communication Technologies (ICTs) can enhance, enlarge and contribute to efficient sharing of agricultural information. He stresses that the relevancy of the information medium through which the information is passed and the language used in disseminating the information is central to how ICTs can be used as tools to meet the needs of the farmers in which they are deployed. As argued by Zijp (1994), ICT has many potential applications in agriculture extension that can bring new information services to farmers. Access to such new information is a crucial requirement for sustainable agriculture development.

Agriculture development depends to a large extent on how knowledge is successfully generated, transferred and applied. The process of creating and putting into use idea, practice, or object that is perceived as new by an individual or other unit of adoption is referred to as innovation (Temel, Janssen & Karimor, 2002). The introduction of ICT based information channels by the Ministry of Agriculture, Livestock and Fisheries to disseminate technologies is thus a form of an innovation. This study adopted the concept used by Rogers (2003) in his research and work that is widely accepted in communication and technology adoption studies. While studying how innovation occurs, Rogers (1995) argued that it consists of four stages: *invention*, *diffusion* (or communication) through the social system, *time* and *consequences*. The information flows through networks. This study attempted to investigate mainly the factors that would be relevant to successful adoption of the use of ICT innovation by the MoALF, amongst the targeted users.

Innovation diffusion research has attempted to explain the variables that influence how and why users adopt a new information medium, such as the ICT. Diffusion of innovations theory sees innovations as being communicated through certain channels over time and within a particular social system (Rogers, 1995). Individuals are seen as possessing different degrees of willingness to adopt innovations and thus it is generally observed that the portion of the population adopting an innovation is approximately normally distributed over time (Rogers, 1995). Five adopter categories are classified as: (1) innovators, (2) early adopters, (3) early majority, (4) late majority, and (5) laggards. These categories follow a standard deviation-curve, very little innovators adopt the innovation in the beginning (only 2.5%), early adopters make up 13.5percent a short time later, the early majority 34percent, the late majority 34percent adopt after some time, and finally the laggards make up 16percent (Rogers,1995). Members of each category typically possess certain distinguishing characteristics. For instance, innovators are venturesome, educated and have multiple information sources while early adopters are said to be social leaders, are popular and educated. Early majority have deliberate and many informal social contacts. The late majority adopters are skeptical, traditional and found on the lower socio-economic status. Finally, laggards rely on neighbours and friends as main information sources and fear debt.

The rate of adoption of innovations is impacted by five factors, namely: relative advantage, compatibility, trialability, observability, and complexity (Rogers, 1995). The first four factors are generally positively correlated with rate of adoption while the last factor, complexity, is generally negatively correlated with rate of adoption (Rogers, 1995). The actual rate of adoption is governed by both the rate at which an innovation takes off and the rate of later growth. Low cost innovations may have a rapid take-off while innovations whose value increases with widespread adoption (network effects) may have faster late stage growth. Innovation adoption rates can, however, be impacted by other phenomena. For instance, the adaptation of technology to individual needs can change the nature of the innovation over time. In addition, a new innovation can impact the adoption rate of an existing innovation and path dependence may lock potentially inferior technologies in place.

2.7 Theoretical Framework

The model of knowledge transfer to be used by this study is diffusion of innovation (Rogers, 2003).The diffusion of innovation theory as illustrated in Figure I, shows the main elements that influence the spread of a new idea: the innovation, communication channels, time, and a social system. The theory has potential application to information technology, ideas, artefacts and techniques (Clarke 1999: I). That is, diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. In adopting innovations, individuals progress through five stages, namely: knowledge, persuasion, decision, implementation, and confirmation. If the innovation is adopted, it spreads via various communication channels. During communication, the idea is rarely evaluated from a scientific standpoint; rather, subjective perceptions of the innovation influence diffusion. The process occurs over time. Finally, social systems determine diffusion, norms on diffusion, roles of opinion leaders and change agents, types of innovation decisions, and innovation consequences.

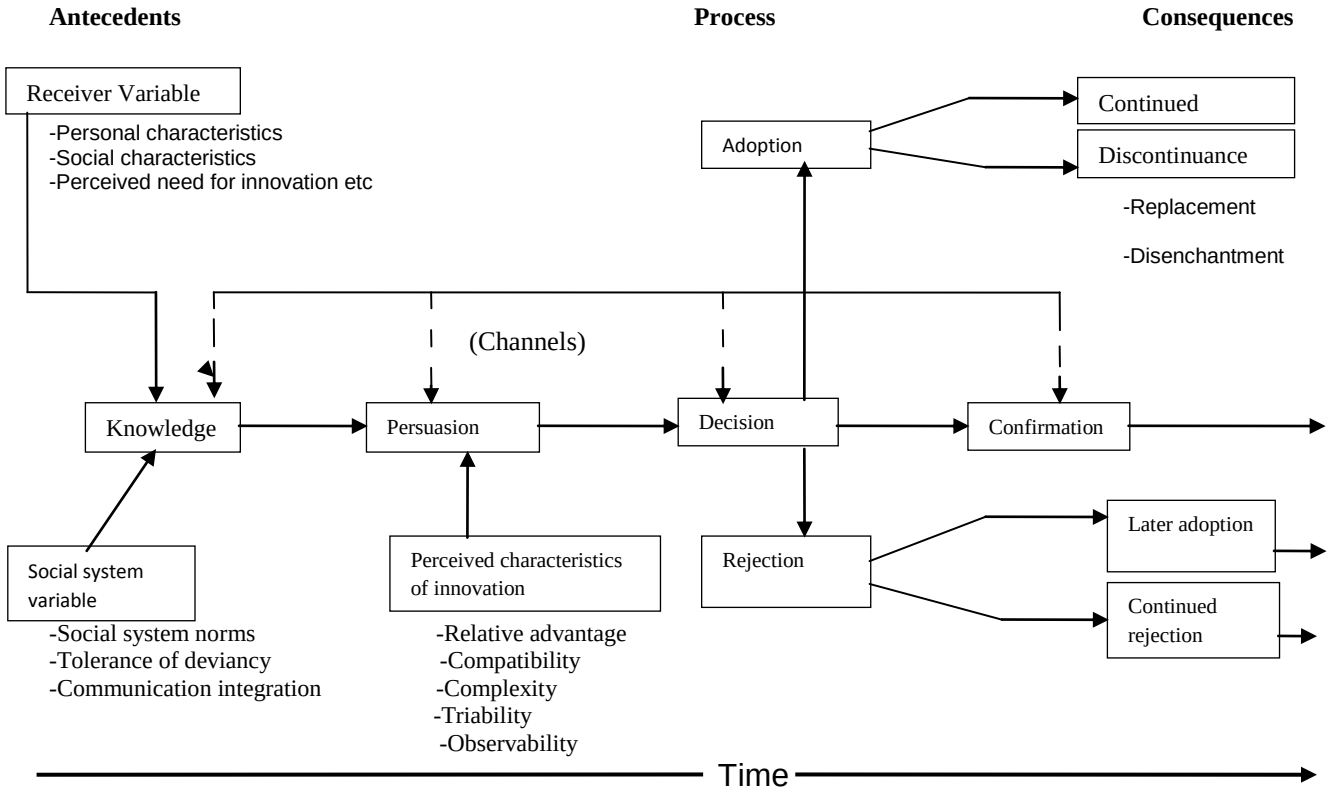

Figure 1: **Diffusion of innovation model. Source: Rogers (1995)**

This study focused on the other diffusion theory, the theory of perceived attributes that focuses on how potential users view characteristics of the use of innovations and particularly ICT based information innovations. These have been typically categorised as those that relate to the characteristic of **complexity**; which is the degree of difficulty of understanding and /or use of innovations from the perspective of the respondent, **compatibility**; which concerns itself with a host of factors relating to the degree to which the innovation is compatible to the respondent's objectives or life, **trialability**; which deals with the potential to experiment with the practice on a smaller, less intensive scale. The expectation is that if an individual can implement the new practice on a trial basis he or she can possibly even modify the potential practice further to meet their specific needs. **Relative advantage** speaks to the possibility of increased income, reduced cost, or other factors that may make adopting innovations advantageous over other alternatives, including doing nothing while **observability** relates to the degree to which the potential user of an innovation has had the opportunity to see it used or see the results of the implemented practice or technology (Rogers, 2003). The theory has also been widely applied to investigate diffusion of agricultural innovations (Rogers & Scott 1999:4, Rogers 1995, Sunding & Zilberman 2000). Thus the theory's application to information technology and agriculture made it the most appropriate theoretical framework for this study.

2.8 Conceptual Framework

Application of ICT in agriculture is increasingly important, especially in developing countries like Kenya. Exponential growth in information and communication technology (ICT), especially the internet, has transformed the ability to take advantage of knowledge developed in other places or for other purposes (Arnold & Bell, 2001). These technological innovations and associated knowledge snippets complemented with institutional innovations and support of appropriate policy would contribute to higher productivity and sustainability of agriculture (Suresh *et al*., 2008).

The internet could enable farmers to become part of the information flow process and even to instigate the process of information flow rather than waiting for the information to be presented to them via radio, TV, newspapers, newsletters, bulletins or other traditional technologies

(Madukwe, 2006).Other concepts relevant to the diffusion of innovations framework and having influence on adoption/rejection decisions include those relating to the communication channel, social networks, and external factors (Rogers, 2003). Communication channels include the extension agent or agency and attributes of the communication program (for example, extension program type or means of disseminating information). Social networks and systems include support systems such as a local farmer organisation or association and the type and amount of interaction with professionals following the extension intervention. Finally, external factors such as markets, natural disasters, policy, and unanticipated events all affect adoption of practices.

The conceptual framework used in this study was based on Diffusion of Innovation Systems. There is conceptual progression from looking at various extension delivery systems and entry points for knowledge dissemination considering the diversity of farmer and commodity needs. For extension to result to the intended impact there is need to package sub-county specific, commodity specific information based channels that offer a 'basket of options' information materials for farmers and extensionists. In summary, the more profitable, understandable, personally compatible, observable, and testable the participant considers the innovation, the higher the potential for adoption.

This study focused on five elements: (1) the characteristics of ICT channel which were perceived to influence its adoption; (2) factors that individuals considered when deciding whether to adopt use of ICT as a new idea, product or practice; (3) the characteristics of individuals that make them likely to adopt the use of ICT; (4) the perceived consequences for individuals and society of adopting use of ICT as an innovation; and (5) communication channels used in the adoption process. Figure 2 is the conceptual framework used in this study showing independent, moderator and dependent variables. The dependent variables were considered at the level of access and utilisation of the Ministry of Agriculture, Livestock and Fisheries ICT based information channels namely NAFIS, mobile telephony and the internet. The independent variables in the study were the factors influencing access and utilisation of these ICT based information channels such as; educational levels, income levels, age, gender, availability of electricity, distance to the extension office and frequency of interaction with extension staff. The

moderating factors were the government policies, suitability of the information and technology, cost of ICT and general infrastructure.

