ASSESSMENT OF CONSTRAINTS IN INFORMATION AND COMMUNICATION TECHNOLOGY USE IN BANANA PRODUCTION;

A CASE OF KIMILILI, BUNGOMA COUNTY, KENYA

BY

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May, 2013

DECLARATION

This dissertation is my own work and has never been presented in any other university or any other institution of higher learning before.

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SUPERVISORS' RECOMMENDATIONS

This dissertation has been submitted for examination with our approval as University of Nairobi Supervisors.

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DEDICATION:

To my children David, Lillian, Linet and Basil, and my grandson Melvin

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ABBREVIATIONS AND ACRONYMS

AEZ	Agro Ecological Zone
CCK	Communications Commission of Kenya
CD	Compact Disc
DOI	Diffusion of Innovation
GOK	Government of Kenya
ICT	Information and Communication Technology
IU	International Unit
IT	Information Technology
KACE	Kenya Agricultural Commodity Exchange
KARI	Kenya Agricultural Research Institute
KGs	Kilogrammes
MOA	Ministry of Agriculture
MG	Milligrammes
SMS	Short Message Service
SPSS	Statistical Package for Social Sciences
TC	Tissue Culture
UM	Upper Midland zone
UON	University of Nairobi
US$	United States of American dollar

ABSTRACT

Information and communication technologies play an important role in development, the world over, for disseminating information. However, this potential has not been fully exploited, leading to low productivity in Banana production. This study's overall objective was to assess the constraints in ICT use by banana farmers of Kimilili subcounty. The variables selected included sources of information constraints, ICT use, yield and adoption. The methodology was a household survey accomplished through questionnaires. A total of 135(one hundred and thirty five) respondents were identified through systematic random sampling, from a population of 209.

The results indicated that, ICTs are used by very few farmers (38% use mobile phones and 1% use computers). On services, 14.1% use SMS service and 45.3% use voice calls. 97% of farmers find information accessed not applicable. Lack of knowledge was one of the major problems preventing farmers from attaining food self sufficiency. Three constraints significantly influence comparing with 5% level of precision ICT use: tool availability (inverse) with p value at 0.001(0.1%), infrastructure (inverse) at 0.011 (1.1%), and geographic remoteness (positively) at 0.004 (0.4%). Mobile phone users exhibited a variety of benefits, but the difference between them and non users were not significant. The use of mobile phones enables the users to have higher yields with a small margin of 4%. There are more adopters among ICT users than non users with a difference of 1.6%. ICT use influenced adoption positively. The study recommends that national and county governments should facilitate digitization of extension messages, improve infrastructure and carry out trainings for extension agents and farmers.

Key words: ICT use, constraints, information sources, yields, Adoption.

CHAPTER ONE

1.0 INTRODUCTION

1.1. Background to the study

Information and communication technologies (ICTs) are the highways that can facilitate the trade and exchange of innovations to address pressing agricultural challenges such as meeting the food needs of a growing world population Rusten et al., (2003). According to Aker (2010), Agricultural production and yields in developing countries have lagged far behind those in developed countries over the past few decades. Numerous studies on the adoption of agricultural technologies have attempted to identify the determinants of technology adoption as the access to information and the role that information plays (Aker, 2010). Even if beneficial, the transformation from hard copy style of dealing with transactions and markets and trade to sophisticated and technologically advanced digital methods and standards presents its own complexities (May et al., (2007). This may be responsible for the lagging behind of yields in developing countries.

As (Aker (2010) notes, the role of Agriculture in economic development is the role it plays in reducing poverty and serves as an engine for growth in developing countries. However, 75 percent of those surviving on less than US$1 a day lived in rural areas in 2002. There has been unprecedented range of pressures generated by globalization, climate change, the global financial and economic crisis, high food and fuel prices, and internal challenges, on Kenya's economic growth. To achieve ambitious development aims set out in Vision 2030, Kenya's development blueprint to 2030, growth rates must be further boosted (GOK, 2010)a. It is important to note that hunger and malnutrition (including micronutrient deficiencies) are major causes of poverty, a key constraint to the attainment of the vision

2030. They affect the ability of individuals to escape poverty in several ways (Flaherty, (2009)

We live in an information economy in which the major source of wealth and prosperity is the production and distribution of information and knowledge according to Laudon & Laudon, (2010). One of the important processes in knowledge management is knowledge transfer. It is important to have transfer of knowledge to locations where it is needed and can be used. Communication processes and information flows drive knowledge transfer in organizations or systems. Alavi & Leidner, (2001) conceptualize knowledge transfer in terms of five elements: (1) perceived value of the source unit's knowledge, (2) motivational disposition of the source (i.e., their willingness to share knowledge), (3) existence and richness of transmission channels, (4) motivational disposition of the receiving unit, and (5) the absorptive capacity of the receiving unit, defined as the ability not only to acquire and assimilate but also to use knowledge. However, Kenyan extension agents do not have access to ICT yet they need these tools to disseminate research information to farmers, Kiplang'at & Ocholla (2005).

Banana is an important food security crop in Kenya and its growing is both an economic undertaking for income earning and food source. Nutritionally it contains potassium, (467mg), magnesium, (43mg), phosphorus (27mg), calcium (7mg), selenium (1.3mg), iron (4mg), vitamin A (22.5mcg), vitamin B6 (0.7mcg), niacin (6mg), panthothenic acid (31mg), vitamin E (.67 IU), and trace amounts of zinc, manganese and copper, (Nderito (2008).

Many factors determine the yield of bananas including soil, agronomic practices, spacing, cultivator planted, type of propagating material and the management of the sucker succession. They vary in the number of fruits per year and the sizes of the fruits. Average is

3-7 tonnes/acre for dwarf according to Nderito, (2008) earning Ksh. 18 billion annually. As noted by (Acharya & Mackey, (2008), the average size of banana holdings in Kenya is 0.21-0.32 hectares. Nearly 83.5% of the total banana output comes from small-scale farmers owning up to 0.5 hectares of land. The average size of banana holdings in Kenya is 0.21-0.32 hectares. It constitutes 37.6% of total value of fruits produced and 11.1% of the total value of domestic horticulture, GOK (2011). Unfortunately banana production is challenged by pest and disease damage and post harvest losses. Interventions include the provision of clean planting material such as tissue culture seedlings. Another intervention is capacity building in crop husbandry (GOK, (2011).

This study focused on two tools (Mobiles and computers): the Mobile phones for voice, SMS and internet, and Computers use for internet browsing, collaboration & networking, e-commerce and emailing for information on banana production and marketing.

1.2 Problem Statement

ICT use plays an important role in access to information by farmers in an effective, efficient, cheap and more convenient manner. The benefits of such knowledge and services include adoption of new varieties and increased productivity, better marketing, and control of pests and diseases to mention but a few.

However, currently this may not be the norm among the banana farmers in Kimilili Sub County. There may be constraints that make it difficult for the farming communities to fully exploit their potential in the use of ICTs for communication (Hallberg et al (2011). (Okyere & Mekonnen (2012) found out that, 89.10 per cent of the Kenyan population (28.08 million mobile phone subscriptions) had access to mobile services in 2012, with the percentage land mass covered by mobile services of 34.45 % (Communications commission of Kenya, 2012). There were a total 6.15 million Internet subscriptions in Kenya, (CCK,

2012), 89.10% are connected to mobile but not necessarily for the purpose of communicating on banana farming. In a study on ICT access gaps in Kenya by CCK it was established that the population using mobile telephones in Bungoma County is 34.2% while those accessing internet at least once a month are 2.8%, CCK (2011). From these figures, it is clear that the use of ICTs for banana information is low. Information on constraints experienced by Banana farmers in the use of ICT is lacking and/or not readily available. Some of the problems caused by inadequate use of ICTs: traditional over-the-counter transactions cost more than those conducted via the Internet, consume more staff time and more paper supplies (including printing) than electronic transactions.

This study was designed to investigate why there was inadequate use of information communication technologies (ICTs) for information on banana production and marketing. It sort to determine the constraints that influence the use of ICT tools and how use of ICT influences the yields and the adoption of TC bananas. Information on constraints/barriers may assist in determining why banana farmers have limited access to ICT and new information on banana production and marketing.

1.3 Justification

Mwombe, (2010) recommends that policy makers need to develop appropriate ICT model or a centralized repository for all actors in the agriculture sector for effective and efficient information sharing and dissemination. At the same time, he recommends further research to be contacted to find out technology-specific attributes and socio-economic factors that impede actors in agriculture sector to effectively promote and use ICTs in their day-to-day endeavor in meeting farmers' needs, (Mwombe, (2010). Farmers as the target group are the most important of those actors that this research can focus on.

According to (May et al., (2007), research is required that is designed around the needs of the target population, rather than those of the providers of ICT, hence, it is important to engage farmers in data collection on this matter.

The choice of banana farmers for this study is motivated by the fact that banana is regarded as a food security crop which is widely grown in Kimilili sub-county. It is generally expected that these farmers may not experience the kind of food shortage and seasonality experienced by their fellow farmers. Needless to say, consumption of balanced diet is very a basic requirement for the sustainable livelihoods. This study aimed at determining the farmers' information sources, their use of ICTs and the constraints they experience in using ICTs.

The development partners will understand the status of the communities they support and plan better for the future. The results of the study will contribute to citizens by giving them credible information. It will also be a contribution to peer reviewed literature on this subject. If this study was not done the farmers would continue experiencing constraints and information would not trickle down to them. This would lead to low productivity, poor marketing of bananas and low adoption of new improved varieties.

1.4 Objectives of the Study

1.4.1 General Objective

The general objective is to assess the constraints encountered by banana farmers in the use of information communication technologies for accessing information.

1.4.2 Specific objectives

1. To determine the sources of information used by banana farmers in Kimilili.
2. To assess whether constraints influence ICT use by banana farmers in Kimilili.
3. To compare productivity/yield among ICT users and non users.

1.5 Hypothesis

H_0: Constraints do not influence ICT use in banana production and marketing in Kimilili.

1.6 The Scope of the study

The study targets the Banana farmers of Kimilili Sub County. It intends to investigate the information sources, the use of ICT and the constraints in ICT use. Most of the bananas in Kenya are grown on an average of 0.32 hectares of land. Most producers are small-scale farmers with 0.5 hectares of land or less Acharya & Mackey, (2008). The study focused on the constraints in the use of mobile phones and computers by these farmers.

1.7 Limitations of the study

This study was limited by the sampling methods, inadequate tools for data collection and the budget which lead to generalization of the results. Other limitations included limited literature on the topic especially in developing countries where not many studies have been done. Furthermore, the literature on the studies that have been done is not readily accessible.

1.8 Outline of the study

This study is organized in five sections. The current section discusses the background, identifies the problem, and the objectives addressing the problem stated. The second section deals with the literature review relevant to the specific objectives of this study. In section three, the objective is conceptualized and the research approach described,

including the analysis. The fourth section discusses the results, while in the fifth, presents the conclusions and recommendations.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature concerning the constraints in ICT use in production of bananas. It is a case of banana production in Kimilili sub county, Bungoma County. Empirical review will concern what other scholars have done on constraints in the in ICT use in Agriculture. The study takes the approach of examining the topic as set out in the 3 objectives namely to identify the sources of information, determine whether constraints influence ICT use and to compare ICT users and non users among banana farmers in Kimilili.

2.2 ICT use in banana production, and marketing

Viewpoints on the role of ICTs in rural development can be grouped into four major categories, namely: political, economic, social and technological (Kituyi & Andigun, (2008). In their article on appropriate evaluation methods for ICTs, Shadrach & Summers (2002**),** appreciate that the growth of the ICT sector is very fast in that there are new solutions found everyday to the practical problems faced on the ground. The factors that affect technological projects are often centered on the user behaviour to the technology which may vary from place to place according to the social setting.