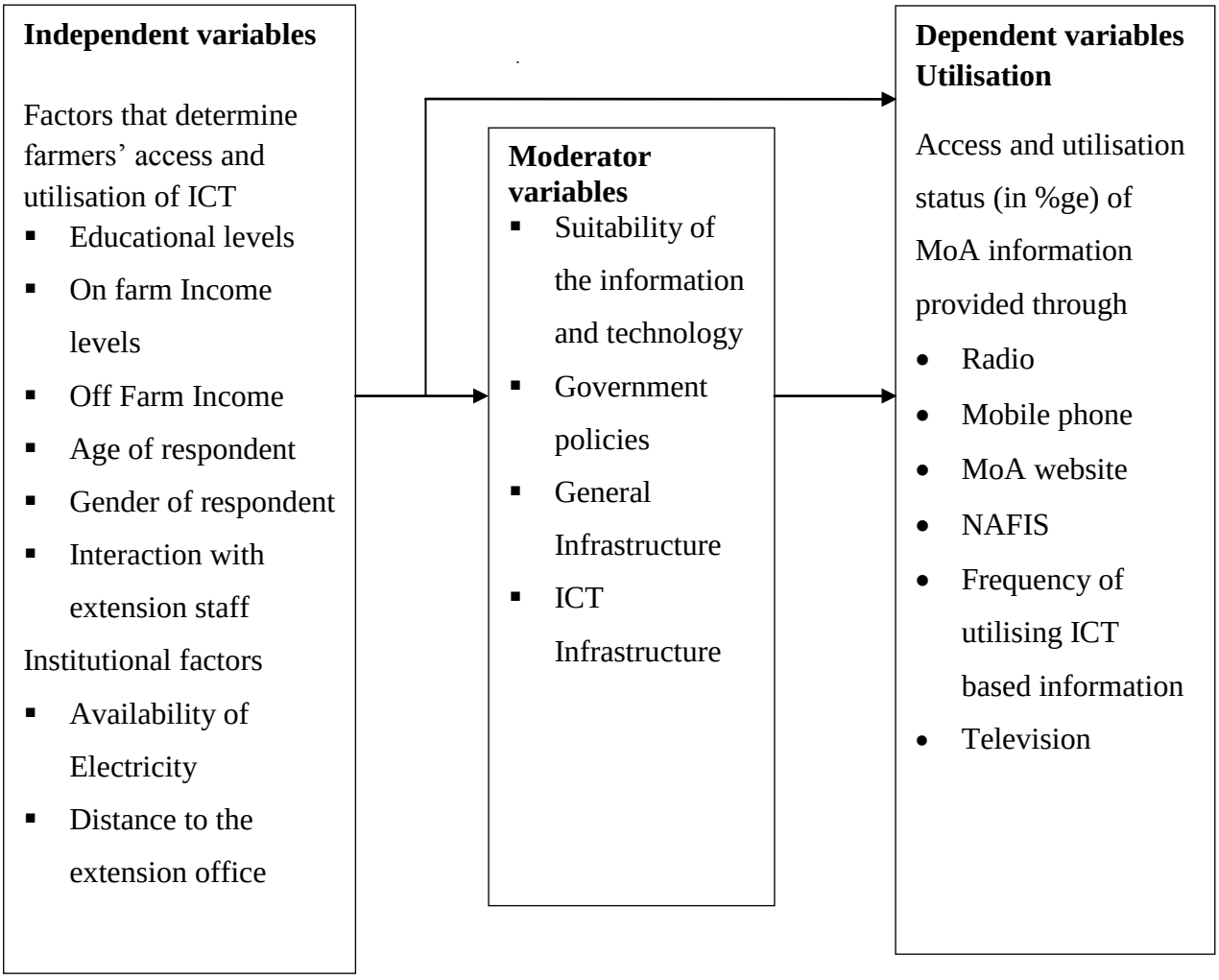

Figure 2*:* A Conceptual Framework showing independent variables, moderator variables and dependent variables

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter provides an overview of the methodological approaches and research design applied in this study. It also gives highlights on sampling, sample size, the data collection instrument used in the study and how the data was analysed.

3.2 Research Design

This study used a cross sectional survey design to collect data from the study population. Such a design allows gathering of information on the population at a single point in time. While using this method, the respondents were allowed to describe existing phenomenon without any intervention or control factors. This study design has the advantage of allowing comparison of literate/illiterate, youth/aged among other groups without manipulating the independent variable (Mugenda & Mugenda, 2003).

3.3 Location of the Study

This study covered Bahati division of Nakuru North Subcounty, Nakuru County. The study area has a population of 102,000 and is located approximately 10km to the East of Nakuru town. Bahati Division has an area of 364 km^2 with four locations. The estimated population density is 282 /km^2 (KNBS, 2009).

The agro-ecological zones range from the upper highlands to lower highlands. The rainfall pattern in Bahati is bimodal with an annual mean of 800mm and a relative humidity of 83percent. The mean minimum and maximum temperatures are 10°C and 26°C respectively (KARI Lanet, 2010). The area was selected because it is medium potential agricultural zone where farmers engage in different types of enterprises. It is relatively fairly served by ICT based information channels such as internet, mobile telephony given its proximity to Nakuru town. Other forms of infrastructure including road, telephone and electricity which support ICT utilisation are in place. Being close to Nakuru town, the area is cosmopolitan with different ethnic communities living there thus providing diversity in responses.

3.4 Target Population

The study targeted the 24074 households in Bahati Division (KNBS, 2009) on the basis that they are the targeted users of the selected MoALF ICT based information innovations. The head of each household was requested to fill the questionnaire while the researcher would assist in administering it where the respondent experienced challenges. If the household head was not available, the next household was considered for the exercise. Sampling frame was the list of the 24,074 households of Bahati division from the Nakuru district Central Bureau of Statistics' office.

Table 1

Distribution of Farmers in Bahati Division

Location	Agro ecological zones	Total population	Total farmers population	Farmer's population percentage
Kiamaina	LH_3	31,699	8,487	35
Ndungiri-Kirima	UM_3-LH_3	15,762	2,692	11
Bahati	LH_3-LH_2	24,195	5,913	25
Kabatini	LH_3-UH_2	29,878	6,982	29
		101,534	24,074	100%

Source: KNBS & MoA

3.5 Sampling Procedure and Sample Size

The sample size was obtained using as proposed by Nassiuma (2000).

$$n = \frac{NC^2}{C^2 + (N-1)\,e^2}$$

Where n= sample

N=population

C= Coefficient of variation

e= standard error

Nassiuma (2000) asserts that most surveys or experiments usually accept a coefficient of variation of at most 30 percent; this study took 21 percent coefficient of variation and a standard

error of 0.02. The lower limits for coefficient of variation and standard error were selected to ensure low variability in the sample and minimise the degree of error.

Therefore the sample size for the study was;

$$n = \frac{24074 \times (21\%)^2}{(21\%)^2 + (24074-1)(0.02)^2}$$

$$= 110$$

This was appropriate since the minimum sample size recommended is 100 (Borg & Gall, 1983).

A reconnaissance study was conducted in Bahati division to determine the characteristic conditions of the area. Chania, Thayu, Kiamaina and Ndungiri sub-locations were randomly selected for the study from Bahati, Kabatini Kiamaina and Ndungiri-Kirima locations respectively. By use of systemic random sampling, the fifth household in the selected sub-location was considered for interview until a total of 110 respondents were selected and finally interviewed during this study in the four locations of the division. The sample represented the major geographical, social and occupational, exposure and economic differences of the farmers' population. The interviews were conducted with head of households.

Table 2

Distribution of Sample Selected for Interviews

Location	Total population	Farmers' population percentage	Sublocation	Sample size
Kiamaina	8,487	35	Kiamaina	39
Ndungiri-Kirima	2,692	11	Ndungiri	12
Bahati	5,913	25	Chania	27
Kabatini	6,982	29	Thayu	32
Total	24,074	100		110

3.6 Instrumentation

Data were collected using a questionnaire with closed and open-ended questions (Appendix A) while secondary information was used to supplement the responses that had gaps. Items in the

tool had been developed on the basis of the objectives of the study. Part A of the questionnaire was used to collect basic information on the socio-demographic characteristics of the population. It was also used to establish the number of real ICT equipment either owned or accessed by the population and the services accessed from them. Part B of the tool aimed at collecting the information on population's sources of agricultural extension messages. Part C of the instrument was used to collect information on the population's knowledge on ICT based information channels, use and challenges faced in use of ICT. Adjustments were made to the tool after pretesting.

3.6.1 Validity

The questionnaire was subjected to scrutiny by professionals in the Department of Agricultural Education & Extension to assess the content, construct, criterion and face validity. Achieving the validity ensured adequate sample and right parameters were measured (content), test accurately represented a reality (construct), results were credible (criterion) and the project looked good at face value. Comments and suggestions provided were incorporated into the proposal for the study to improve the quality of the instruments in order to ensure that the results and inferences of the study were accurate and meaningful. This required ensuring that the items in the questionnaire were clear, concise, complete, comprehensive and unambiguous before being used in the field. Correct sampling was done to allow generalisation to other people, times and contexts and hence giving it external validity.

3.6.2 Reliability

According to Mugenda and Mugenda, (2003), reliability is the measure to which an instrument yields consistent results over repeated trials. Thus reliability is the measure of consistency. Reliability of the questionnaire for this study was assessed by pilot-testing 30 questionnaires in the neighbouring Dundori division within Nakuru County which has households with similar socio-economic characteristics as those in the target study area. The instrument used was considered reliable after it achieved a reliability coefficiency of 0.8281 using Cronbach alpha scale obtained on the sample of 30. According to Fraenkel and Wallen (2000), a reliability of 0.70 or higher is preferable for research purposes.

3.7 Data Collection

An introductory letter was obtained from the Graduate School of Egerton University to facilitate acquisition of a research permit from the National Commission for Science, Technology and Innovation to enable the researcher carry out the study among farmers in Bahati Division without any hindrance. Authority to conduct research was sought from the District Commissioner, Nakuru North Subcounty while the Ministry of Agriculture, Livestock and Fisheries staffs in the district were contacted to plan for the data collection. During the actual data collection, each household in the sample was visited to administer the questionnaire with English, Kiswahili or Kikuyu used as language of communication. General observation was also used to capture data that could be available for documentation. Respondents were contacted personally to give and facilitate acquisition of more accurate responses.

3.8 Data Analysis

When the data collection was completed each questionnaire was numbered and the data sorted out appropriately. The data were checked to ensure that all the information had been properly collected and recorded for completeness and internal consistency**.** Data processing that involved categorisation of the data, coding of questionnaire items and data entry and verification by the computer was done. During data entry, the information relating to each subject in the study was keyed into the computer in the form of the relevant code. An analytic cross-tabulation was done to investigate if there is a relationship between various independent variables and the dependent variables. Descriptive and inferential statistics procedures were used for data analysis.

Descriptive statistics which include modal distribution, means, standard deviation, frequencies and percentages was used to summarise the data. Exploratory methods were used to analyse objective one and establish what the data revealed about the preferred source and channel of agricultural information amongst farmers in Nakuru North Subcounty. Objective two was analysed by exploratory methods to find out what the data showed about the level of access and utilisation of the MoALF provided ICT initiatives in Nakuru North Subcounty. Chi Square statistical test was used for testing objective three and four to determine how a farmer's socioeconomic status and selected institutional factors affected his/her access and utilisation of

the MoALF ICT initiatives in Nakuru North Subcounty and helped generalise the results from the sample to the population.

Analysis of the data was done with the help of Statistical Package for Social Sciences (SPSS) version 17.0 software. Hypotheses were tested at 0.05 level of significance. Table 3 shows the summary of analysis of data during the study.