Parida et al., (2010) identified five critical advantages associated with the use of ICTs in small firms from a study done in Sweden, as follows: access to global markets, enhancement of internal and external communication, facilitating collaborations, driving innovation, and achieving lower costs.

The internet dramatically reduces the costs associated with making information available to others and accessing global information and knowledge resources, Kituyi & Andigun (2008). May et al., (2007) in a study carried out in South Africa on ICT usage, established that ICTs play an important role in improving knowledge management and information generation. Establishing the information needs and skills of farmers is a priority challenge when contemplating ICT policy for agricultural development. Marketing information was a priority need for many farmers in India, which is a role model for other developing countries in ICT use. More specifically, farmers wanted to know the prices of the commodities that they were expecting to sell in places other than the village in which they lived. Information on land records was also seen as important, question and answer service, Weather forecast, post-harvest technology, information on crop insurance, and accounting and payment systems.

ICT may well enable the penetration of larger producers into markets previously served by small and medium enterprises (May et al., 2007). In addition, the spread of ICT would strengthen the relative power commodity chains where internet-based information sources are able to control e-commerce.

From the same South African study, May et al., (2007) add that ICT also facilitated reporting grievances and obtaining routine official documents such as income and domicile certificates which had previously required paying bribes to local officials. In addition the government department websites could improve the access of entrepreneurs to information regarding regulations and applications. Finally they observe that, ICT itself can be used as a way of establishing the needs of farmers.

One promising area for agricultural extension to reach large number of farmers in Africa is using information communication technologies (ICTs): mobile telephony,

innovative community radio and television programs, mobile phones in combination with radio, video shows, information kiosks, web portals, rural tele-centers, farmer call centers, video-conference, offline multimedia CDs, open distance learning, etc. ICT-based agricultural extension brings incredible opportunities and has the potential of enabling the empowerment of farming communities (Okyere & Mekonnen, (2012).

The rapid spread of information and communication technologies (ICT) in developing countries over the past decade offers a unique opportunity to transfer knowledge via private and public information systems. Mobile phones not only provide new opportunities for rural farmers to obtain access to information on agricultural technologies, but also improve agricultural extension systems. ICTs have been used in providing information on market prices, weather, transport and agricultural techniques via voice, short message service (SMS) and internet, (Aker, (2010).

The findings from the study by Okello et al., (2011) on drivers of use of information and communication technologies by farm households by smallholder farmers in Kenya showed that the use of ICT tools in general and mobile phones in particular, can help resolve the idiosyncratic market failures that smallholder farmers face due to lack of access to market information. These findings therefore suggest the need for policymakers and the private sector to invest in making access to ICT tools by smallholder farmers easier. They also suggest that farmers use ICT tools and especially mobile phones to reduce the costs of access to market information.

Mwombe (2010) in a study on utilization of ICT in banana production in Gatanga district established that growth of mobile phone has been explosive, and they have been used for provision of market links to farmers, reduction of transaction cost and use as electronic money transfer and improving banana productivity and market efficiency

resulting into increased farm income for smallholder farmers. He established mobile phones were accessible by 91.4%. Of those who access mobile phone only 31% use them for banana information. There is therefore need to develop Kenyan based information systems to provide banana information.

The District Development Plan (2008-2012), for Bungoma North district(now subdivided into Kimilili and Tongaren sub counties), indicates that mobile service coverage in the district was 80%, households with radios 85%, number of households with electricity-mostly in towns and trading centers with electricity-3 out of 6, number of cyber cafes were 2 and 1 library (GOK (2009).

A study carried in Bungoma North district in 2010 established that banana market information was obtained through electronic media (e.g. radio and television) and print media (e.g. newspapers and extension bulletins) as well as farm interpersonal sources, such as neighbours, brokers and extension staff. It costed farmers Ksh.200 to advertise their crops in the local Fm radio station, West Fm, (GOK, 2010b).

2.3 Sources of information on banana production and marketing

According to Singh, (2006), many Asian countries including India, Indonesia, Thailand and Vietnam have short message service (SMS) through cellular telephones for market prices of agricultural commodities. These cater to a range of clients from farmers to market intermediaries. The countries have web based market agricultural information services. The type of services that make use of "new" ICT include call centers, help desks, web based question and answers, frequently asked questions, e-mail based electronic discussion lists and on-line "communities of practice". This is leading to transformation of how ICT use is also transforming through extension with the focus in rural development on universal access. Along the decades, there have been many changes as to how we receive our

information and how it effects us. Outlets such as television, films, music, the internet, print, billboards, and other pictures are examples of ways we keep up with today's world and its events; both important and unimportant to people (Kari & Marcos, 2010). Information on the fair trade banana supply in Vancouver is available on www.spud.ca, the website for the world's biggest banana producers, situation of small banana producers. It is a source that can be accessed by all people via internet.

According to Kiplang'at & Ocholla, (2005), ICTs entail electronic means of capturing, storage, retrieval, manipulation, transmission or receipt of digital data and the way these processes work together in agricultural information system. They enable the handling of digital information, which comprise computer hardware and software. They basically provide the interface through which information is shared or transferred. Network is a factor in the access of the systems and use of the computer programmes involved. Other examples include radio, television, and telephone.

MFarm Limited is a Kenyan software solution and agribusiness company founded in 2010. M-Farm, works as a transparency tool for farmers. It gives up to date market information to link farmers to buyers through their market place, and current agri-trends. They give the wholesale market prices of commodities in the main wholesale markets in Nairobi, Eldoret and Kitale. Information is given on various crops including tissue culture banana from their biotech series. It is possible for farmers to get disease-free suckers for planting, increasing the yield of bananas. It also provides links to other helpful websites with information. The web is linked to twitter, face book, and mobile phone through Samsung. It is accessible through the website www.mfarm.co.ke. Tegemeo Institute is an organization aiming at improving Kenya's domestic horticultural production and marketing

system. It carries out studies and gives production and marketing statistics through a website; www.aec.msu.edu.

Despite all the different electronic sources of information outlined above, many farmers use the traditional extension approaches for getting knowledge on agriculture. The extension approaches used in 2012 by Kimilili sub county agriculture office included group visits, individual farm visits, barazas, field days, farmer's seminars/workshop, common interest groups, field and office visits as well as field information desks. The combination of these methods enabled them to reach a total of 11, 458 farmers in 2012 (MOA, 2012).

2.4 Constraints in ICT use by banana farmers.

ICT is beyond the reach of many potential beneficiaries (May et al., 2007). Many of the constraints of ICT use relate to causes of digital divide among households, and it appears to depend on various factors, some of which are outlined here below: Ethnicity and gender; individual citizens' access appears to be patterned in terms of ethnicity, gender (with higher proportions of males than female reporting access), and composition of household (with two adult and one or two child households most likely to have access). Access also appears to be spatially differentiated within countries towards more economically prosperous regions (Selwyn, (2004).

2.4.1 Policy and governance

Many developing countries have had weak policy frameworks that did not favour the growth of the information sector. The public sector (Research, extension, training & education) has exhibited inability to adapt and adopt these technologies and inadequate human capacity of intermediaries. This has led to inappropriate or weak policy regimes,

inadequate locally created content and uneven ability to derive economic and social benefits from information-intensive activities (Wolff & MacKinnon, (2002).

Parida et al (2010), identified eight specific barriers to ICT adoption as: ICT unsuitable for the type of business, limited level of ICT skills or competence within the firms, lack of standardized ICT related applications, cost factors, issues with access to ICT, lack of trust, and legal uncertainties. Affordability, physical access and prerequisite skills to use internet and computer related services were constraints to majority of farmers in a study by Mwombe (2010).

In a study done by Boryung & Pawlowski (2011) in New Orleans' brainstorming was done to identify issues that constrain ICT use in distributed research. The following came out as the issues that can be applicable to Kenya: differential levels of competency with technologies, tool availability, unreliability of technology during group communication, difficulties facilitating and making contributions to online group discussion, usability issues/user friendliness, ICT-mediated communication is less effective/productive as opposed to face-to-face communication, cost of software/equipment/services, differences in participants' preferences and choices of collaboration tools (e.g. Skype, Yahoo), discomfort of some individuals related to mediated communication, information overload, security/security policy issues, insufficient technical support available, incompatibility of technologies, technology infrastructure limitations, Boryung and Pawlowski (2011).

In Africa, ICT projects also come with a range of challenges including: technological dependence; lack of accessible telecommunication infrastructure in many rural and remote areas; capital cost of technologies, high cost of on-going access and support; inherent need for capacity building; often difficulty in integrating with existing media, and

local communication methods and traditions; and, often lack of involvement of all stakeholders in planning, especially women and youth (Okyere & Mekonnen 2012).

Regionally, from South Africa, geographic remoteness and sparseness of communities, especially in rural areas, and internet access are economic circumstances affecting service providers in the Agricultural industry. This said, separating technology limitations from cases where the end-user faces capacity constraints that inhibit him or her from engaging in the technology, such as lack of skills, confidence and motivation (May et al., 2007).

Conventional mechanisms for obtaining information may be declining, squeezed out by new technologies and perhaps open a 'digital divide' between those that have access to technology and those that do not. Indeed, the notion of 'digital poverty' has been used to distinguish barriers to ICT usage arising from resource and skills constraints, infrastructure and unrealized demand (May et al., (2007). The use of this concept encompasses the lack of means with which to access ICT, the lack of skills to use the ICT and inadequate information about the usefulness of ICT.

In Kenya bureaucracy**,** lack of professionalism in the business sector, corruption, illiteracy, and poverty are responsible for lack of use of ICT. The Internet is a secondary need especially to rural elites since they first need to learn how to handle a computer before using it. In addition, the cost is high for average users (Hallberg et al., (2011)

2.4.2 Education system and attitude

Education system in Kenya has been structured such that there is hoarding of information instead of sharing. Most people keep information to themselves to gain advantage over the others. It is also believed that only those who have gone to school are knowledgeable (Hallbeg et al., (2011)

The finding from a study by (Okello et al., 2011) among Kenyan farmers, that literacy conditions the use of ICT tools, highlights the need to design tools that can be more easily used by the usually less educated smallholder farmers. Another important finding of the same study is the importance of electricity.

2.4.3 Electricity and other social factors

Past studies have suggested the difficulties farmers have in accessing electricity for powering their ICT tools. Hence there is need to design phones that can be solar-powered to reduce dependence on electricity which is usually less available in rural areas.

The study by (Okello et al., 2011) finds that the decision to use ICT tools in general and mobile phones in particular and intensity of use for agricultural transactions is affected by age, primary occupation of the farmer, the cost of transport to the output market, nearness to electricity for charging phone batteries, the number of crop enterprises, farming experience, literacy levels, crop income and asset value, gender, household size, owning mobile phone, farming experience, literacy levels, crop income and asset value, gender of the household head, literacy level of the household head, the household size, and endowment with physical and financial assets. These findings indicate that the use of ICT tools in general and mobile phones in particular are driven by a number of farmer specific and farm specific variables as well as capital endowment and location variables.

2.5 ICT users and non users comparison

From a study carried out in Rift Valley Kenya by Kwambai and Wanyama (2002), increased banana production can increase food and household income. The study also noted that there was lack of technical knowledge on availability of improved and clean planting materials (TC), banana management, soil fertility, moisture stress and pest management. According to (Rusten et al., 2003), in economic terms, information has become so critical

that it needs to be recognized explicitly as a fourth production factor in agriculture. Digital divide, the difference between those people with access to computers, internet service and telephones as well as training relevant to their lives, and those with none is an emerging issue in this field. Studies show a hierarchy resulting in differing levels of engagement and consequences. There are differences of opportunity to access and use. On the other hand, there are the inequalities of outcome resulting from engagement with these technologies (Selwyn 2004).

Physical bandwidth in developing countries is low, because it is prohibitively expensive. Low-income countries are paying more than ten times the price that high- and middle-income countries pay for a broadband connection. Connectivity in the South is much more expensive than connectivity in the "wired" North, and while there will be improvements, connectivity is nevertheless likely to remain much more expensive for the foreseeable future (Habler & Jackson, 2010). This amounts to bandwidth gap.

The differences between the ICT users and non users can be studied by observing the yield of bananas and the adoption of tissue culture (TC) banana varieties. The average yield of TC banana was projected to increase to 34.0 tonnes per hectare by 2011 and to 35.78 tonnes per hectare by 2016. The average yield of non-tissue culture banana on the other hand, was expected to go up to 12.75 tonnes by 2011 and 13.40 tonnes per hectare by 2016, Acharya & Mackey (2008). According to Aker, (2010), stagnating growth in yields is attributed to access to information among other reasons. The average banana yield in Kimilili Subcounty is estimated at 30 tonnes/ha, MOA (2011), which is low as compared to the projected yield (Acharya & Mackey, 2008; MOA, (2011).

To reduce the digital divide requires a "systems" approach broadly attacking all the causes or constraints. One suggested method is making ICTs more attractive for non users

including old people, women, and ethnic minorities. This is design, culture, language, and identity Dijk and Hacker (2003)

2.6 Theoretical framework

2.6.1 Uses and Gratification Theory

Figure 1 is the theoretical framework for the theories and the variables of the study.

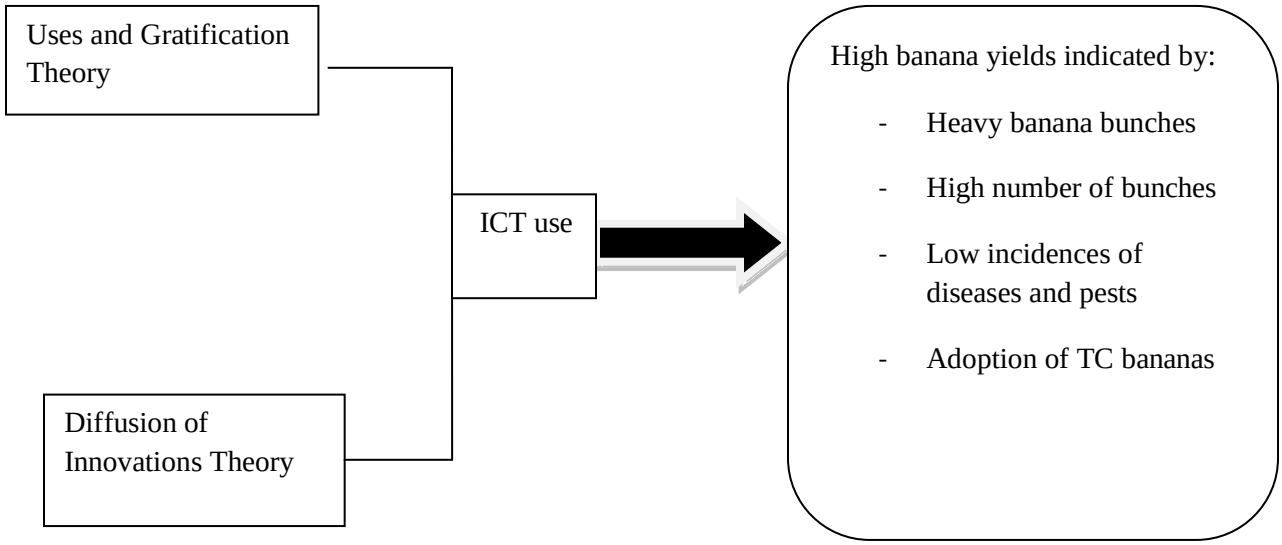


Figure 1: Theoretical Framework

Source: Author

According to Jere and (Davis, (2011), this theory attempts to explain the gratifications consumers seek in a particular medium and their perceptions and affinity for that medium and its content. It has been instrumental in understanding why consumers choose to continue their use of a specific medium. Researchers argue that, whereas people's initial encounters with a medium might be accidental, due to curiosity about its novelty, continuing use would be highly unlikely if the medium did not provide them with specific benefits.

Jere & Davis (2011) provided a useful meta-categorization of gratification factors in which they identified three types of gratification sought by consumers: content gratifications,

process gratifications and social gratifications. Content gratifications apply when consumers use a particular medium for the content it provides them. Process gratifications apply when consumers use a medium because they enjoy the process of using the medium (for example, surfing the web) while social gratifications apply when consumers use a medium to gratify their need for social interaction. Audience members are aware of and can articulate their reasons for consuming various media content (Wimmer & Dominick, (2009).

This theory will be used in this study to demonstrate that the audience has control over which media to use and for what purposes. The study focuses more on the information needs met by the uses the audiences explore. This is seen to be achieved through the content gratifications discussed above. Limitation of the Theory is that it is more audience centered. The assumption is that sources cover the subject of banana production, marketing and utilization.

2.6.2 Diffusion of Innovation Theory

(Rogers 1995) in the diffusion of innovations (DoI) theory states that the rate of diffusion of innovation is a function of the nature of communication channels, and the extent of the change agent's promotional efforts. Early adopters, are more open to channels of communication, and engage in more active information seeking. Mass media channels are relatively more important at the knowledge stage, whereas interpersonal channels are relatively more important at the persuasion stage (Clarke, (1999).

DoI theory is at its best as a descriptive tool, and less strong in its explanatory power, for the rate of adoption of innovations. The innovations to be investigated here are tissue culture bananas, banana management, marketing and utilization. The study seeks to

establish the role ICTs play as communication tools in the adoption of innovations (Clarke, 1999).

2.7 Conceptual Framework

2.7.1 Interrelationship among of key variables in the study

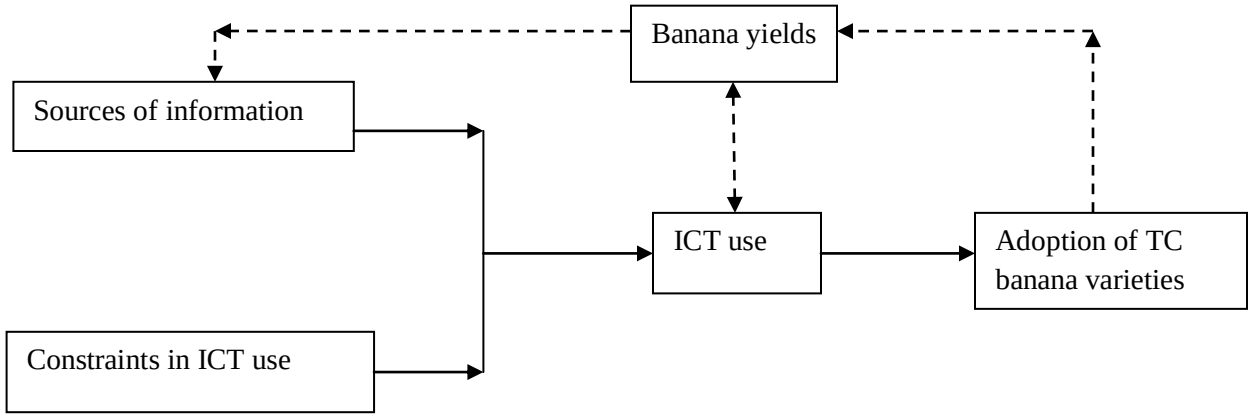


Figure 2: Interrelation among variables

Figure 2 gives an overview of interrelationship among key variables for the study.

The figure shows, sources of information and their constraints influence on ICT use. This in turn influences the banana yields and adoption of tissue culture banana varieties. Based on the interaction of the key variables, the following conceptual framework (Figure 3) was derived.

2.7.2 Conceptual Framework of constraints on ICT use in Banana

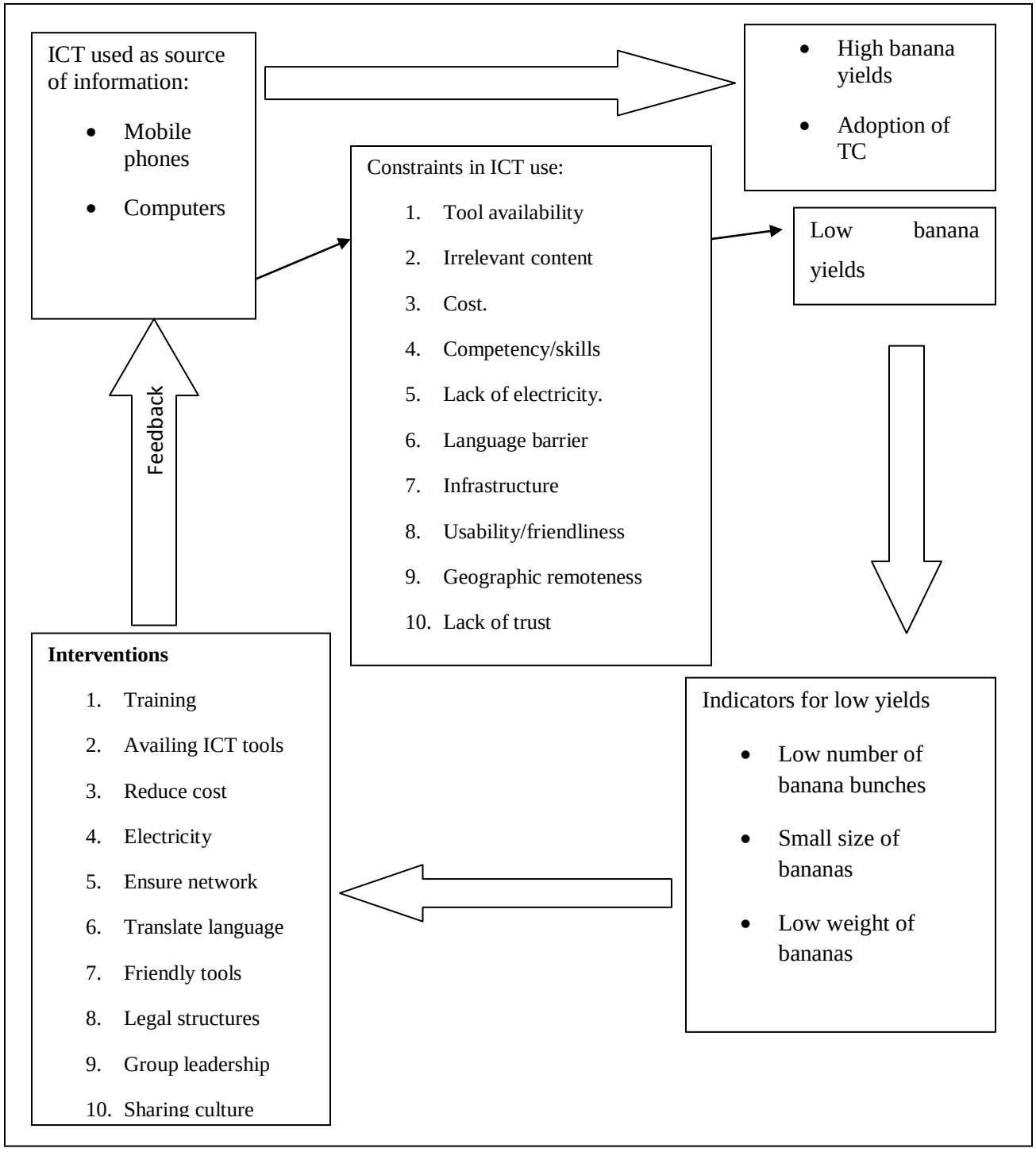


Figure 3: Conceptual framework: Author

Explanation of the conceptual framework:

The use of ICTs is influenced by the constraints. In the ideal situation, the ICT use leads to high yields. On the other hand, the ICT use in the presence of constraints, results in low banana yields. The indicators for the low yields include: low number of banana bunches, small size of banana bunches, and low weight of bananas. In the event of constraints, interventions are required to solve the problem of low yields. The interventions include: training, availing ICT tools, reducing the cost of ICT tools, electricity, ensuring network availability in all areas, translating content into various languages, availing user friendly tools, adoption of TC banana, and legal structures put in place to address the disputes in this sector.