Table 3

Summary of Data Analysis

Hypothesis	Independent Variable	Dependent Variable	Statistical test
H_o1 There is no statistically significant relationship between the utilisation status of MoALF information platforms and Age of farmers in Nakuru North Subcounty	• Age of respondent	Utilisation status of MoALF information platforms namely • Radio • Mobile phone • MoALF website • NAFIS	Chi Square
H_o2 There is no statistically significant relationship between the utilisation status of MoALF information platforms and level of education of farmers in Nakuru North Subcounty	• Education level	Utilisation status of MoALF information platforms namely • Radio • Mobile phone • MoALF website • NAFIS	Chi Square

H_o3 There is no statistically significant relationship between the utilisation status of MoALF information platforms and gender of farmers in Nakuru North Subcounty	• Gender of respondent	Utilisation status of MoALF information platforms namely • Radio • Mobile phone • MoALF website • NAFIS	Chi Square
H_o4 There is no statistically significant relationship between the utilisation status of MoALF information platforms and distance travelled to access an extension office to farmers in Nakuru North SubcountySubcounty	• Distance to an extension office	Utilisation status of MoALF information platforms namely • Radio • Mobile phone • MoALF website • NAFIS	Chi Square
H_o5: There is no statistically significant relationship between the utilisation status of MoALF information platforms and access to electricity to farmers in Nakuru North Subcounty.	• Access to electricity	Utilisation status of MoALF information platforms namely • Radio • Mobile phone • MoALF website • NAFIS	

CHAPTER FOUR
RESULTS AND DISCUSSIONS

4.0 Introduction

This chapter presents results following the data analysis and the attendant discussions of the study findings. The chapter provides brief description of the sample and the general socioeconomic status and disaggregation of the respondents.

4.1 Gender of the Respondents

Exposure to new technologies introduced by agricultural agents may reach different gender groups variably. Of the 110 farmers interviewed, 54 (49.1%) were males while 56 (50.9%) were females. Table 4 shows the sample distribution by gender.

Table 4
Gender distribution among respondents
(N =110)

Variable	Frequency	Percentage
Gender		
Males	54	49.1
Females	56	50.9

The results show that there was a fair gender distribution of the questionnaires among respondents who participated in the study. Coupled with the age (41-50 years) of the majority of the respondents, the results represent a population that would ordinarily be expected to be active in an economic activity like farming to earn a living.

4.2 Age of the Respondents

Age may be crucial to a respondent's preference on which technology to adopt and employ in agriculture. A youthful population would be expected to be attracted to ICT related engagements unlike the elder segment in a society. Respondents were asked to state their ages during the interview by the researcher. The ages were then grouped into four categories for the analysis purposes.

Table 5 illustrates the distribution of the respondents based on the age. The results reveal that majority (54.5 %) of the farmers in Bahati are youthful and this suggests there could be a high level of labour supply to farming.

Table 5

Age distribution among respondents

(N =110)

Variable	Frequency	Percentage
Age		
20-30	12	10.9
31-40	21	19.1
41-50	27	24.5
Over 50	50	45.5

4.3 Respondents' Level of Education

Education may be key to the ability of a user to access and utilise ICT. According to the results illustrated in Figure 3, an equal proportion (42.7%) of the farmers had attained primary compared to secondary (42.7%) education. The study also revealed that only (9.1%) farmers had attained post secondary education.

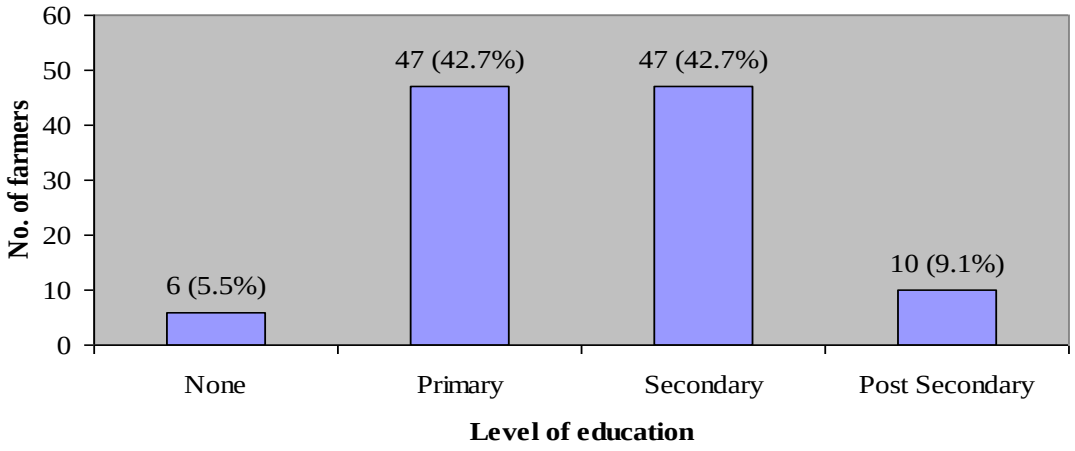

Figure 3: Level of education

Distribution of respondents according to level of education showed that most of the respondents had some formal education, ranging from primary education to post secondary education.

This implied that most (51.8%) of the respondents (farmers) were literate enough to use ICTs. Indeed, with only less than 5.5 percent of the respondents with no formal education, the community in this area would be expected to be outgoing and informed of the different sources of agricultural information. This coupled with the fact that 91.8percent of the respondents indicated farming as the main occupation would interest an institution like the MoALF to target this community with innovations such as ICT aiming at improving the agricultural productivity in this area.

4.4 Types of Land Tenure System

Land ownership has an important contribution to how a farmer utilises and makes investments in his/her land. This signifies the importance of establishing the status of the ownership in the study area. The study (Figure 4) reveals that (73.6%) of the land in the study area is privately owned, (10.9%) is communal while (15.5%) is leased. This therefore gives farmers a free hand in choice of investment and control.

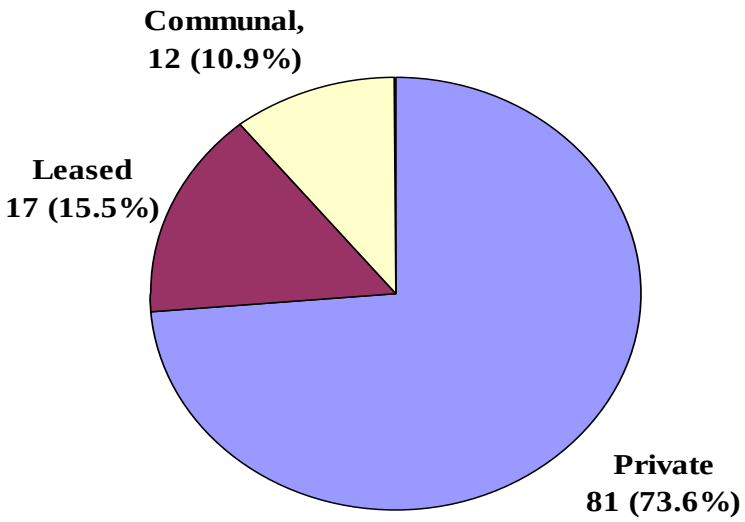

Figure 4: Land tenure system

4.5 The main occupation of the household heads

When asked about their main occupation, the respondents had varied responses as illustrated in Table 6. Out of the 110 respondents interviewed, (91.8%) eked their living out of farming, (7.3%) were in business while the remaining (0.9%) depended on formal employment.

Table 6

Main Occupation of the respondents

(N =110)

Occupation	**f**	**%**
Farmer	101	91.8
Business	8	7.3
Formal employment	1	0.9
Others	0	0
Total	**110**	**100.0**

This could be explained by the fact that Bahati and Nakuru County in general is a settlement area where farmer associations procured land from the former white owners, settled and practised farming though in smaller scale. Only a few family members mostly the youth venture into other gainful employment in the urban areas while the ones left to do farming do it for subsistence and may not be motivated to use ICT let alone for agriculture purposes.

4.6 Distance travelled to reach an extension office/agent

Farmers reach the extension agent by visiting the extension office or by interacting with them when on field trips. Results in Figure 5 illustrate that 39.1percent of the farmers interviewed indicated they travelled a distance of 1-3 km to reach extension agent, 32.7 percent travelled a distance of 3-5 km while 1.8 percent travelled over 10km for the same service.

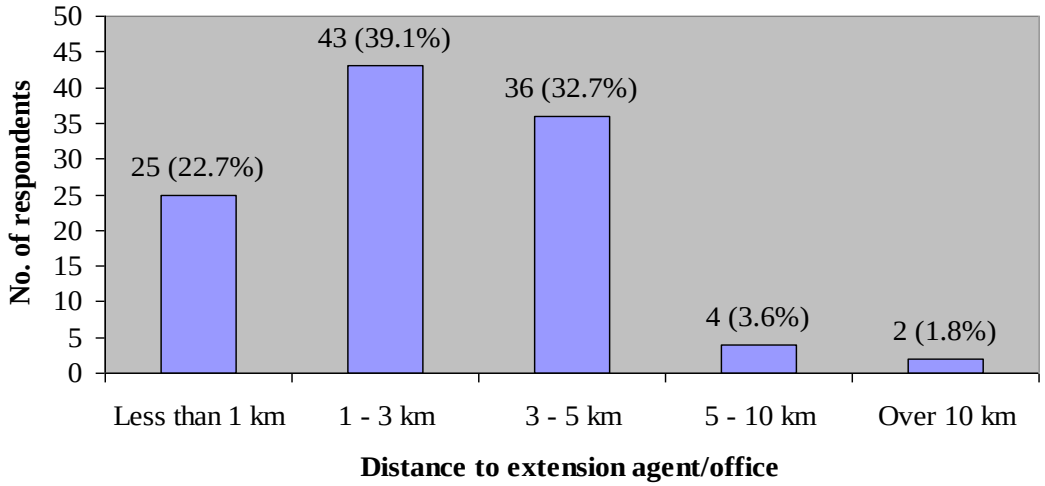

Figure 5: Distance to extension agent/ office

Bahati division being within a high potential area for agriculture has MoALF offices and staff upto locational level thus the short distance required to reach an extension office. The extension officers also use motorbikes for their extension work thereby making them accessible to the farmers. The short distances covered to reach an extension office or officer increases the chances of a farmer interacting often with the staff and learning about new innovations that would include ICT in extension service delivery.

4.7 Access to Media

Media including ICT plays an important role in dissemination of information to farmers. It was evident that farmers in Bahati had access to a variety of media from which they could source agricultural information. Radio, mobile phone, television, internet and computer were some of the media used to deliver MoALF ICT innovations. Respondents were asked if they had access to these media types. As indicated in Table 7, a majority of the farmers indicated that they owned or accessed services of a radio (96.4%), mobile phone/ Telephone (95.5%) and TV (70.9%). This concurs with study's findings by the World Bank, (2008 & 2011) that revealed that over by 95 percent and 90 percent of the households in developing countries own or access radio and mobile services for accessing information. Bertolini (2004) had also observed in his

study that the 'telephone as one of the ICT is the most used (if any) by the majority of farmers in Africa'.

Table 7

Status of access to media by respondents

Type of media accessed/used	**Accessibility status by respondents**			
	Yes		**No**	
	f	**%**	**f**	**%**
Radio	106	96.4	4	3.6
Mobile phone/Telephone	105	95.5	5	4.5
Television	78	70.9	32	29.1
Internet	13	11.8	97	88.2
Computer	11	10.0	99	90.0

Other media were internet and computer where only 11.8 percent and 10 percent respectively of the respondents indicated they could access them. The results suggest a general low usage of the computer and internet based ICT by farmers in the study area. For instance, even though 95.5 percent of the households own mobile phones, a much smaller proportion (11%) of them indicated they use these devices to access any other ICT based agricultural applications such as 'iCow' available in the area.

Radio and mobile phones were common in most households probably because the two are portable and easy to operate with basic education level. Though not used for acquisition of agriculture related information, they have the potential to provide relevant extension information and service. Kweku's (2006) findings indicate that radio is the most highly used media in accessing development and agricultural information.

4.8 Connection with electricity

The respondents were asked to indicate if they had connected electricity to their homes. The results in Table 8 show that of the 110 farmers who participated in the study, 47.3 percent were connected to electricity while 52.7 percent were not.

Table 8

Electricity connection status

(N =110)

Connection to electricity	Frequency	Percent
Yes	52	47.3
No	58	52.7
Total	**110**	**100.0**

In the study, erratic power supply was the most prevalent problem mentioned for non-regular access and use of ICT. Reliable and affordable power supply is a necessity in using most ICT gadgets such as mobile phones, computers among others.

The high cost of connectivity had discouraged many respondents to apply for the connection. This could explain the low status of access to ICT. The newly introduced affordable group application by the Kenya Power and the rural electrification initiative may tilt this status.

4.9 Reception of information on agriculture related activities

The MoALF uses the extension fora such as field days, agricultural shows and fairs to communicate new innovations to farmers and general public. Findings in Table 9 show that a majority (93.6%) of the farmers received agricultural related information in Bahati division.

Table 9

Status of reception of agriculture related information

(N =110)

Status	Frequency	Percent
Yes	103	93.6
No	7	6.4
Total	**110**	**100.0**

This could be attributed to the area being generally agricultural and that is also well served by extension agents (I staff: 800 farmers compared to national ratio 1:1200), mobile connectivity and other media. Its proximity to Nakuru town also offers an opportunity to the local population to access information related to agriculture.

4.10 Frequency of receiving information

The frequency of receiving information on agriculture was assessed in three categories; daily, weekly and monthly. Findings presented in Figure 6 show that 55.5 percent of the farmers received information weekly, 29.1 percent received monthly while 15.5 percent received daily.

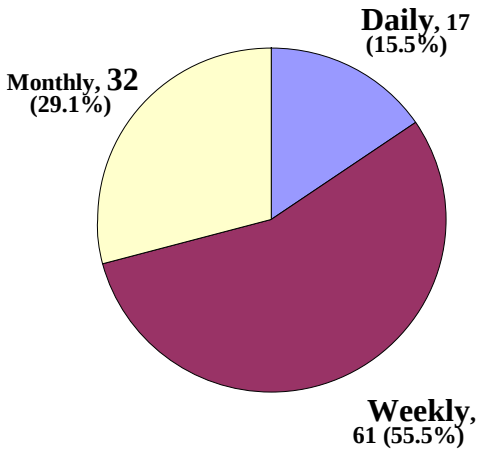

Figure 6: Frequency of receiving information on agricultural related activities

The short distances covered to reach an extension office or officer increases the chances of farmer interacting more oftenly with the staff and learning of new innovations such as new seed varieties, value addition techniques, ICT in extension service delivery among others. This is an indication that there is potential to transform agriculture in this study area by disseminating appropriate information and technology during these regular interaction with information sources.

4.11 Testing of the Hypotheses

This section focuses on inferential analysis to establish how farmers access and utilise ICT based information particularly mobile telephony, NAFIS (National Farmers Information Service) and web based Ministry of Agriculture, Livestock and Fisheries channels. Chi Square tests were used to determine the likelihood of the farmers' accessing and utilising the MoALF ICT's platforms against different selected socio-economic factors such as gender, age and level of education. Further the role played by selected institutional factors such as distance travelled to reach an extension agent/ office and connectivity to electricity in regard to the likelihood of influencing the access and utilisation of the platforms was investigated.

i. To investigate whether there was significant relationship between the utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and Age of farmers in Nakuru North Subcounty.

Hypothesis

H_o1: There is no statistically significant relationship between the utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and age of farmers in Nakuru North Subcounty.

In order to test the hypothesis, I did Chi square tests on several variables. The results obtained on ages of the respondents visa vis utilisation status of agricultural information platforms *(Radio, mobile telephony, MoALF website, NAFIS)* are presented in Table 10-13.

Table 10 shows the results of the analysis of relationship of age and the utilisation of radio information platform among respondents

Table 10

Chi square statistics and results on utilisation of radio across farmers of different age brackets.

	Radio			
Age	Never used	Sometimes used	Frequently used	Total
30 yrs and below	0	4	8	12
31-40 yrs	3	11	7	21
41-50 yrs	3	7	17	27
51-60 yrs	1	7	14	22
61-70 yrs	2	8	5	15
71 yrs and above	2	9	2	13
Total	11	46	53	110
Chi-Square Tests				
	Value	df	Asymp. Sig. (2-sided)	
Pearson Chi-Square	16.268	10	0.092	
Likelihood Ratio	18.330	10	0.050	
Linear-by-Linear Association	3.148	1	0.076	
N of Valid Cases	110			

The results show that there was no significant relationship between age and likelihood of farmers utilisation of radio services provided by MoALF, at $p<0.05$ level.

Table 11 shows the results of the analysis of relationship of age and the utilisation of mobile phone/telephone information platform among respondents

Table 11

Chi square statistics and results on utilisation of mobile phone/telephone across farmers of different age brackets.

Age	Mobile Telephone			
	Never used	Sometimes used	Frequently used	Total
30 yrs and below	8	2	2	12
31-40 yrs	15	4	2	21
41-50 yrs	20	4	3	27
51-60 yrs	21	0	1	22
61-70 yrs	11	3	1	15
71 yrs and above	7	6	0	13
Total	82	19	9	110

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	15.293	10	0.122
Likelihood Ratio	17.937	10	0.056
Linear-by-Linear Association	0.308	1	0.579
N of Valid Cases	110		

The results show that there was no significant relationship between age and likelihood of farmers utilisation of mobile telephone services provided by MoALF, at $p<0.05$ level.

Table 12 shows the results of the analysis of relationship of age and the utilisation of NAFIS information platform among respondents

Table 12

Chi square statistics and results on utilisation of NAFIS across farmers of different age brackets.

	National Agriculture Farmers Information Service			
Age	Never used	Sometimes used	Frequently used	Total
30 yrs and below	9	2	1	12
31-40 yrs	14	6	1	21
41-50 yrs	19	7	1	27
51-60 yrs	20	2	0	22
61-70 yrs	13	2	0	15
71 yrs and above	9	4	0	13
Total	84	23	3	110
Chi-Square Tests				
	Value	df	Asymp. Sig. (2-sided)	
Pearson Chi-Square	7.956	10	0.633	
Likelihood Ratio	9.037	10	0.529	
Linear-by-Linear Association	1.643	1	0.200	
N of Valid Cases	110			

The results show that there was no significant relationship between age and likelihood of farmers utilisation of NAFIS provided by MoALF, at $p<0.05$ level.

Table 13 shows the results of the analysis of relationship of age and the utilisation of MoALF website information platform among respondents.

Table 13

Chi square statistics and results on utilisation of MoALF website across farmers of different age brackets.

	Ministry of Agriculture, Livestock and Fisheries website			
Age	Never used	Sometimes used	Frequently used	Total
30 yrs and below	8	3	1	12
31-40 yrs	13	5	3	21
41-50 yrs	20	5	2	27
51-60 yrs	16	5	1	22
61-70 yrs	9	6	0	15
71 yrs and above	7	6	0	13
Total	73	30	7	110

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.555[a]	10	0.575
Likelihood Ratio	9.511	10	0.484
Linear-by-Linear Association	0.062	1	0.803
N of Valid Cases	110		

The results in tables 10-13 show that there was no significant relationship between age and farmers utilisation of agricultural information platforms provided by MoALF, at $p<0.05$ level and therefore no evidence to warrant rejection of the null hypothesis. This finding was unexpected and is in contrast to findings by Wole, (2009) that suggest that the young set of respondents was capable of using ICTs more than the older people. Past studies had also suggested that this category of farmers is more literate and better able to use ICT tools (Okello, Ofwona-Adera & Mbatia, 2010). This contrast could be explained by the fact that majority of the

respondents had at least primary level of education thus had basic skills to use ICT. The introduction of mobile phone services such as for money transactions has enabled and made users irrespective of age learn to operate these basic ICT gadgets.

ii. To investigate whether there was significant relationship between the utilisation status of MoALF information platforms(Radio, Mobile phone, MoALF website, NAFIS) and level of education of farmers in Nakuru North Subcounty

Hypothesis

H_o2: There is no statistically significant relationship between the utilisation status of MoALF information platforms (Radi*o,* Mobile pho*ne,* MoALF website, NAFIS) and level of education of farmers in Nakuru North Subcounty.

In order to test the hypothesis, I did Chi square tests on several variables. The results obtained on *levels of education* of the respondents visa vis utilisation status of agricultural information platforms *(Radio, mobile telephony, MoALF website, NAFIS)* are presented in Table 14 -17.

Table 14 shows the results of the analysis of relationship of education level and the utilisation of radio information platform among respondents.

Table 14

Chi square statistics and results on utilisation of radio across farmers of different education levels.

	Radio			
Level of Education	Never used	Sometimes used	Frequently used	Total
None	2	3	1	6
Primary	4	20	23	47
Secondary	5	18	24	47
Post-Secondary	0	5	5	10
Total	11	46	53	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.122[a]	6	0.410
Likelihood Ratio	6.285	6	0.392
Linear-by-Linear Association	1.729	1	0.189
N of Valid Cases	110		

The findings of the study revealed that farmers' level of education did not have any significant relationship with utilisation of *Radio services platform provided by MoALF*. at $p<0.05$ level.

Table 15 shows the results of the analysis of relationship of education level and the utilisation of mobile phones/telephone information platform among respondents. From the results, it is evident that farmers' level of education did not have any significant relationship with utilisation of *Mobile phone platform provided by MoALF* at $p<0.05$ level.

Table 15

Chi square statistics and results on utilisation of mobile phones/telephone across farmers of different education levels.

	Mobile Telephone			
Level of Education	Never used	Sometimes used	Frequently used	Total
None	4	2	0	6
Primary	34	11	2	47
Secondary	39	5	3	47
Post-Secondary	5	1	4	10
Total	82	19	9	110
Chi-Square Tests				
	Value	df	Asymp. Sig. (2-sided)	
Pearson Chi-Square	18.696[a]	6	0.005	
Likelihood Ratio	13.395	6	0.037	
Linear-by-Linear Association	1.819	1	0.177	
N of Valid Cases	110			

Table 16 shows the results of the analysis of relationship of education level and the utilisation of NAFIS information platform among respondents The results revealed that farmers' level of education had no significant relationship with utilisation of *NAFIS* at $p<0.05$ level.

Table 16

Chi square statistics and results on utilisation of NAFIS across farmers of different education levels.

	National Agriculture Farmers Information Service (NAFIS)			
Level of Education	Never used	Sometimes used	Frequently used	Total
None	4	2	0	6
Primary	35	11	1	47
Secondary	38	7	2	47
Post-Secondary	7	3	0	10
Total	84	23	3	110
Chi-Square Tests				
	Value	df	Asymp. Sig. (2-sided)	
Pearson Chi-Square	2.965[a]	6	0.813	
Likelihood Ratio	3.321	6	0.768	
Linear-by-Linear Association	0.079	1	0.779	
N of Valid Cases	110			

Table 17 shows the results of the analysis of relationship of education level and the utilisation of MoALF website information platform among respondents. The findings do not reveal any significant relationship between education level and use of the MoALF website at $p<0.05$ level.

Table 17

Chi square statistics and results on utilisation of MoALF website across farmers of different education levels.

	Ministry of Agriculture, Livestock and Fisheries website			
Level of Education	Never used	Sometimes used	Frequently used	Total
None	4	2	0	6
Primary	35	11	1	47
Secondary	30	12	5	47
Post-Secondary	4	5	1	10
Total	73	30	7	110

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.107[a]	6	0.311
Likelihood Ratio	7.483	6	0.278
Linear-by-Linear Association	4.202	1	0.040
N of Valid Cases	110		

Results of the study revealed that farmers' level of education did not have any significant relationship with utilisation of MoALF platforms (*Radio, Mobile phone, MoALF website and NAFIS*) at $p<0.05$ level. We thus have no evidence to reject the null hypothesis stated. The results contrasts what ITU (2003) observed that there are digital divide in the access and use of ICTs because of socio-cultural and economic factors (including gender, income, age, education) around the world.