The presence or absence of the constraints influences the use of ICTs, adoption of TC bananas and yields which affect utilization and incomes among farming communities. Based on the sustainability livelihoods framework, dependent variables (ICT use), are the outcomes, while the ICTs themselves are seen to be the asset. They are classified as physical capital, which enable the communities to escape from the vulnerability context. Access and influence are very important aspects of these assets.This approach demands more holistic understanding of poverty, and of the linkages between different livelihood components while assessing the impact of any technology projects. An ICT intervention should enhance the livelihood capabilities and assets while not undermining the natural resources base (Shadrach & Summers 2002**).**

CHAPTER THREE

3.0 METHODOLOGY

3.1 Area of Study

The study was carried out in Kimilili Subcounty, Bungoma County in Western Kenya. The subcounty boarders Mt. Elgon subcounty to the north, Bungoma North to the east, Bungoma West subcounty to the south, and Bungoma Central to the west. The subcounty has 2 administrative divisions, 8 locations and 18 sub-locations and covers an area of 181.2 km^2 out of which 152 km^2 is arable land. The population is 132, 822 people out of whom Kimilili division has 70,725 and Kamukuywa has 62,097 MOA (2011). The Population density is 729 persons per square kilometers. The number of farm families is 12,000 and farm holdings are 11,700 with Kimilili having 5139 and Kamukuywa 6561. The average family size is 8. The average farm size is 1.3 Ha and the number of households is 32,420. The District is on altitude of 1400—1750 meters above sea level. The temperature ranges from 13-26^0 C and the annual rainfall ranges between 1200 and 1800 mm per annum. The district experience 2 rainy seasons: the long and short rains. Long rains start in March and go on until August, while the short rains are between September and November. Most farming activities take place during the long rains (MOA, 2011).

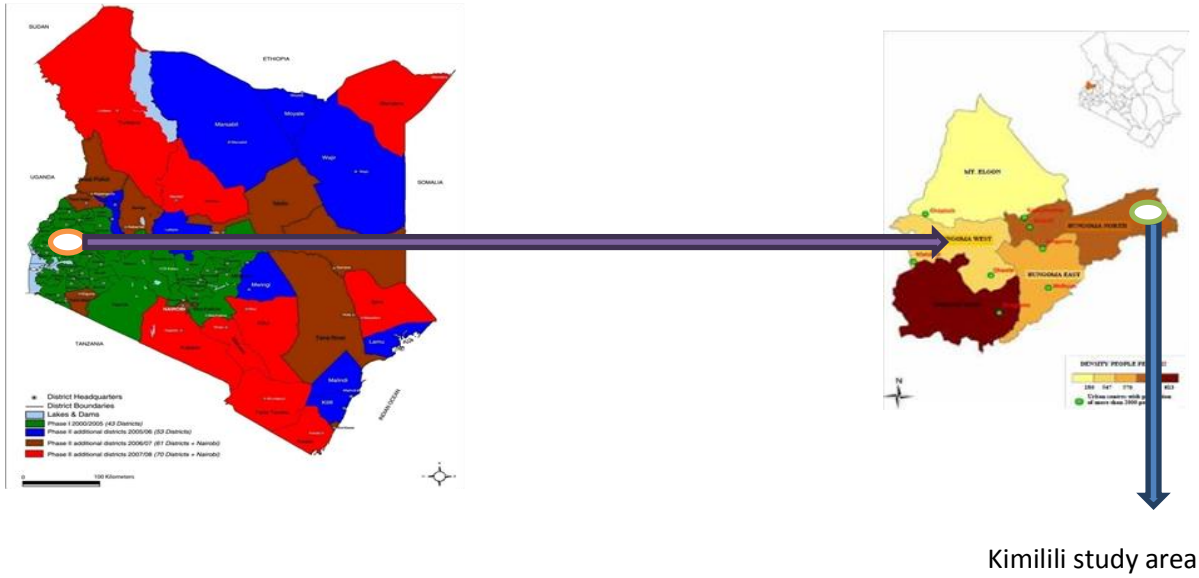
Farmers in Kimilili practice mixed cropping. The main cash crops includes: coffee (*coffea arabica*), Sugar cane *(Saccharum officinarum)* and Sunflower (*Helianthus annuus)*. The common food crops are: maize (*zea may*), common beans (*phaseolus vulgarii),* bananas (*musa,spp*), potatoes (*solanum,tuberosum*), finger millet *(Eleusine coracana)*, sorghum *(Sorghum bicolor*), cassava (*Manihot esculenta*) and a variety of fruits and vegetables. Livestock in the area include cattle, goats, sheep, pigs, rabbits and chicken. The study was carried out in two villages namely Siuna and Sinoko from the two divisions. The identified

villages were those with the highest number of farmer growing bananas in the subcounty (MOA, (2011).

3.1.1 Map of Kenya showing counties and Agro ecological zones

Map of Kenya

Bungoma County map



Kimilili study area

Figure 4: Source:GoK, (2012)

3.2 Data and data sources

Primary data was collected from the sources outlined below:

- From the farmers by use of questionnaires.
- Interview Schedule was administered to key informants (village elders) for background information about the sample population and the target area in general.

3.3 Data collection methods

Primary data was collected with the help of research assistants, who were trained to undertake administration of field survey by use of questionnaires to the households. Pilot testing was done in a different village of the same district.

3.4 Sampling

According to Mugenda & Mugenda, (2006), 50% sample of the target population is large enough and can be used to represent the target population if such population is large enough to justify sampling. However, a larger sample is better. Key informants from the two villages involved in banana production promotion were interviewed.

Purposive sampling was done to identify banana farmers in the two villages of Kimilili Subcounty to form the study population, based on the Ministry of Agriculture reports. According to Ministry of Agriculture reports, Sinoko village and Siuna village are the villages in the 2 divisions with the highest banana farmers (MOA, 2011). From the two villages, Sinoko has 116, while Siuna has 93. The total was 209, and provided the sampling frame.

Using the Fisher's exact test (Fishers et al., 1991), the minimum sample size was determined to be 135 as shown below:

The formula for sample size determination was $n = \frac{Z^2 \alpha/2 \; p \; Q}{L^2}$,

Where:

n = Required sample size

Q = 1-p

Zα/2 = Confidence level at 95% (standard value of 1.96)

p = Estimated prevalence of ICT use in Kimilili 50% (Proportion)= 0.5

L = Level of precision at 5% (standard value of 0.05).

$n = \frac{1.96^2 \times 0.5 \times (1-0.5)}{(0.05)^2} = 384$

For a finite study population of 209, correction factor was used. The actual sample size was,

$n' = \frac{1}{1/n+1/N}$ = Reciprocal of $1/n+1/N$

Where n' = the actual sample size

Reciprocal of (1/384+1/209) = 1/(1/384+1/209) = 135.338 = Approx 135 (actual sample size)

This translates to 64.5 % of the population of 209

In order to get the sample of 135 from the two villages, systematic random sampling was used. From each village, a number was arrived at by dividing its population by the total population to get the fraction out of the whole population. This fraction is then multiplied by 135 to get the number to be taken from that particular village. This leads to a figure of 75 for Sinoko village and 60 for Siuna village.

Table 1: Samples from the villages

Division	Location	Sub-location	Village	Number of farmers	Respondents selected
Kamukuywa	Kamukuywa	Kamasielo	Sinoko	116	116/209 x 135 = 75
Kimilili	Kimilili	Chebukwabi	Siuna	93	93/209 x 135 = 60
Total Number of Respondents (Sample)				209	135

Source: Author's Field Survey, (2013)

3.5 Data Analysis

According to (Mugenda & Mugenda, 2003), the first step in data analysis is to describe or summarize the data using descriptive statistics. Descriptive analysis was done with emphasis on SPSS, stata and Microsoft Excel programmes. Analysis was guided by objectives of the study and identification of appropriate statistical analysis techniques. It needed further data investigation that would assist in answering the objectives of the research study in order to draw sound conclusions.

3.3.5.1 Descriptive analysis

Objective 1: To determine the sources of information used by banana farmers in Kimilili. This objective was achieved by asking respondents to state which of the sources indicated they used for information on banana production. Various options were given for them to select from a Likert scale, the one applicable to them by ticking never use, sometimes use, often use and always use. Different sources were coded as follows: Voice = 1, SMS =2, Internet search =3, Networking =4, Internet= 5 Email =6, e-commerce =7, Others (Specify) =8.

Sources of information were grouped and tabulated, and the frequency means, and percentages calculated. It was explained in narrative form to bring out the patterns of use from responses.

Objective 2: To assess whether constraints influence ICT use by banana farmers in Kimilili. The constraints listed include: Tool availability, Irrelevant content, Cost, Lack of electricity, Competency/skills, Language barrier, Infrastructure, Usability/friendliness Time/effort to learn, Geographic remoteness, Lack of trust. For each constraint, a respondent indicates whether it is a constraint (yes) =1 or not a constraint (no =2).

Objective 3: To compare ICT users and non users among banana farmers in Kimilili. The respondents indicated whether they use = 1 or not use =2 each of the tools, mobile phones and computers. The respondents were also required to state the number of banana bunches they harvest in a normal year from the portion of farm in which their crop stands. From that, the yield in tonnes per hectare per year was calculated. a) 15-20 = 1, b) 20-25 =2, c) 25-30 =3, d) 30-35 =3, e) 35-40=4. On comparison of users and non users of ICTs were tabulated, and line graph developed for comparison of their yields and adoption.

3.5.2 Linear Regression Analysis

Regression is the determination of statistical relationship between two or more variables Kothari (2004). In this model, a group of independent variables (constraints) together, predict the dependent variable or are regressed against the dependent variable, (use of ICTs). The various constraints (costs, language barrier, infrastructure, unavailability etc) that affect ICT use form the independent variables. The model to be used in the study takes the form below:

$$Y= B_0 + \beta_1X_1 + \beta_2X_{2+}.....\beta_nX_n + \varepsilon$$

The model states that Y is a linear function of the predictors, plus statistical noise. The coefficients (the β's) are nonrandom but unknown quantities. The noise term ε is random and unobserved. It is assumed that these ε's are statistically independent, each with mean 0 and unknown standard deviation σ.

Where: Y – is the dependent variables (Use of ICTs,)

In our model, the respondent either uses ICTs(Y=1) or does not(Y=2).

X_{1-3} - are the independent variables (Constraints)

B_0 - Is a constant; the concept explaining the level of performance given and it's the Y value when all the predictor values (X1, X2, X3,) are zero,

B_{1-3} or $\beta_1, \beta_2, \beta_3$, – Are constants regression coefficients representing the condition of the independent variables to the dependent variables.

ε – is the error. (Extraneous) Error term explaining the variability of quality of service as a result of other factors not accounted for.

Y= ICT use

X1 - Tool availability

X_2 - Infrastructure

X_3 - Geographic remoteness

Karl Pearson's coefficient of correlation (r)

Karl Pearson's coefficient of correlation, also known as product moment correlation coefficient (r) enabled determination if there is a strong correlation between the constraints and the use of ICTs. Its value lies between ±1 Kothari (2004). An r value of ≥0.5 shows a strong linear relationship.

Coefficient of determination (r^2)

This coefficient of determination r^2 (which is the square of r) was calculated for objective 2 as part of regression analysis to determine the fraction of the ICT use that is explained by the constraints.