While this finding was unexpected, it may suggest that the available platforms are not providing the appropriate information tailored to the farmers' needs and that there may have been minimal sensitisation by the extension agents.

iii. To investigate whether there was significant relationship between the Utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and gender of farmers in Nakuru North Subcounty)

Hypothesis

H_o3: There was no statistically significant relationship between the utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS) and gender of farmers in Nakuru North Subcounty

In order to test the hypothesis, I did Chi square tests on several variables. Table 18-21 shows the results obtained on utilisation status of agricultural information platforms *(Radio, mobile telephony, MoALF website, NAFIS)* across different gender groups of the respondents.

With the findings revealing that the population in the study area had near equal gender and education distribution besides mobile ownership, there was no significant variation in terms of utilising the ICT platforms across gender groups.

Table 18 shows the results of the analysis of relationship of gender and the utilisation of radio information platform among respondents. There was no significant relationship between gender and the utilisation status of radio services platforms provided by the MoALF at $p<0.05$ level.

Table 18

Chi square statistics and results on utilisation of radio across farmers of different gender.

Gender	Radio			
	Never used	Sometimes used	Frequently used	Total
Male	5	19	30	54
Female	6	27	23	56
Total	11	46	53	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.371[a]	2	0.306
Likelihood Ratio	2.380	2	0.304
Linear-by-Linear Association	1.587	1	0.208
N of Valid Cases	110		

Table 19 shows the results of the analysis of relationship of gender and the utilisation of mobile phone information platform among respondents. The results did not show any evidence of any significant relationship between status of gender and utilisation of mobile phones platform provided by the MoALF at $p<0.05$ level.

Table 19

Chi square statistics and results on utilisation of mobile phone/ telephone across farmers of different gender.

	Mobile Telephone			
Gender	Never used	Sometimes used	Frequently used	Total
Male	42	9	3	54
Female	40	10	6	56
Total	82	19	9	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.065[a]	2	0.587
Likelihood Ratio	1.084	2	0.581
Linear-by-Linear Association	0.933	1	0.334
N of Valid Cases	110		

Table 20 shows the results of the analysis of relationship of gender and the utilisation of NAFIS information platform among respondents. There is no evidence to support any significant relationship between status of gender and the utilisation of NAFIS platform provided by the MoALF at $p<0.05$ level.

Table 20

Chi square statistics and results on utilisation of NAFIS across farmers of different gender.

	National Farmers Information Service (NAFIS)			
Gender	Never used	Sometimes used	Frequently used	Total
Male	42	12	0	54
Female	42	11	3	56
Total	84	23	3	110
Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)	
Pearson Chi-Square	3.008[a]	2	0.222	
Likelihood Ratio	4.166	2	0.125	
Linear-by-Linear Association	0.725	1	0.395	
N of Valid Cases	110			

Table 21 shows the results of the analysis of relationship of gender and the utilisation of MoALF website information platform among respondents. The results reveal no significant relationship between gender and the utilisation of MoALF website platform at $p<0.05$ level.

Table 21

Chi square statistics and results on utilisation of MoALF website across farmers of different gender.

	Ministry of Agriculture, Livestock and Fisheries website			
Gender	Never used	Sometimes used	Frequently used	Total
Male	35	15	4	54
Female	38	15	3	56
Total	73	30	7	110

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	0.230[a]	2	0.891
Likelihood Ratio	0.230	2	0.891
Linear-by-Linear Association	0.192	1	0.661
N of Valid Cases	110		

When radio, Mobile phone, MoALF website and NAFIS variables were tested against gender of respondents, the study revealed no relationship with the Utilisation status of MoALF information platforms and as such the null hypothesis is not rejected.

This reinforces an earlier study by Mottin-Sylla, (2005), that found out that with regard to mobile access, if factors other than gender are held constant no significant gender effect for mobile phone utilisation can be found. Thus women with similar income, education and employment status are as likely as men to own and utilise a mobile phone.

The findings further contradicts the study by Souter et...al, (2005), that showed that on average women tend to be more marginalised than men, and are therefore less likely to make frequent use of ICT. This could be explained by the fact that the population in the study area is middle aged

with equal educational level among gender groups. There has also been accelerated lobbying for promoting girl child empowerment to uplift her status in society.

iv. To investigate whether there was significant relationship between the utilisation status of MoALF information platforms(Radio, Mobile phone, MoALF website, NAFIS) and distance travelled to access an extension office to farmers in Nakuru North Subcounty

Hypothesis

H_o4: there is no statistically significant relationship between the utilisation status of MoALF information platforms (Radio, Mobile phone, MOALF website, NAFIS) and distance travelled to access an extension office to farmers in Nakuru North Subcounty.

In order to test the hypothesis, I did Chi square tests on several variables. Table 22-25 shows the results obtained on utilisation status of agricultural information platforms *(Radio, mobile telephony, MoALF website, NAFIS)* across farmers travelling different distances to reach an extension/ agent.

Table 22 shows the results of the analysis of relationship of distances travelled to reach an extension agent/office and the utilisation of radio information platform among respondents. The results reveal that there is no significant relationship between the status of utilisation of radio information platform provided by the MoALF and the distance travelled to access an extension worker at $p<0.05$ level.

Table 22

Chi square statistics and results on utilisation of radio across farmers who travel different distances to reach an extension agent.

	Radio			
Distance to an extension office/agent	Never used	Sometimes used	Frequently used	Total
Less than 1 km	3	12	10	25
1 - 3 km	5	17	21	43
3 - 5 km	2	14	20	36
5 - 10 km	1	3	0	4
Over 10 km	0	0	2	2
Total	11	46	53	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.070[a]	8	0.427
Likelihood Ratio	10.417	8	0.237
Linear-by-Linear Association	0.757	1	0.384
N of Valid Cases	110		

Table 23 shows the results of the analysis of relationship of distances travelled to reach an extension agent/office and the utilisation of mobile information platform among respondents. The results reveal indicate that there is no significant relationship between the status of utilisation of mobile telephone information platform provided by the MoALF and the distance travelled to access an extension worker at $p<0.05$ level.

Table 23

Chi square statistics and results on utilisation of mobile phone/telephone across farmers who travel different distances to reach an extension agent.

	Mobile Telephone			
Distance to an extension office/agent	Never used	Sometimes used	Frequently used	Total
Less than 1 km	17	7	1	25
1 - 3 km	37	2	4	43
3 - 5 km	26	7	3	36
5 - 10 km	1	2	1	4
Over 10 km	1	1	0	2
Total	82	19	9	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	14.010[a]	8	0.082
Likelihood Ratio	14.353	8	0.073
Linear-by-Linear Association	1.246	1	0.264
N of Valid Cases	110		

Table 24 shows the results of the analysis of relationship of distances travelled to reach an extension agent/office and the utilisation of NAFIS information platform among respondents. The results indicate that there is a significant relationship between the status of utilisation of NAFIS information platform provided by the MoALF and the distance travelled to access an extension worker at $p<0.05$ level.

Table 24

Chi square statistics and results on utilisation of NAFIS across farmers who travel different distances to reach an extension agent.

	National Agriculture Farmers Information Service (NAFIS)			
Distance to an extension office/agent	Never used	Sometimes used	Frequently used	Total
Less than 1 km	18	7	0	25
1 - 3 km	37	6	0	43
3 - 5 km	27	7	2	36
5 - 10 km	1	2	1	4
Over 10 km	1	1	0	2
Total	84	23	3	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.465[a]	8	0.036
Likelihood Ratio	13.389	8	0.099
Linear-by-Linear Association	3.155	1	0.076
N of Valid Cases	110		

Table 25 shows the results of the analysis of relationship of distances travelled to reach an extension agent/office and the utilisation of MoALF website information platform among respondents. The results suggest that there is a significant association between the distance travelled to access an extension worker and the utilisation of *MoALF website* platform provided by the MoALF at $p<0.05$ level.

Table 25

Chi square statistics and results on utilisation of MoALF website across farmers who travel different distances to reach an extension agent.

	Ministry of Agriculture, Livestock and Fisheries website			
Distance to an extension office/agent	Never used	Sometimes used	Frequently used	Total
Less than 1 km	15	9	1	25
1 - 3 km	32	10	1	43
3 - 5 km	25	9	2	36
5 - 10 km	1	2	1	4
Over 10 km	0	0	2	2
Total	73	30	7	110

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	36.404[a]	8	0.000
Likelihood Ratio	17.563	8	0.025
Linear-by-Linear Association	4.350	1	0.037
N of Valid Cases	110		

As illustrated by the study findings, there is a significant association between the distance travelled to access an extension worker and the utilisation of *MoALF website and NAFIS* services. This could be explained by the fact that the two platforms would ideally have reached the extension officers who work for the Ministry before rolling down to the farmers. Services of extension workers would play a pivotal role in better use of the MoALF website and NAFIS services. To the contrary, utilisation of radio and mobile platforms had no significant relationship with distance travelled to reach extension service. The study area is well covered by radio,

mobile and internet network infrastructure and farmers would ordinarily use the radio and mobile devices without necessarily seeking much support leave alone travelling to solicit an extension agent's advice. We thus reject the null hypothesis.

v. To investigate whether there was significant relationship between the Utilisation status of MoALF information platforms (Radio, Mobile phone, MoALF website, NAFIS)and access to electricity to farmers in Nakuru North Subcounty.

Hypothesis

H_o5: there is no statistically significant relationship between the utilisation status of MoALF information platforms*(Radio, Mobile phone, MoALF website, NAFIS)* and access to electricity to farmers in Nakuru North Subcounty.

In order to test the hypothesis, I did Chi square tests on several variables. Table 26-29 shows the results obtained on utilisation status of agricultural information platforms *(Radio, mobile telephony, MoALF website, NAFIS)* across farmers of different electricity connectivity status.
Table 26 illustrates the results of the analysis focusing on relationship of connection to electricity and the utilisation of radio among respondents. The findings of the study shows that there is a significant relationship between on connection to electricity and farmers utilisation of radio services platform at $p<0.05$ level,

Table 26

Chi square statistics and results on utilisation of radio across farmers with different connectivity to electricity status.

	Radio			
Connection with electricity	Never used	Sometimes used	Frequently used	Total
Yes	4	29	19	52
No	7	17	34	58
Total	11	46	53	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.890[a]	2	0.019
Likelihood Ratio	7.972	2	0.019
Linear-by-Linear Association	1.953	1	0.162
N of Valid Cases	110		

Table 27 illustrates the results of the analysis focusing on relationship of connection to electricity and the utilisation of mobile phone among respondents. The results of the study indicate there is a significant relationship on status of connection to electricity and farmers utilisation of mobile telephone platform at $p<0.05$ level.

Table 27

Chi square statistics and results on utilisation of mobile phone/ telephone across farmers with different connectivity to electricity status.

	Mobile Telephone			
Connection with electricity	Never used	Sometimes used	Frequently used	Total
Yes	33	13	6	52
No	49	6	3	58
Total	82	19	9	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.393[a]	2	0.041
Likelihood Ratio	6.475	2	0.039
Linear-by-Linear Association	5.268	1	0.022
N of Valid Cases	110		

Table 28 illustrates the results of the analysis focusing on relationship of connection to electricity and the utilisation of NAFIS among respondents. The results of the study indicate there is a significant relationship between connection to electricity and farmers utilisation of NAFIS platform at $p<0.05$ level.

Table 28

Chi square statistics and results on utilisation of NAFIS across farmers with different connectivity to electricity status.

	National Agriculture Farmers Information Service (NAFIS)			
Connection with electricity	Never used	Sometimes used	Frequently used	Total
Yes	34	16	2	52
No	50	7	1	58
Total	84	23	3	110

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	6.595[a]	2	0.037
Likelihood Ratio	6.696	2	0.035
Linear-by-Linear Association	5.752	1	0.016
N of Valid Cases	110		

Table 29 illustrates the results of the analysis focusing on relationship of connection to electricity and the utilisation of MoALF website among respondents. The study findings showed no significant relationship between status of farmers' connection to electricity and utilisation of the MoALF website at $p<0.05$ level.

Table 29

Chi square statistics and results on utilisation of MoALF website across farmers with different connectivity to electricity status.

Connection with electricity		Ministry of Agriculture, Livestock and Fisheries website			
		Never used	Sometimes used	Frequently used	Total
	Yes	29	19	4	52
	No	44	11	3	58
Total		73	30	7	110

Chi-Square Tests	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	5.046[a]	2	0.080
Likelihood Ratio	5.080	2	0.079
Linear-by-Linear Association	3.783	1	0.052
N of Valid Cases	110		

Connectivity to electricity as revealed by the study had significant relationship with farmers utilisation of Radio, Mobile phone and NAFIS except for the MoALF website at $p<0.05$ level, thus we reject the null hypothesis. Indeed, farmers having connection to electricity seem to enjoy more of the services of NAFIS, use of phones and radio to access MoALF services. This concurs with the findings of earlier studies by World Bank (2007) that listed available infra-structure in an area among the factors that are often cited as having an influence on ICT use.

Electricity connectivity not withstanding, farmers in this area did not seem to favour or have knowledge on access of information from website but relied more on radio, TV, field days among other media for information. This could be explained by the fact that most government Ministrys' websites are designed for elite clients with corporate tendencies and with little regard for common citizens.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This section presents the summary of the study, major findings, conclusions and the recommendations of the study by the researcher. It also has proposed further study that the researcher suggests can be carried out on this subject.

5.2 Summary of the Study

The Ministry of Agriculture, Livestock and Fisheries (MoALF) has integrated use of Information and Communication Technology (ICTs) to improve access to information and rapidly transform the delivery of agricultural extension services to farmers. The initiatives include; (1) mobile telephony, (2) web based network and (3) National Farmers Information Service (NAFIS) as channels of delivering extension messages to farmers. Since the introduction of these ICT initiatives in 2000, no empirical study had been conducted to assess their accessibility and utilisation by the target users. This study therefore was carried out to determine and document the actual usage of the government initiatives and the influence of the selected user's socioeconomic characteristics on their access and use. The research of this study was conducted in Bahati Division of Nakuru North Subcounty, Nakuru County.

A cross sectional survey was used in the study where a total of 110 respondents were interviewed. A questionnaire with closed and open-ended questions was used to collect data.The respondents interviewed were head of households. The selected factors were limited to the farmers' socioeconomic characteristics (gender of the user, age of the household head, his/her educational level, land ownership and on farm and off farm income sources) and institutional factors (connection to electricity and distance to the extension office/agent).

Descriptive statistics used for analysis include modal distribution, means, standard deviation, frequencies and percentages. Inferential statistics used was Chi Square with the help of Statistical Package for Social Sciences (SPSS). Stated hypotheses were tested at 0.05level of significance.

The following were the major findings of the study;

1. The study revealed that farmers in this area rely on MoALF extension agents for agricultural information provided during field days, trade fairs, shows, office visits among other

platforms. They also prefer information availed through mass media for instance through radio and Televisions. Radio and mobile phones were common in most households though not used for acquisition of agriculture related information. Farmers in the study area received agricultural related information weekly, monthly and only a few on daily basis.

2. The study indicated that there was generally low knowledge and usage of mainly computer and internet based ICT platforms by farmers in the study area. Even though 95.5percent of the households own mobile phones, a much smaller proportion (11%) of them indicated they use these devices to access any ICT based agricultural applications.
3. The farmer's age, gender and level of education were not significant determinants to the utilisation status of MoALF information platforms.
4. Farmers who had connection to electricity seem to have been enjoying more services of NAFIS, use of phones and radio to access MoALF services. There was a significant association between the distance travelled to access an extension worker and the utilisation of *MoALF website and NAFIS* services but this was not the case for radio and mobile.

5.3 Conclusions

1. The community in Bahati is rich in terms of basket options of agricultural information sources they prefer such as mass media and agricultural forums available to them daily, weekly or on monthly basis. Players in the agriculture sector such as MoALF have realised this potential of ICT for the speedy dissemination of information to farmers who still value and highly regard information and services sourced from the government. However appropriate framework for ICTs access and utilisation are lacking in order to harness potentials which abound with the use of ICTs in enhancing agricultural extension services and improving agricultural productivity among rural a farmer.
2. The initiative by the MoALF to improve extension service delivery through the use of ICT was noble but the execution was not done right. It does not for instance show any evidence of extension agents trained and instructed how to roll it out to its ultimate users.

   Further, the use of ICT is still minimal amongst the public and most lack knowledge of the existing ICT initiatives more so on agriculture whether by the government or other players. The respondents though endowed with mobile phones among other ICT accessories were

more willing to embrace initiatives that have social and financial gains to the households and shun ones for agriculture. Thus availability and provision of an ICT device or channel did not necessarily imply access and utilisation.

3. While the selected farmer's factors of age, gender and level of education were not significant to consider when planning policies and programmes in introducing ICT use in information and extension delivery to farmers, other factors need to be explored. The study may not have been conclusive.
4. Provision of infrastructure such as electricity, extension office, roads and internet appear to play a critical role in ICT use and probably were not considered before roll out of the MoALF initiative.

5.4 Recommendations

The following recommendations are made based on the study findings:

1) There is potential to reach 95percent households who have access to radio and 90 percent adults who own mobile phones and prefer mass media and agricultural forums as source of information. The government and other stakeholders can improve extension services through ICTs that hold great potential for small-scale farmers to be reached to deliver agricultural information and relay feedback from the field. For this to be realized, lacking appropriate framework must be put in place by the government for ICTs to be accessed and utilised by the target users.
2) Ministry of Agriculture, Livestock and Fisheries need to sensitise and train the target users of these ICT based information channels more aggressively as it was evident that most respondents were not aware of them. Further, MoALF, should in future while developing new applications, involve the farmers (bottom up) or at least define user groups of information patterns of farmers in a region in order to fulfill the potential of the communication technology (and speed up information processes).
3) There is need to conduct further studies to enrich this subject by establishing the role played by other household head's socioeconomic factors in use of ICT in agriculture. These factors that can be investigated include income levels, membership to farmer groups or associations, type of crops grown, size of land owned and enterprise value chains involvement.

4) The use of ICT in delivery of extension information to the rural farmers needs to be examined within a 'holistic' context. There is need to engage and ensure a package or initiative has adequate logistical, infrastructural and promotional strategies to ensure success. The MoALF should work in collaboration with other institutions responsible for infrastructural development to ensure all related support services to the ICT use are fixed. Similarly, the extension officers must first be instilled with all the required technology skills and knowledge.

5.5 Suggestion for further research

Further study should be done to evaluate the performance and impact of the MoALF provided ICT initiatives on agricultural productivity and how to guard farmers against increasing ICT related fraud and propose mitigation measures for greater value of ICT and impact on farmers' welfare.

There is also need to investigate the role played by other household head's socioeconomic factors such as income levels, membership to farmer groups or associations, type of crops grown, size of land owned and enterprise value chains involvement in use of ICT in agriculture by farmers.

REFERENCES

Abdullah F. A. & Bahaman A. S. (2013). Factors Impinging Farmers' Use of Agriculture Technology. Asian Social Science; Vol. 9, No. 3; 2013.

Adekunle, A. A., Olowu T.A. & Ladele A. (2004). *Bridging the gap between farmers and researchers, the effect of resource centers on the productivity of farmers in Katsina, Katsina State of Nigeria.* IITA publication 46pp.

Adhiguru, P., Birthal, P.S. & Ganesh, K. B.(2009). Strengthening Pluralistic Agricultural Information Delivery Systems in India. *Agricultural Economic Review* 22 (1) 71-79. African Economic Outlook, (2009). Technology Infrastructure and Services in Africa. Available at AfricanEconomicOutlook.org.

Akunyili, D. (2010). ICT and E-Government In Nigeria : Opportunities And Challenges. Paper presented at The World Congress On Information Technology , Amsterdam, The Netherlands, Retrieved from http://goafrit.wordpress.com/2010/06/12/ict-and-e-government-in-nigeria-prof-akunyili.

Ali, J. (2011). Use of quality information for decision-making among livestock farmers: Role of Information and Communication Technology. *Livestock Research for Rural Development. Volume 23, Article #43.* http://www.lrrd.org/lrrd23/3/ali23043.htm Retrieved April 27, 2011.

Annerose, D. (2007). Manobi launches in Senegal a free-access SMS market information service. Press release available at http://www.manobi.sn/sites/za/index.php?M=9&SM=20&Cle=54.

Arnold, E. & Bell, M. (2001). Some New Ideas About Research for Development. *In Partnership at The Leading Edge: Danish Vision for Knowledge, Research and Development.* Danish Ministry of Foreign Affairs, Copenhagen Denmark.

Arokoyo, T. (2005). ICT's Application in Agricultural Extension Service Delivery. *Journal of Agricultural Extension in Nigeria,* 245-251.

Attygalle, D., Gamage, G., Jayasinghe, U., Samaranayake, V.K. & Wimalaratne, P. (2006). Distant Learning Initiatives in Sri Lanka with specific reference to ICT based learning: issues and strategies. Paper presented at International IT Conference (IITC), Colombo.

Batchelor, S. & O'Farrell, C. (2003). Guiding principles for ICT interventions. In FAO (ed.) *Revisiting the 'Magic Box': Case studies in Local Appropriation of Information and Communication Technologies (ICTs).* Rome: Food and Agriculture Organization. www.fao.org/documents/show-cdr.asp?url-file=/DOCREP/006/Y5106E/Y5106E00.HTM

Batte, M. T., Jones, E. & Schnitkey, G.D. (1990). Computer Use By Ohio Commercial Farmers. *American Journal of Agricultural Economics*, 72, 935-945.

Bertolini, R. (2004). Strategic thinking: making information and communication technologies

work for food security in Africa. <http://www.ifpri.org/pubs/ib/ib27.pdf> (Accessed July 14 2013).

Bonaglia F., Labella P. & Marshal J. (2007). Promoting Commercial Agriculture In Africa. *ATDF Journal Vol 5, Issue ½.* OECD Development Center, Paris.

Borg, W. R. & Gall, M. D. (1983). *Educational research: An introduction.* Longman, New York.

Brennan, R. (2001). An essay on the history and future of reliability from the perspective of replications. *Journal of Educational Measurement,* 38, 295-317.

Cebeci, Z., Erdogan, Y. & Kara,T. (2008). TrAgLor: ALOM-Based Learning Objects Repository for Agriculture. In: Proc. of the Int.4th Scientific Conference "eLearning and software for education (eLSE'08)". 17-18 April 2008, Bucharest, Romania.

Cecchini, S., & Scott, C. (2003). Can information and communications technology applications contribute to poverty reduction? Lessons from rural India, information technology for development, 10 (2), 73-84.

Central Bureau of Statistics, (2007). *ICT Sectoral Reports*. Government Printer, Nairobi.

Chambers, R. & Conway, G.R. (1992). '*Sustainable Rural Livelihoods*: Practical Concepts for the 21st Century.' Discussion Paper 296. Brighton, UK: Institute of Development Studies.