Table 2: Operational definition of variables

Variable	Type of variable	Indicators	Measures
Sources of information	Independent	Types of ICT tool services used. Never use, sometimes use, often use, Always use.	Voice calls=1, SMS=2, Internet search=3, Email=4, Networking=5, Market information system=6 Others=7
Constraints	Independent	Low number of users Lack of electricity Lack of shops for tools Non adoption of TC varieties	Tool availability Irrelevant content Cost. Lack of electricity Competency/skills Lack of electricity. Language barrier Infrastructure Usability/friendliness Time/effort to learn Geographic remoteness Lack of trust Constraint(yes)=1 Not a constraint=2
Use of ICTs	Dependent	Used/not used (Intervening variable)	Users=1, Non users=2
Yields	Dependent	No. of bunches	Number
Adoption	Dependent	Adopted/Not adopted	Adopted=1 Not adopted=2

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

4.1 Introduction

This chapter examines socio economic characteristics of the respondents, sources of information used by respondents, constraints in ICT use, the ICTs commonly used, and the services the banana farmers in Kimilili sub county use to seek and/or receive information on banana production. It also covers the comparison between the ICT users and non users. Linear regression model was used to test hypothesis that constraints do not influence ICT use in banana production and marketing.

4.2 Socio economic characteristics of respondents

Figure 6 is a pie chart showing the percentages of the males and females among the respondents.

4.2.1 Gender of the respondents

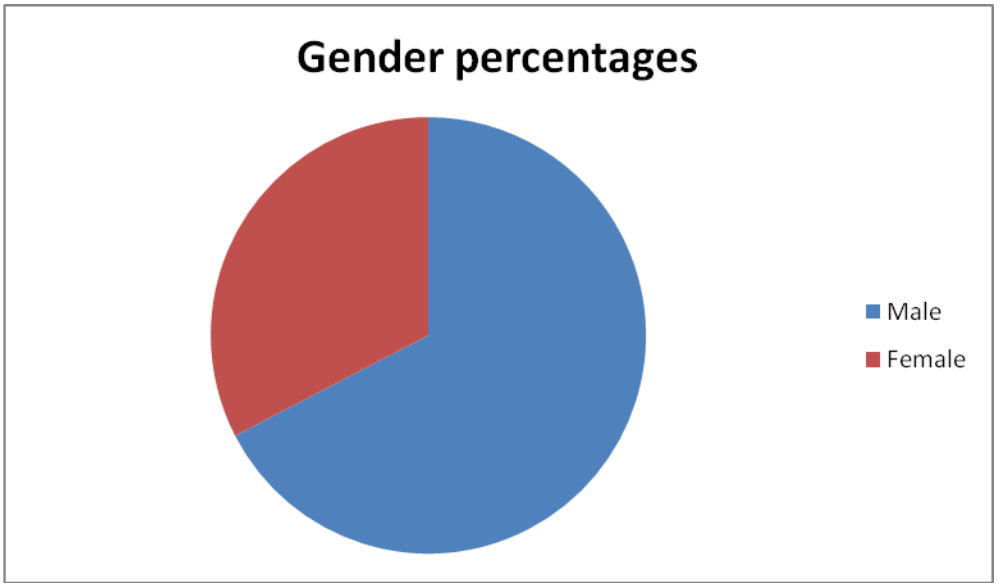


Figure 5: Gender of respondents

From the data collected, 67.2% of the respondents were male while 32.8% were female.

4.2.2 Age of respondents

Figure 7 shows the age of the respondents

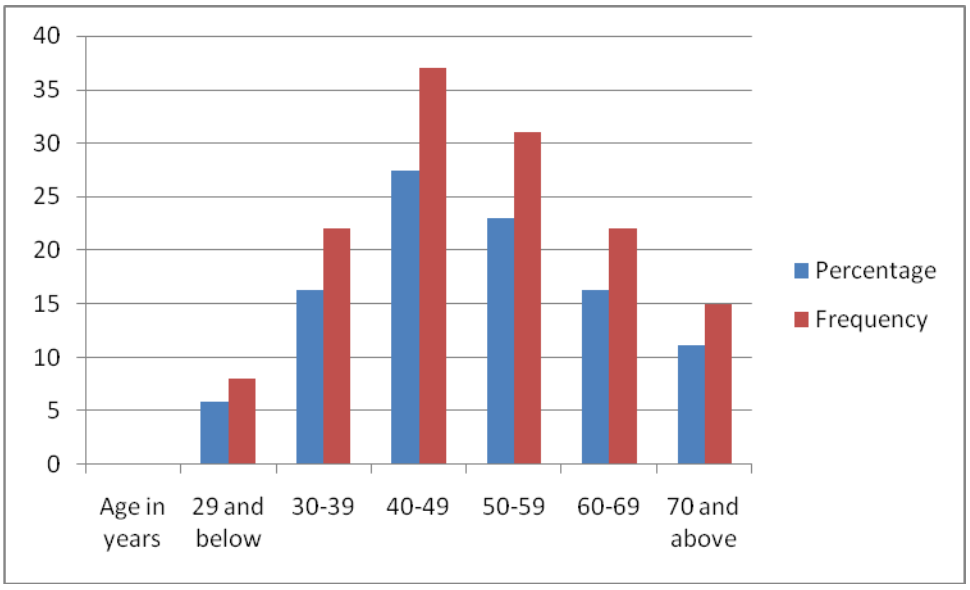


Figure 6:Age of respondents

The ages of the respondents ranged between 22 and 88 with the mean at age 51. Most of the farmers are aged 40 years and above (77.8%).

4.2.3 Number of persons per household

Table 3 represents the persons per household of the respondents' families.

Table 3: Persons per household

No. range	Frequency	Percentage
1-4	22	16.3
5-9	84	62.2
10-14	24	17.8
15-19	5	3.7
Total	135	100

The family size was minimum of 1 and maximum of 19 members of a household. The average family

size was 7 members; most of the households had 5-9 members (62.2%).

4.2.4 Farm size in acres

Figure 7 is a graphical representation of the farms of the respondents in acres.

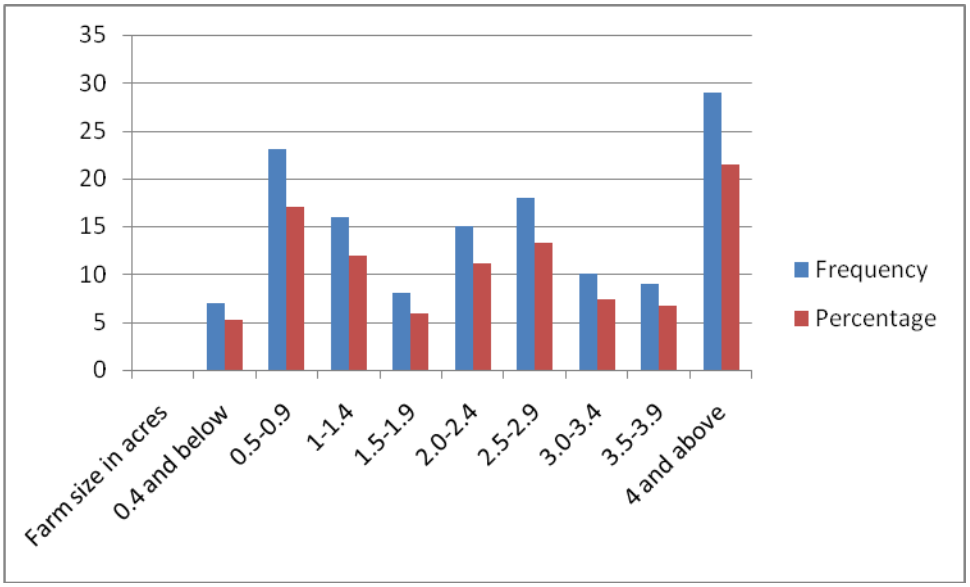


Figure 7: Farm size in acres

Figure 7 shows that land sizes in Kimilili are spread with 59.2 % having between 0.5 acres and 3 acres. This land size can support the average family size of 8 (MOA, 2011). This data agrees with literature that most producers are small-scale farmers (Acharya & Mackey, 2008). The proportion of farmers with more than 4 acres was 21.5%.

4.2.5 Cultivated land

Figure 8 is a graph of the cultivated land out of the total farm owned by the respondents.

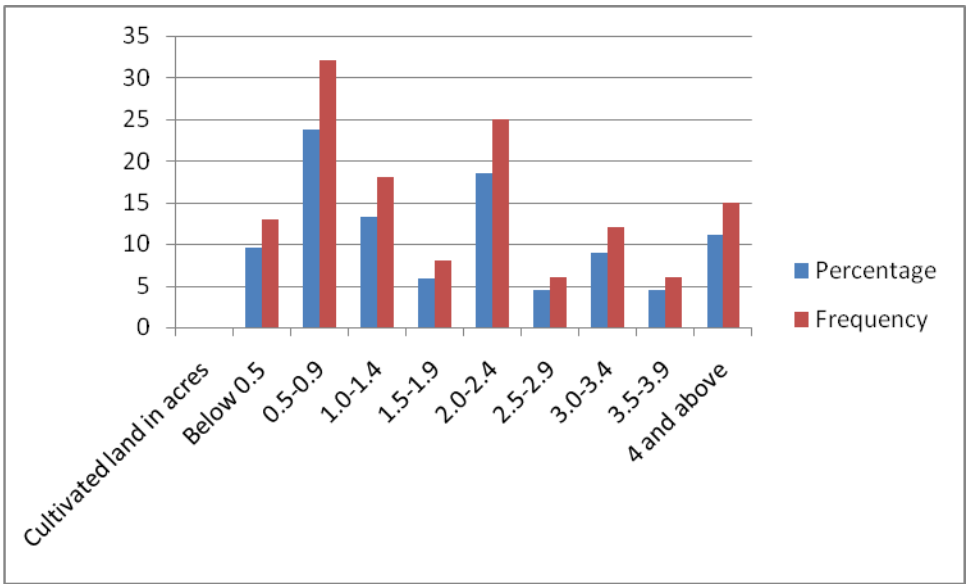


Figure 8: Cultivated land

In comparison with the total land area in Figure 8 it is clear that not all land available to the farmers is cultivated. Most of the farmers (95%) cultivate between 0.5 acres and 3 acres.

4.2.6 Land under Bananas

Out of the cultivated land, figure 9 shows the land under bananas.

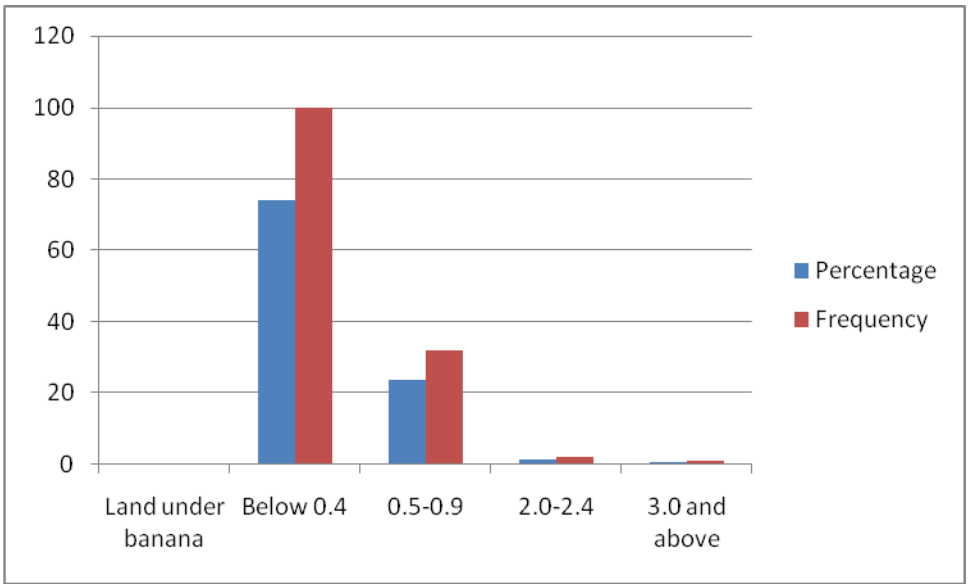


Figure 9: Land under banana

Most of the bananas (97%) are grown on land of less than 0.9 acres, confirming what was found out by Acharya & Mackey (2008), that most of the bananas in Kenya are grown on an average of 0.32 hectares (0.8 acres) of land.