Cieslikowsk, D.A., Halewood N.J., Kimura, K., & Zhen-Wei Qiang, C. (2009). Key trends in ICT development (World Bank Report). Retrieved July 20, 2013, from the Communication Initiative Network website: www.comminit.com/en/node/298770/307.

Communication Commission of Kenya (2010). Annual Report For 2009/2010 Financial Year. CCK, Nairobi.

Cronbach, L. J. (2004). My current thoughts on Coefficient Alpha and successor procedures. *Educational and Psychological Measurement,* 64, 391-418.

Davis, K. & Place, N. (2003). Current concepts and approaches in agricultural extension in Kenya. *Proceedings of the 19th Annual Conference of AIAEE*. Raleigh, North Carolina, U.SA: 745 - 756

District Agriculture Officer Nakuru (2007). Annual Report. Prepared By Muriithi,S. W., Nakuru.

Ebadi, R. (2005), *IT and Education*. A case study of the Requirements and Challenges of Information and Communication Technology System to Train Private Agricultural Insurance Brokers.

Elizabeth, M., John, A. (2006). Normative Images of Communication Media Mass and Interpersonal Channels in the New Media Environment. Available online at: http://onlinelibrary.wiley.com/doi/10.1111/j.1468-2958.1993.tb00310.x/abstract

Evans, P. & Wurster T.S. (2000). *Blown to Bits*. Boston: Harvard Business School Press.FARA, (2009). 2009 FARA Secretariat Annual Program Planning and 4th Executive Board Meetings Proceedings. Available at http://farastaff.blogspot.com/2009_03_01_archive.html

Farah, A. A. & Bahaman, A. S., (2009). Factors Impinging Farmers' Use of Agriculture Technology

Feder, G. & Slade, R. (1984). The acquisition of information and the adoption of new Technology. *American Journal of Economics*, 66,312-320.

Food and Agriculture Organization (FAO) (2011). *The state of food and agriculture*. Rome, Italy. Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (FAO) (2007). *The state of food and agriculture*. Rome, Italy. Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (FAO) (2004). Institute building to strengthen agricultural extension. 27th FAO regional conference for Asia and the pacific Beijing, China, May, 17th – 21st, 2004.

Food and Agriculture Organization (FAO) (2001). *Farmer innovation and new technology options for food production, income generation and combating desertification (KEN/99/200). Progress Report - 2001*: Nairobi, Kenya. Food and Agriculture Organization of the United Nations.

Food and Agriculture Organization (FAO) and World Bank (2000). *Agricultural Knowledge and Information Systems for Rural Development. Strategic Vision and Guiding Principles.* Rome and Washington DC: FAO and World Bank.

Food and Agriculture Organization (FAO) (2012). *Radio still reaches most Kenyan farmers—but agricultural information still not useful enough.* Accessed from http://www.zhaw.ch/fileadmin/user_upload/linguistik/_Institute_und_Zentren/IAM/PDFS/News/final_report_Kenya_agri_communication_IAM_MMU_01.pdf on 29th October 2013.

Food and Agriculture Organization (FAO) (2008). Available on http://faostat.fao.org.

Fraenkel, J.R. & Wallen, N.E. (2000). *How To Design And Evaluate Research In Education,* New York, NY.Mc Graw-Hill Companies Inc.

Gakuru, M., Winters, K. & Stepman, F. (2009). Inventory of Innovative Farmer Advisory Services Using ICTs. Available on

http://www.fara-africa.org/media/uploads/File/NSF2/RAILS

Gollakota, K. (2008). ICT use by businesses in rural India: The case of EID Parry's Indiagriline. *International Journal of Information Management*, 28 (4), 336-341

Government of Kenya (2009). The East African Marine Systems Cable Officially Launched, Kenyan Government Press Release, 12 June 2009.

Hall, A. (2006). Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems. Presentation at the workshop on Expert Workshop on Innovation Systems in Agriculture. June 12, 2006, World Bank, Washington, DC.

Hayrol Azril, M. S., Md Salleh, H., & Bahaman, A. S. (2009). Level of Agro-based Website Availlable on www.ccsenet.org/ass Asian Social Science Vol. 9, No. 3; 2013 124 Malaysian Agricultural Entreprenuers: A Case Study of Malaysia. J. Agriculture and Social Science., 5, 55-60.

Hilbe, J. M. (2009). *Logistic Regression Models*. Chapman & Hall/CRC Press.

IICD (2005). The TIC Bolivia Country Programme, International Institute for Communication and Development. The Netherlands.

ITU, (2009). Information Society Statistical Profiles 2009 – *Africa*. ITU Telecommunications Development Bureau Geneva Switzerland, International Telecommunication Union.

Janssen, W. (2006). Towards an intervention framework for strengthening agricultural innovation capacity. Presentation at the workshop on Expert Workshop on Innovation Systems in Agriculture. June 12, 2006, World Bank, Washington, DC.

Jayathilake, H., Jayaweera, B.P. & Waidyasekera, B. C. (2006). ICT Adoption and Its Implication On Agriculture In Srilanka. Wanyamba University , Srilanka.

Jon, C. (2008). *Social Media and ICT in Kenyan Agriculture*. University Press, Nairobi.

Joseph, P**.** (2006). E-Commerce: An Indian Perspective 2nd Ed. Available on http://www.digitaldividend.org/pdf/echoupal_case.

KARI, (2004). 2004 Annual Report Prepared By Dr Mukhisira, Nairobi, Kenya.

KARI Lanet, (2010). About KARI Lanet. Available at http://www.kari.org/index.php?q=content/about-kari-lanet

Kavulya, J. (2010). Kenya Builds Digital Villages and Lays the Foundation for a Brighter Future. Retrieved from www.cue.edu on May 5 2011.

KNBS, (2009). Kenya National Figures and Facts. Available at

www.knbs.or.ke/knbsinformation.

Kweku, A .K. (2006). Demystifying ICT diffusion and use among rural women in Kenya. Unpublished paper presented to ProLISSA 2006 Conference.

Kothari, C.R. (2004). *Research Methodology: Methods and Techniques*. 2nd Ed. New Age International Publishers, New Delhi.

Kurtenbach, T. & Thomson, S. (2000). Information Technology Adoption: Implications For Agriculture. Available on https://www.ifama.org/conferences

Leary, J. & Berge, Z.L. (2005). Trends and challenges of e-learning in national and international agricultural development. *International Journal of education and Development using ICT* 2(2), 51-59.

Lio, M., & Liu, M.C. (2006). ICT and agricultural productivity: evidence from cross-country data. *Agricultural Economics,* 34 (3), 221–228.

Madukwe, M. C. (2006). *Delivery of Agricultural Extension Services to Farmers in Developing Countries*. University of Nigeria, Nsukka, Nigeria.

Mariquita, P., (2010). The e-Extension Program for Agriculture and Fisheries - Presentation Transcript [Power point slides]. Philippines: Mappala Agricultural Training Institute.

Meera, N., Jhamtani, S. & Rao, D.U.M. (2004). *Information And Communication Technology In Agricultural Development:* A Comparative Analysis of three Projects From India. Agricultural Research And Extension Network, New Delhi.

Mercella, R. & Knox, K. (2004). Systems for the Management of Information. *Information Research* 9, 2, 72.

Ministry of Agriculture (2009). *2008-2012 Strategic Plan:* Agriculture Information Resource Centre, Nairobi, Kenya.

Ministry of Information & Communication (2006*). 2006 Kenya ICT Strategy Collaboration and Outsourcing for Economic Growth.* AIRC, Nairobi.

Molony, T. (2008). Running Out of Credit: The Limitations of Mobile Telephony in a Tanzanian Agricultural Marketing System, *The Journal of Modern African Studies*, 46, 637-658.

Mottin-Sylla, M.H. (2005) *The gender digital divide in Francophone Africa*: A harsh reality. Dakar: ENDA Third World. ISBN 92-95049-11

Mugenda, M.O., & Mugenda, G.A. (2003). *Research methods*; *Quantitative and qualitative approaches*. Acts Press, Nairobi, Kenya.

Mwakaje, A. G.(2010). Information and Communication Technology for Rural Farmers Market

Access in Tanzania. *Journal of Information Technology Impact*, Vol. 10, No. 2, pp. 111-128, 2010.

Mytelka L. & Farinelli, F., (2000). *Local Clusters, Innovation Systems and Sustained Competitiveness.* Discussion Papers 5, United Nations University, Institute for New Technologies.

Nassiuma, D.K. (2000). *Survey Sampling: Theory and methods*. Nairobi University Press, pp 50-62, Nairobi, Kenya.

Nkurumah, K. (2006). Promoting access to and use of relevant Information and Communication Technologies (ICTs) by women farmer groups to produce healthy vegetables. CSIR-Crops Research Institute, Kumasi.

Nyirenda, J. T. (2010). Unlocking the Promise of ICTs for Transforming Agriculture in Africa. NEPAD, e-Africa Commissions, Pretoria, South Africa.

Okello, D. (2009). *Women & ICT*. East African Educational Publishers, Kenya

Okello, J.J., Ofwona-Adera, E., Mbatia, O.L.E, & Okello, R.M. (2010). Using ICT to integrate smallholder farmers into agricultural value chain; The case of DrumNet project in Kenya. International Journal of ICT and Research Development, 1, 23-37. http://dx.doi.org/10.4018/jictrda.2010010102

Parikh, T.S., Patel, N. & Schwartzman, Y. (2007). A Survey of Information Systems Reaching Small Producers in Global Agricultural Value Chains, in Proceedings of the 2nd IEEE/ACM international conference on ICTs and Development. Bangalore, India: http://www.stanford.edu/~neilp/pubs/ictd2007.pdf.

Patrick, G. F., Gerrard, F.F., Musa, W. G. & Doster, D.H. (1993). Information Sources of Large Scale Farmers. *CHOICES. Third Quarter*. Pp 40-41

Priestley, M. & Swope, A. (2008). *DITA maturity model.* A Just Systems Whitepaper. Available at http://na.justsystems.com/files/Whitepaper-DITA_MM.pdf.

Rao, N..H. (2007). A framework for implementing information and communication technologies in agricultural development in India. *Technological Forecasting and Social Change*,74(4), 491-518.

Rees, D., Momanyi, M., Wekundah, J., Ndung'u, F., Ondodi, J., OyureA.O., Andima, D., Kamau, M., Ndubi,J., Musembi, F., Mwaura, L., & Jorderma, R. (2000). Agricultural knowledge and information systems in Kenya – implications for technology dissemination and development. *AGREN Network Paper* No. 107.

Richardus, E. I. (2011). E-LEARNING : Information Technology and Education "Dealing with the New Paradigms of Learning".

Rogers, E. M. (1995). *Diffusion of Innovations*. 4th ed. New York: Free Press.

Rogers, E. M. (2003). *Diffusion of Innovations*. 5th ed. New York: Free Press.

Rogers, E.M. & Scott, K..L. (1999). *The Diffusion of Innovations model and outreach from the national network of libraries of medicine to Native American communities.* [onIine] available : http://nnlm.gov/pnrlevaIlrogers.html. [accessed on 10/1/14].

Rusten, E. & Ramirez, S. (2003). *Future Direction in Agriculture and Information and Communication technologies (ICTs) at USA ID.* United States Agency for International Development.

Saravanan, R., (2010), (Ed.) *ICTs for Agricultural Extension: Global Experiments, Innovations and Experiences*, New India Publishing Agency (NIPA), New Delhi.