4.2.7 Banana yields

Figure 10 shows the approximate yield of bananas in tonnes/Ha.

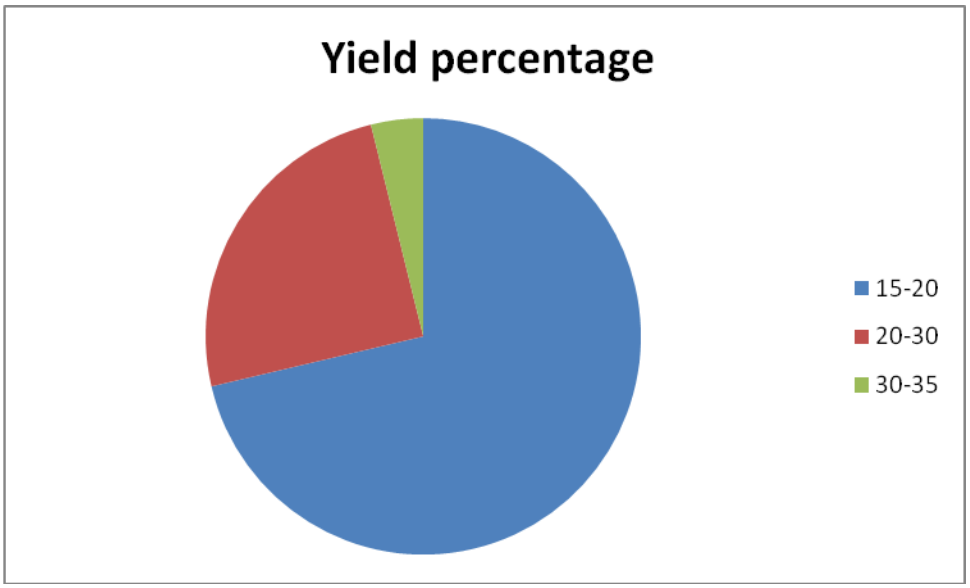


Figure 10: Approximate banana yield in t/ha

The approximate average yield of bananas (all varieties) in Kimilili Sub County is 15-20tonnes/ha. From literature, The average yield of tissue culture banana was projected to increase to 34.0 tonnes per hectare by 2011. The average yield of non-tissue culture (TC) banana on the other hand, was expected to go up to 12.75 tonnes by 2011, Acharya & Mackey (2008). Average would be23.3T/Ha. Our yield above is below the projections of 23.3 T/Ha or above.

4.2.8 Data on the area from key informants

From the one key informant per village, an interview schedule was administered and in table 4.

Table 4: Key informants data

ICT service and enabling facilities	Rating
Electricity supply	None
Computer services(cyber cafes)	None
Network for communication	not prevalent
Communication boosters for telecommunications	0
Computer shops	0
Mobile phone shops	0
Shopping centers	2
Distance to shopping center(where mobile charging can be done)	2 Kilometers
Any organizations promoting bananas	5
Distance to the nearest market for bananas	8
Number of tarmacs' roads	0
Murram road	2
Commonly used means of transportation for bananas	Bicycle

From the interview schedule conducted with key informants, there was lack of electricity in the homes of all respondents, Computer services such as cyber cafe for email and internet search were completely lacking in the entire villages, network for communication was reported as not prevalent, communication boosters for telecommunications were at least 6 kilometers away from the villages, and there no computer and mobile phone shops, except in the nearest town which is 8 kilometers away on average. There were 2 shopping centers in the 2 villages where mobile phones could be

charged. Distance from the homes to the market centers on average was found to be 2 kilometers. 5 organizations promote banana growing (One acre fund, Ministry of Agriculture, V.I Agro forestry, and KARI). Distance to nearest market for bananas is 2 kilometers, the local shopping centers. The road network is made up by earth roads. The commonly used means of transportation for bananas was found to be bicycles, although pickups and ox carts are also used. These observations lead the study to the impression that the two areas are already constrained in terms of infrastructure and the farmers from them may not be expected to be regular users of mobile phones and computers information sourcing. These observations have a bearing on the constraints encountered in ICT use.

4.3 ICTs used as sources of information on banana

Farmers of Kimilili who participated in the study indicated the various sources of information they use for information on production and marketing of bananas. The sources and percentages of respondents who use them are given here below:

Table 5: ICT components used for information

	Never use	Sometimes use	Often use	Always use	Valid Percent
Voice calls	54.8	39.3	3	3	100
SMS	85.9	12.6	1.5	0	100
Internet search	100	0	0	0	100
Email	100	0	0	0	100
Networking	98.5	1.5	0	0	100
E-commerce or market information system	97	0	0.7	0	100

Table 7 above shows that all the farmers (100%) do not use internet services including the internet

search through search engines such as Google, and emailing. A big majority do not use social networks (98.5) and e-commerce/ market information systems (97), for their information on banana production and marketing. The only ICT service they make use of more often is the SMS (14.1%) and voice calls (45.3%) which are offered via the mobile phones. A few respondents used the market information systems (0.7% or 1 person) and social networking (1.5% or 2 persons). These percentages show that majority rely on other sources other than the ones mentioned in the study.

4.3.1 Farmers opinion on the usefulness of the information accessed

The table 6 below shows the mobile phone users opinion on the usefulness of the information accessed from them

Table 6: Farmers' opinion on usefulness of information accessed

	Not at all	Little extent	Great extent	Not applicable	Valid percent
Mobile phone percentage					
Voice	19.3	37.0	4.4	39.2	100
SMS	31.9	14.8	0	53.3	100
Internet search	27.4	0	0	72.6	100
Networking	27.4	0	0.7	71.8	100
Computer percentage					
Internet	4.4	0	0	95.5	100
Email	2.2	0.7	0	97.0	100
Networking with other farmers	2.2	0.7	0	97.0	100
e-commerce	1.5	0.7	0	97.7	100

4.3.2 Mobile phone for communication

As noted from the previous section, voice communication and to a lesser extent, SMS are the main types of ICT communication used for the purpose of banana production and marketing. Therefore their usefulness is also reflected by the percentages, 41.4%% indicate that the voice communication was useful and 14.8% indicated that information from SMS was useful. The few that use internet search, social networks and e-commerce/market information systems, still find it not useful. Very few (4.4) felt that the information helped them. Worth noting is that mobile phones are only used for voice communication and SMS services but not for internet searching, networking and e-commerce. Those who picked on not applicable were those that did not use any of the ICTs, and they were the majority (53% for SMS and 39% for voice communication).

4.3.3 Computers for communication

Internet is not used at all while social networking, e- commerce/market information systems and e-mail are only used minimally by 0.7% each. In each case, only 0.7% or 1 person found it useful. "Not applicable" included all those respondents that indicated never use in the previous section. This group happens to be majority (97%).

4.4 Constraints in ICT use for banana production and marketing

This section sort to establish the main reasons for farmers' difficulty in meeting their food requirements. The aim was to understand whether knowledge/ information was identified as a constraint.

4.4.1 Ranking of general constraints in farming

Table 7: Ranking of the general constraints

Reasons for difficulty in meeting food requirements	N	Rank
Inadequate knowledge	122	2
High cost of inputs	127	1
Poor quality of farm inputs	98	6
Poor marketing channels	108	5
Low soil fertility	118	3
Incidence of pests and disease	113	4

This section explored the general challenges in farming that made it difficult for the respondents to meet their food need. From those interviewed, it came out that the 3 most important reasons that prevent them from meeting their families' food needs were; high cost of inputs, inadequate knowledge and low soil fertility. Others are: high incidences of pests and diseases, including the rodents and maize lethal necrotic disease that threatened whipping out the crop of maize in the previous year, and last but not least poor quality farm inputs. The preliminary finding that comes out clear at this stage is that knowledge is very important and acquiring information through whatever means would assist off set this challenge.

4.4.2 Constraints in ICT use

Table 8 shows the constraints experienced by banana farmers. Yes means it is a constraint while a no for a specific constraint means it is not seen as a constraint.

Table 8: Percentages of farmers with constraints

	Constraints	**YES**		**NO**	
1	**Tool availability**	Frequency	Percentage	Frequency	Percentage
	mobile phone	46	34	89	66
	Computer	133	99	2	1
2	**Irrelevant content**				
	internet search	133	99	1	1
	e-commerce/market information	128	95	6	5
3	**High cost of software/equipment/services/bandwidth**				
	Voice communication	84	62	51	38
	SMS	111	82	24	18
	Internet search	135	100	0	0
	e-commerce/market information	132	98	2	2
	Email	133	99	1	1
	Networking with other farmers	125	93	9	7
4	**Competency/skills**				
	Voice communication	57	42	78	58
	SMS	94	70	41	30
	Internet search	135	100	0	0
	e-commerce/market	135	100	0	0
	Email	135	100	0	0
	Networking with other farmers	127	94	8	6
5	**Lack of electricity/batteries**				
	Voice communication	98	73	37	27
	SMS	98	73	37	27
	Internet search	113	84	22	16
	e-commerce/market information system	113	84	22	16
	Email	113	84	22	16
	Networking with other farmers	111	82	24	18

	Constraints	YES		NO	
6	**Language barrier**	Frequency	Percentage	Frequency	Percentage
	Voice communication	70	52	64	48
	SMS	112	83	23	17
	Internet search	134	99	1	1
	e-commerce/market information system	134	99	1	1
	Email	132	98	3	2
	Networking with other farmers	128	95	7	5
7	**Technology infrastructure limitations**				
	Voice communication	90	67	45	33
	SMS	101	75	34	25
	Internet search	135	100	0	0
	e-commerce/market information system	134	99	1	1
	Email	132	98	3	2
	Networking with other farmers	126	93	9	7
8	**Usability/lack of user friendliness**				
	Voice communication	89	66	46	34
	SMS	114	84	21	16
	Internet search	132	98	3	2
	e-commerce/market information system	130	96	5	4
	Email	132	98	3	2
	Networking with other farmers	129	96	6	4
9	**Geographic remoteness/accessibility**				
	Voice communication	81	60	54	40
	SMS	102	76	33	24
	Internet search	124	92	11	8
	e-commerce/market information system	124	92	11	8
	Email	124	92	11	8
	Networking with other farmers	118	87	17	13
10	**Lack of trust/legal uncertainties**				
	Voice communication	84	62	51	38
	SMS	90	67	45	33
	Internet search	133	99	2	1
	e-commerce/market information system	132	98	3	2
	e-mail	133	99	2	1
	Networking with other farmers	127	94	8	6

4.4.3 Tool availability

Computers availability is very low (with 99% seeing it as constraint), prompting the farmers not to have access to them even if they had the money to purchase. However, mobile phones are more available with only 34% saying its availability is a constraint.

4.4.4 Irrelevant content

This is a constraint that has a high percentage for internet search (99%) and e-commerce (95%). As noted from previous sections, most respondents do not use these 2 services, making them unable to enjoy its benefits. This makes it easy for them to see irrelevant content from these services to be a constraint. Part of this could be due to attitude given most of them do not use it.

4.4.5 Cost of software/equipment/services/bandwidth

The cost is a constraint most for internet (100%), email (99), e-commerce/market information system (98), networking (93%), all related to browsing. Even SMS is seen as costly at 85% of respondents. The only service seen to be affordable for banana information communication is voice communication. Considering the actual costing of these services, one would expect SMS to be cheaper but the farmers see voice communication to be worth of spending the money since it enables them to complete transaction ones.

4.4.6 Competency/skills

Competency/skills are a serious problem for most of the respondents in terms of e-commerce and use of market information systems (100%), email (100) and social networking (94).