Soriano, C.R.R. (2007). Exploring the ICT and rural poverty reduction link: Community telecenters and rural livelihoods in Wu'an, China. The *Electronic Journal of Information Systems in Developing Countries*, 32

Souter, D., Scott., N., Garforth, C., Jain, R., Mascarenhas, O., & McKemey, K. (2005). The economic impact of telecommunications on rural livelihoods and poverty reduction: A study of rural communities in India (Gujarat), Mozambique, and Tanzania (Report of DFID KaR Project 8347). Project managed for DfID by CTO.

Sunding, D. & ZiIberman, D. (2000). The agricultural innovation processes: research and technology adoption in a changing agricultural sector.[on-line] available: http://are.berkeley.edulzilber/innovationchptr.txlf[accessed12/3/13].

Suresh, P. & Derek B. (2006). The funding and organization of agricultural research in India: Evolution and emerging policy issues. In PG Pardey, JM Alston and RR Piggott (eds), *Agricultural R&D Policy in the Developing World*. Washington, DC: International Food Policy Research Institute.

Suresh, P., Tripp, R. & Louwaars, N. (2007). Intellectual property rights in plant breeding and biotechnology: assessing impact on the Indian seed industry. *Economic and Political Weekly* XLII (3): 231-24

Swortzel, K. A. (2001). The Role of Information Technology in Agriculture. *The Agricultural Education Magazine*. 46-51.

Taragola, N & Gelb, E. (2005). Information And Communication Technology Adoption In Horticulture. Available at http://departments.agri.huji.ca.il/economics/gelb-hort.

Temel, T., Janssen, W. & Karimor, F. (2002). *The agricultural innovation system of Azerbaijan*: An assessment of Institutional Linkages. The Hague: International Service for National Agricultural Research.

The Open University (2011). Open Learn Labspace. Available at (labspace.open.ac.uk/mod/resource/view.php?id=371982. Accessed on September 1st, 2011).

The World Bank, (2011). "Module 9: Strengthening Agricultural Marketing", *ICT in Agriculture eSourcebook.*.

Truong, T. N. C. (2008). Factors affecting farmers' adoption of technologies in farming system: A case study in OMon district, Can Tho province, Mekong Delta, 16, 107-112.

Tunji A., (2005). ICT's Application in Agricultural Extension Service Delivery. *Journal of Agricultural Extension in Nigeria, 245-251.*

UNCTAD (2008). *Foreign Direct Investment Report*. United Nations, New York.

Vachara P. & Walker D., (2005). Factors affecting ICT diffusion: A case study of three large Australian construction contractors. *Engineering, Construction and Architectural Management,* Vol. 12 Iss: 1, pp.21 – 37.

Van Audenhove, L. 2003. Towards an integrated information society policy in South Africa: an overview of political rhetoric and policy initiatives 1994 – 2000. 2003. Cape Town: HSRC Publishers. <www.hsrcpress.ac.za> (Verified September 6 2007).

Warren, F.M., Soffe, R.J. & Astone, M.A.H. (2000). Farmers, Computers and The Internet: A study of Adoption In Contrasting Regions Of England. Farm Management 10, 11 Pp 665-684

Wijekoon, RRA. (2006) Interactive Multimedia for Technology Transfer in Agriculture. Paper presented in the Conference on Building Digital Collection for Empowering Sri Lanka. 1-3 Nov 2006. Sri Lanka.

Wole, M. O. (2009). Analysing Socio-Demographic Differences in Access and Use of ICTs in Nigeria Using the Capability Approach *Issues in Informing Science and Information Technology,* Volume 6, 2009.

World Bank (2004). *The World Bank Research Observer, vol. 19, no. 1.* Washington DC.

World Bank (2007a). World Bank RCIP Countries. The Africa Regional Communications Infrastructure Program. World Bank. Washington, DC, USA.

World Bank (2007b). World Development Report 2008 – Agriculture for Development. World Bank. Washington, DC, USA.

World Bank (2006). *Agriculture Investment Source book*. Washington DC.

World Bank (2008). *Cultivating Knowledge and Skills to Grow African Agriculture: A Synthesis of an Institutional, Regional, and International Review. Economic and Sector Work*. Agricultural and Rural Development Department, Washington, D.C., World Bank.

World Development Report 2008. *Agriculture for Development. Agriculture and Rural Development Department,* The World Bank, Washington, DC, USA.

World Bank (2009). *Mobile banking in Southern Africa.* Available at (http://www.fmbmalawi.com/makwacha.html. Accessed on April 18th 2011).

Zijp, W., (1994). *Improving The Transfer and Use of agricultural information*- a guide to Information Technology. Washington, World Bank.

APPENDICES

APPENDIX A:

A Questionnaire on a survey of Farmers' Knowledge on Utilisation of ICT Based Information in Nakuru North Subcounty, Nakuru County, Kenya.

Introduction

I am James Wanjohi a second year student undertaking a master's degree in Agricultural Extension. The purpose of this survey is to assess how farmers access and utilise ICT based information particularly mobile telephony, NAFIS (National Farmers Information Service) and web based Ministry of Agriculture, Livestock and Fisheries channels. This study is for academic purposes and is meant to generate knowledge relevant to providing a framework for the design and implementation of sustainable ICT-enabled extension services for agricultural development. I would greatly appreciate if you could complete every item in the questionnaire and return to the enumerator. The information provided by the respondent will be treated with utmost confidentiality. Thank you very much for participating in this study.

Please fill the following details appropriately

Date _____/_____/_____.

Location _____.

Sub-location _____.

Section A. (Socio-Demographic Information) Please tick as appropriate.

1. Gender 1= Male ☐ 2=Female ☐
2. Age of Respondent (Years) _____.
3. Education Level:

   1=None ☐ 2=Primary ☐ 3=Secondary ☐ 4=Post secondary ☐ 5= Others (specify) ☐

4. Marital Status

   1=Single ☐ 2=Married ☐ 3=Widowed ☐ 4=Separated ☐

5. Main occupation of the household head: ***(Please tick one)***

   1=Farmer ☐ 2=Business ☐ 3=Formal employment ☐ 4=Others specify ☐

6. What is the total size of your land in acres? *(Approximate)* _____.

7. What size of your land in acres is under farming? _____.

8. Land tenure system

   1=Private ☐ 2=Leased ☐ 3=Communal 4=Others specify ☐

9. How long have you been involved in farming activities? _____ *(Years).*

10. Do you interact or seek services of extension staff? ***(Please tick one)***

    1= Yes ☐ 2= No ☐

11. If yes, how often do you interact?

12. 1=Daily ☐ 2= Weekly ☐ 3=Monthly ☐ 4= Others specify ☐

13. What distance do you travel to reach an extension agent/office?

    Less than 1km ☐ 1-3km ☐ 3-5km ☐ 5-10km ☐ Over 10km ☐

14. Do you own or have access to the following:

Radio	1= Yes ☐ 2= No ☐
Television	1= Yes ☐ 2= No ☐
Mobile phone/Telephone	1= Yes ☐ 2= No ☐
Computer	1= Yes ☐ 2= No ☐
Internet	1= Yes ☐ 2= No ☐

15. Are you connected with electricity? 1= Yes ☐ 2= No ☐

16. Do you receive information on agriculture related activities? ***(Please tick one)***

1= Yes ☐ 2= No ☐

17. If yes, how often do you receive information on agriculture related activities?

1=Daily ☐ 2= Weekly ☐ 3=Monthly ☐ 4= Others specify ☐

18. What services do you access from the following? (***Please tick appropriately)***

Radio	Agriculture inputs information	☐	Entertainment	☐
	Agriculture extension	☐	News	☐
	Weather information	☐	Others specify	☐
	Agriculture Market prices	☐		
Television	Agriculture inputs information	☐	Entertainment	☐
	Agriculture extension	☐	News	☐
	Weather information	☐	Others specify	☐
	Agriculture Market prices	☐		
Mobile phone/Telephone	Agriculture inputs information	☐	Entertainment	☐
	Agriculture extension	☐	News	☐
	Weather information	☐	Others specify	☐
	Agriculture Market prices	☐		
Computer	Agriculture inputs information	☐	Entertainment	☐
	Agriculture extension	☐	News	☐
	Weather information	☐	Others specify	☐
	Agriculture Market prices	☐		
Internet	Agriculture inputs information	☐	Entertainment	☐
	Agriculture extension	☐	News	☐
	Weather information	☐	Others specify	☐
	Agriculture Market prices	☐		

Section B: Agricultural Information Access

19. Please indicate the main source and frequency of information on agriculture related activities that you receive? ***(Please tick one)***

Source of Agricultural Information	**Frequency**
Government extension services	1= Frequently used ☐ 2=Sometimes used ☐ 3=Never used ☐
Information exchange with fellow farmers	1= Frequently used ☐ 2=Sometimes used ☐ 3=Never used ☐
Farmer associations	1= Frequently used ☐ 2=Sometimes used ☐ 3=Never used ☐
Internet	1= Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐
Ministry of Agriculture, Livestock and Fisheries website	1= Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐
Local traders and middle-men	1= Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐
Newspapers	1= Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐
Private extension providers	1=Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐
Radio	1=Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐
Television	1= Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐
Agriculture information desks	1=Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐
National Agriculture Farmers Information Service (NAFIS)	1= Frequently used ☐ 2= Sometimes used ☐ 3=Never used ☐

Mobile Telephone	1= Frequently used ☐ 3=Never used ☐	2= Sometimes used ☐
Other: _____	1= Frequently used ☐ 3=Never used ☐	2= Sometimes used ☐

Section C: Utilisation of ICT Based Information channels

20. What constraints if any do you experience in utilizing agricultural information provided through the following ICT Based information channels: *Please list any three main constraints*

ICT Based information channel	**Main Constraints**
Mobile Telephone	i. ..... ii. ..... iii. .....
Ministry of Agriculture, Livestock and Fisheries website	i. ..... ii. ..... iii. .....
National Farmers Information Service (NAFIS)	i. ..... ii. ..... iii. .....

21. 1 **Farmers level of Trust and Confidence on information sources**.

In the table below please indicate your opinion on the following source of agricultural information in terms of **importance and relevance, accuracy and reliability** of the information it can provide, and the **authority and legitimacy** of the information.

Please tick in the appropriate box.

Source of Agricultural Information	**Provide(s) Important and Relevant Information**	**Provide(s) Accurate and Reliable Information**	**Provide(s) Authoritative and Legitimate Information**
Government extension services	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Information exchange with fellow farmers	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Farmer associations	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Internet	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Ministry of Agriculture, Livestock and Fisheries website	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Local traders and middle-men	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Newspapers	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Private extension providers	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Radio	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Television	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Agriculture information desks	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
National Agriculture Farmers Information Service (NAFIS)	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
KAINet	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Infonet-biovision	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Mobile Telephone	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐
Other: _____	YES ☐ NO ☐	YES ☐ NO ☐	YES ☐ NO ☐

22. Please indicate the extent to which you *agree or disagree* with the following statements. *Score each statement using the following scale, placing the rank number in the space provided*

1= disagree, 2=agree, 3 =no information or opinion

22.1 Farmers in the neighbourhood are aware of the Ministry of Agriculture, Livestock and Fisheries ICT Base nformation channels

22.2 Ministry of Agriculture, Livestock and Fisheries ICT Based information channels provide adequate information that meets the needs o ocal farmers

22.3 Introduction of Ministry of Agriculture, Livestock and Fisheries ICT Based information channels has had significant positive impact on fa ers' livelihood in Nakuru.

22.4 Local farmers lack the capacity to utilize information provided through Ministry of Agriculture, Livestock and Fisheries ICT base formation channels.

22.5 Use of ICT based information is the future of extension in Kenya.

23. What are your comments on the Ministry of Agriculture, Livestock and Fisheries's initiative to provide agriculture extension information through ICT Based channels?

_____.

24. Suggest how these ICT Based channels can be improved to serve the intended clients well.

_____.