4.4.7 Lack of electricity/batteries

This is a problem but not felt heavily as other constraints. It affects internet search e-commerce and email equally at 84%. As much as electricity is not connected to all the farms, they do not feel so pressed up by it as a constraint because they do find a way of going round the problem by taking their tools for charging elsewhere. As such they may need to factor in the cost if time spent taking their machines for charging.

4.4.8 Language barrier

Language is a barrier for communication mainly in internet search (99%), e-commerce (99%) and email (98%). This is likely to be due content predominantly being published in English language. Many of the farmers, including those that are educated may prefer local language or Kiswahili.

4.4.9 Technology infrastructure limitations/network

Technological issues seem to affect all ICT services in the study area but more particularly on internet (100%), e-commerce (99%), and email (98%). Infrastructure was used in the study to refer to availability of boosters for mobile phone network connections.

4.4.10 Usability/user friendliness

Usability and user friendliness refers to the design of the ICT tools and the information systems used in them. This is a constraint across board for more than 66% of the respondents for all ICT services listed. The highest are internet and email (98% each) and networking and e-commerce (96% each).

4.4.11 Geographic remoteness/accessibility

All services are affected for over 60% of respondents. It is highest in internet (92%), e-commerce (92%0 and email (92%). Geographic remoteness referred to how far an area is from the urban centers.

4.4.12 Lack of trust/legal uncertainties

This cuts across the services with more than 62% for each service. Many farmers had problems with trusting doing business with somebody they cannot see. They are not aware of legal provisions that can be used to assist in this area. Therefore there is uncertainty.

4.5 Comparison of ICT users and non users in banana production

In this section, farmers were asked to indicate whether they use computers and mobile phones, before the users were to proceed to answer the subsequent questions.

4.5.1 Users and non user percentages

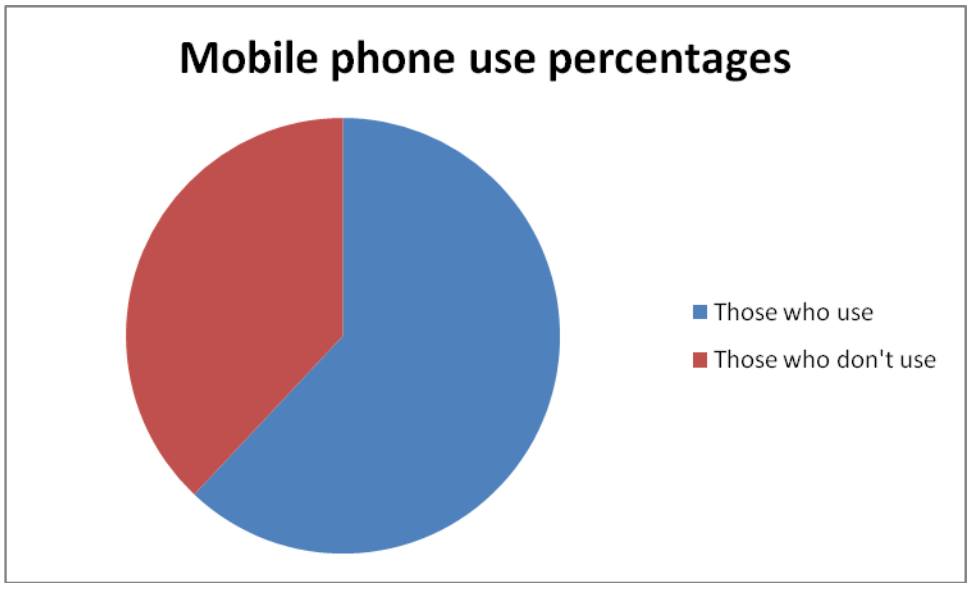


Figure 11: Mobile phone use percentages

Only 38% of the respondents use mobile phones for banana production transactions. The rest, even though may have mobile phone, have not appreciated the role these tools can play in their farming activities

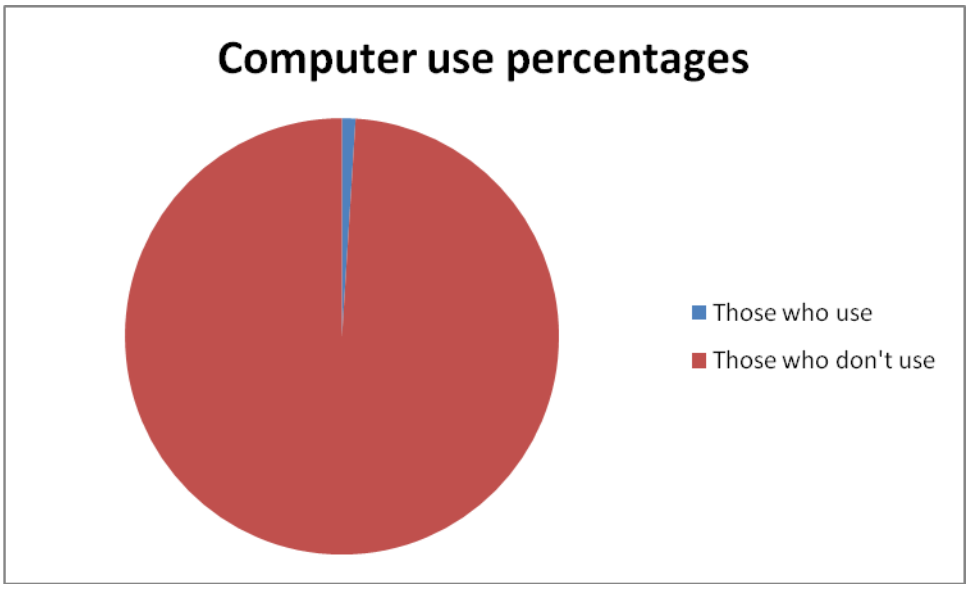


Figure 12: Computers use percentages

As shown in Figure 12, only 1% of the farmers use computers for banana information. From the study, this seems the most distant tool to the respondents and most had difficulties discussing it. However the study impressed upon them the technology behind it being available on their mobile phones making it possible for them to use it without purchasing the particular computers. However, most of them maintained they do not use it.

4.5.2 Topics on which information is sought by users of ICTs

Table below shows the main the sources of information and the means of accessing it for the users.

Table 9: Source and means of accessing information on banana

Source of information (%)				Means of accessing information on bananas (%)							
Topic	mobile phone	Computers	Field days & listening to radio	Internet searching	e-commerce/market information	email	Networking	SMS	Voice	Listening radio programmes	SMS and Voice
Tissue culture banana	68	0	32	0	0	2	0	0	56	33	9
Planting	23	0	77	0	0	0	0	0	15	79	6
Pruning	18	0	82	0	0	0	0	0	10	83	7
Disease/pest control	35	0	65	0	0	0	0	3	26	67	5
Application of fertilizer/manure	33	0	67	0	0	0	0	0	26	67	8
Market information	64.0	0	36	0	0	0	0	2	56	38	4
Utilization	55	0	45	0	0	0	0	2	48	46	4

The users interviewed here indicated that all their information on all topics is accessed from mobile phones, field days and listening to radio. None was from the computer.

On tissue culture banana varieties, most of the information is sought through the mobile phones (68%) by the voice communication (65%). On the following most information is sought from field days and listening to radios: planting (77%), pruning (82%), pests and disease control (65 %,) and fertilizer/manure application 67%. However, market information and information on utilization is sought more from mobile phones (SMS and voice) 64% and 55% respectively. The study shows that email, internet, networking and are not often used services. All these figures indicate that the few ICT users appreciate the different services offered by ICT tools, supporting uses and gratification theory (Jere & Davis, (2011), on content gratifications sought by consumer, which apply when consumers use a particular medium for the content it provides them. Here they mainly use SMS and voice calls for information on tissue culture banana varieties' and marketing (56% each). The rest of topics they use the other sources (field days and radios).

4.5.3 The relevance of information

Table 10: Relevance of information sought

Rating	Frequency	Percentage
Highly relevant	22	16.3
Moderately relevant	31	23.0
Not relevant	2	1.5
Not applicable	75	55.6
Total	130	96.3
Non response	5	3.7
Total	135	100.0

A total of 39.9% found the information relevant while 55.6% indicated that the information was not applicable meaning they did not implement it. This shows the negative attitude by farmers in the use of the ICTs for communication on farming transactions. Therefore users did not demonstrate that they benefited substantially from the ICT use. This would imply little difference between the users and non users.

4.5.4 The proportion of information applied/implemented

In table 11, the users indicated the proportion of information implemented.

Table 11: The proportion of information implemented

Rating	Frequency	Percentage
None	2	1.5
Less than half	34	25.2
More than half	16	11.9
Not applicable	76	56.3
Total	128	94.8
Non response	7	5.2
Total	135	100.0

From table 11, only 37% of the ICT users implemented the advice they got through their mobiles and computers. 56% found it not applicable.

4.5.5 Mobile phone users' and non users' banana yields

Given that computers are only used by a mere 1% it was not easy to use computers as a way of comparing users and non users. Instead, mobile phones were used to compare the users and non users.

Table 12 shows the number of bunches harvested per year by the users and non users of mobile phones.

No. of Bunches per year	No. of Mobile phone users	No. of non mobile phone users
0-50	21	40
51-100	7	13
101-150	6	8
151-200	4	3
201-250	2	1
251-300	1	3
301-350	0	3
51-400	1	3
401-450	0	1
451-500	1	1
Totals	43	76

Table 12: Comparison of mobile phone users' and non users' banana yields

The results in figure 12 indicate that out of the 43 users interviewed, 34% (15) are able to get a yield of 101 bunches and above in a year. Out of the 76 non users, only 30% (23) are able to get a yield of 101 bunches in a year and above. This means that the use of mobile phones enables the users to perform better. However, the small margin of only 4% shows that the farmers have not been able to exploit the capability of the ICTs to the full potential for their farming activities. Users who get higher yields are those who find the information relevant and apply, thus overcoming the constraint experienced by non users.

4.5.6 Mobile phone users' and non users' adoption

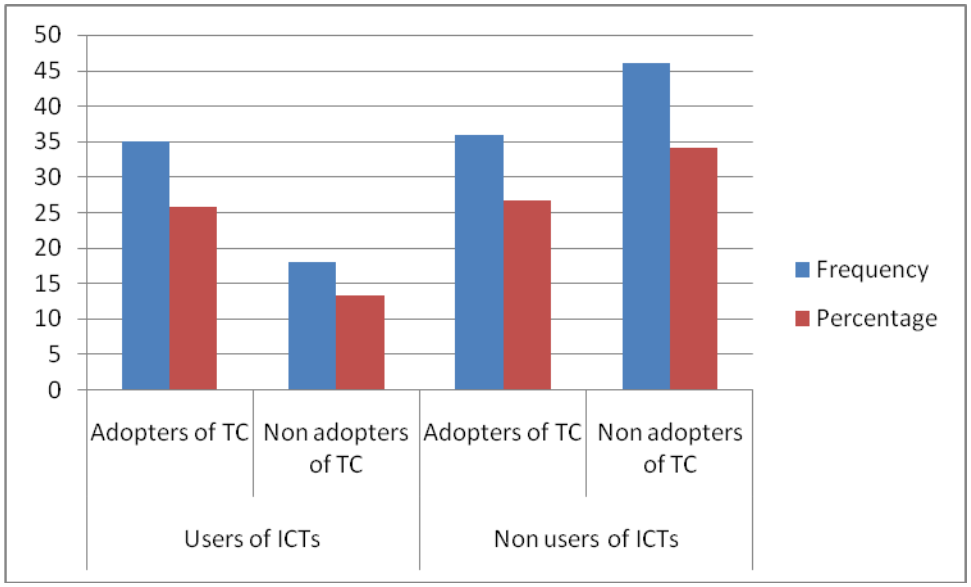


Figure 13: Comparison of adoption by ICT users and non users

Figure 13 shows that the ICT users have a higher adoption percentage (25.9%) than the non adopters of tissue culture bananas(23.3%). Among the non users of ICT, non TC adopters are more (34.1%) than the adopters (18%). This proves right Selwyn, (2004), that digital divide, show a hierarchy resulting in differing levels of engagement and consequence, and there are the inequalities of outcome resulting from engagement with these technologies. Diffusion of Innovations (DoI) theory by (Rogers, (1995), agrees with this: early adopters generally, are more open to communication channels, and engage in more active information seeking (Clarke, (1999).

4.6 Regression Analysis

4.6.1 Testing the influence of constraints on ICT use

Table 13: Regression of constraints against ICT use

Source |	SS	df	MS	Number of obs = 135	
				F(10, 124) =	4.91
Model |	9.0004578	10	.90004578	Prob> F =	0.0000
Residual |	22.7328755	124	.183329641	R-squared =	0.2836
				Adj R-squared =	0.2259
Total |	31.7333333	134	.23681592	Root MSE =	.42817
ICT |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]
availability |	-.3114257	.092886	-3.35	0.001	-.4952731 -.1275784
irrelevant |	.0417765	.222843	0.19	0.852	-.3992923 .4828452
cost |	-.0325314	.4279447	-0.08	0.940	-.8795537 .814491
competent |	.0373666	.3232344	0.12	0.908	-.6024048 .677138
lackelec |	.0488002	.1198863	0.41	0.685	-.1884883 .2860886
language |	-.1996307	.1073041	-1.86	0.065	-.4120155 .0127541
infrastruc~e |	-.3060599	.1191934	-2.57	0.011	-.541977 -.0701427
userbility |	-.0081514	.332148	-0.02	0.980	-.6655654 .6492625
geography |	.5216642	.1789429	2.92	0.004	.1674861 .8758424
trust |	-.2435244	.1889201	-1.29	0.200	-.6174503 .1304014
_cons |	.5558947	.4587345	1.21	0.228	-.3520694 1.463859

From the regression model, the p values for the for constraint were as: irrelevant content had a p value of 0.852 (85%), Cost of software/services had a p value of 0.940 (94%), competency/skills had a p value of 0.908 (98%), lack of electricity 0.685 (68%), usability of tools had 0.980 (98%), language barrier at p value of 0.065 (6.5%) and lack of trust had 0.200 (20%). All these with values more than 5% do not have significant influence on the ICT use. The constraints that are seen to significantly influence ICT use, are: tool availability with p value at 0.001(0.1%), infrastructure at 0.011 (1.1%), and geographic remoteness at 0.004 (0.4%). The above 3 are applied to the regression formula as below:

$Y= B_0 + \beta_1X_1 + \beta_2X_{2+}.....\beta_nX_n + \varepsilon$ ……Equation 1)

B_0 - Is a constant; is the Y value when all the predictor values (X1, X2, and X3) are zero,

B_{1-3} or $\beta_1, \beta_2, \beta_3, \beta_4$ – Are constants regression coefficients.

ε – is the error.

Y= ICT use

X_{1-n} - are the independent variables (Constraints)

X_1 - Tool unavailability

X_2 - Infrastructure

X_3 - Geographic remoteness

Constant (β_0) = 0.56,

error (ε) = (0.09 + 0.12 +0.18)/3 = 0.13

$\beta_1 = 0.31$, $\beta_2 = 0.31$, $\beta_3 = 0.52$

From the regression results equation 1 above:

$Y = 0.56 - 0.31X_1 - 0.31X_2 + 0.52X_3 + 0.205$……equation 2)

ICT use =0.56 – 0.31x Tool availability – 0.31x Infrastructure - + 0.51x Geographic remoteness + 0.31…….....equation 3)

The regression results above leads to rejection of the null hypothesis. Therefore, constraints significantly influence ICT use by the following percentages:

- Tool availability by 31%
- Infrastructure limitations by 31%, and
- Geographic remoteness by 51%

Negative signs above indicate that they affect inversely (one increases when the other decreases) for tool availability and infrastructure limitations.

4.6.2 Karl Pearson's Coefficient of determination (r^2)

The value of r^2 from this model is 0.23 being the proportion of ICT use that is determined by the constraints. This figure shows that only 23% is being determined by the constraints. The square root of r^2, which is r has a value of 0.47. Being less than 0.5 means the correlation between the variables (constraints and ICT use) is not strong.

4.6.3 Testing ICT use, yield and age against adoption of TC banana.

Table 14: ICT use, age, and yield against adoption of tissue culture

Source	SS	df	MS	Number of obs =	121
Model	4.5588827	3	1.51962757	F(3, 117) =	6.95
Residual	25.5898776	117	.218716903	Prob> F =	0.0002
Total	30.1487603	120	.251239669	R-squared =	0.1512
				Adj R-squared =	0.1294
				Root MSE =	0.46767

adoption	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ict	.1955769	.0888694	2.20	0.030	.0195758	.3715781
yield	.0011838	.0003312	3.57	0.001	.0005278	.0018398
age	-.0052876	.0028357	-1.86	0.065	-.0109035	.0003284
_cons	.6118232	.1594392	3.84	0.000	.2960622	.9275841

P value for ICT is 0.030(3%), and yield 0.001 (0.1%) indicate they significantly influence the adoption of tissue culture bananas. The ICT use and yield (independent variables) influence the adoption of tissue culture banana (dependent variable) positively (in the same direction).

CHAPTER FIVE

5.0 SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary

From the results of the study, ICTs are used by very few farmers in banana production and marketing. The mobiles are more exploited than the computers. On specific tools 38% indicated they use mobile phones and 1% use computers. On services or ICT components, 14.1% use SMS service and 45.3% use voice calls. Less than 1% used the market information systems and social networking 1.5%. No farmer uses internet services including the internet search through search engines such as Google, and emailing. They are yet to appreciate the usefulness of information accessed via these tools with 97% saying it was not applicable.

The villages have poor infrastructure in terms of network, electricity and roads. Lack of knowledge is identified as one of the major problems preventing farmers from attaining food self sufficiency. There were ten constraints affecting ICT use with three being significant, comparing with 5% level of precision: tool availability with p value at 0.001(0.1%), infrastructure at 0.011 (1.1%), and geographic remoteness at 0.004 (0.4%) in comparison with 5% level of precision. They influence inversely (when one increases, the other decreases) for tool availability and infrastructure limitations and positively (increase for both) for geographic remoteness.

The ICT users sought information on tissue culture banana varieties through voice communication (65%). Field days and listening to radios are used for information on planting, pruning, pests & disease control and fertilizer/manure application (77%, 82%, 65%, and 67% respectively. However SMS and voice are used for market information and information on utilization (64% and 55% respectively). Only 39.9% of users find the

information relevant, and 37 implement the information so acquired. 34% mobile phone users are able to get a yield of 101 bunches in a year and above, while only 30% of non user get the same yield. This means that the use of mobile phones enables the users to yield higher, though with a small margin of 4%. There are more adopters among ICT users than non users with a difference of (25.9% - 23.3%) 1.6%. ICT use influence adoption positively (in the same direction).

5.2 Conclusions

The following conclusions can be drawn from study:

1. ICT services used as sources of information by banana farmers in Kimilili include the SMS (14.1%) and voice calls (45.3%) which are offered via the mobile phones. Very few respondents (0.7%) used the market information systems and social networking (1.5% or 2 persons). However, majority (up to 82%) still rely on the traditional method of acquiring information from either their fellow farmers (farmer to farmer or from extension agents through the methods of field days and listening to radio)
2. There constraints such as, tool availability, infrastructure limitation and geographical remoteness/accessibility significantly influenced ICT use in banana production.
3. ICT users and non users in banana production have very little difference between them in terms of benefits from the information accessed that is only 37% of users found it of benefit. There was no significant difference in the yields between users and non users.

5.3 Recommendations

1. The governor Bungoma County to allocate funds for each Agricultural extension agent to have access to a computer and facilitate digitization of the extension messages for farmers. The banana farmers should appreciate and endeavour to embrace ICTs to reap its benefits.

2. The Principal Secretary for ICT to address the policy issue. He may encourage more investment in shops for mobiles and computers, cyber cafes for computer services. Interventions in technology/infrastructure limitations, cost of software and lack of trust include implementation of policy to provide infrastructure. Subsidy or free internet would go a long way in uplifting the community. Network infrastructure including boosters and telecommunications equipment such as the fiber optic cables would be handy.

3. The subcounty agriculture officer to help reduce the gap between users and non users of ICTs by improving the farmers' competency and skills through capacity building such as training for staff and farmers to gain the skills in making use of the services. Such trainings should include issues on the legal frameworks available.

Recommendations for further study:

1. More work should be conducted to establish the impact of specific SMS services being offered by various agencies such as the Kenya Agricultural Research Institute, Kenya Plant Health Inspectorate Service, "Shamba Shep-up" by CitizenTelevision channel and information systems such as National Agricultural Farmers Information Service, Kilimo Market Information, "m-farm" and Market information service by KACE, Kenya.

2. The accessibility of ICTs to the extension agents also needs to be investigated to establish how well equipped the source of this much needed knowledge is to disseminate it using the modern technology/e-government.

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APPENDICES

Appendix 1: Questionnaires

Start time……..End time…… Questionnaire code__/__/__/

Questionnaire for household heads Interview on constraints in information and communication technologies (ICT) use for banana farmers in Kimilili.

code__/__/__/ Interview date __/__/____/Day/Month/Year

Name of interviewer: ……Mobile phone no……..……

BASIC INFORMATION

Division: …….. Location: ……..AEZ……..

Sub-location: …… Village: ……....

Name of group: …… …….. Membership: **.....**

Farmer's Name…… Mobile phone no……..

Age…….. Gender……

i) Household size; Please specify the number …….

ii) What is the size of your farm? _____Acres, _____Hectares(Ha)

iii) How many acres of the land do you currently cultivate? _____ Acres, _____Ha

iv) Out of the cultivated land, how much is under bananas;
No. of stools _____ No. of acres_____, No. of hectares_____

v) How much of the bananas are tissue culture/improved
No of stools_____ No. of acres_____ No. of Hectares_____

vi) How much yield of the bananas in bunches and kilogrammes did you realize last year?

No. of bunches ……Approximate weight of a bunch……..Kilogrammes (Kgs)

Small bunch=10-15kgs, Medium=15-20kgs, Large =20-30

Yield in Tonnes/Ha

a) 15-20 { } b) 20-30 { } c) 30-35 { } d) 35-40 { }

SECTION 1: INFORMATION SOURCES

Objective 1: To determine the sources of information used by banana farmers in Kimilili .

1.1 ICT used Likert scale

Which of the following ICTs do you use for information on banana production?

ICT component	Never Use	Sometimes Use	Often Use	Always Use
Voice calls				
SMS				
Internet search				
Email				
Networking				
E-commerce or market information system				

1.2 From your own opinion to what extent has each helped you in issues pertaining to banana production, marketing and utilization? (**On a scale of 1-4: 1= Not at all, 2=little extent, 3=great extent 4=Not applicable**).

a) Mobile phone

Voice { } SMS { } Internet search { } Networking { }

b) Computers:

Internet { } email { } Networking with other farmers { } e-commerce { }

Others (Specify) ……

SECTION 2: CONSTRAINTS IN ICT USE

Objective 2: To assess whether constraints influence ICT use by banana farmers in Kimilili.

2.1 What is the primary (most recurrent) reason for difficulty in meeting your household food needs? Rank in order of importance?

Reason/s	**Tick**	**Rank**
a) Inadequate knowledge		
b) High cost of in puts		
c) Poor quality of farm inputs		
d) Poor marketing channels		
e) Low soil fertility		
f) High incidences of pests and disease		
g) Others (specify----------		

2.2 Indicate whether each of the following factors are constrains in your using ICTs in obtaining information on bananas. (To be attempted by all respondents)

(No=2 Yes=1) Tick in the appropriate box either 1 or 2 for each.

1 means it is a constraint, 2 means it is not a constraint

No.	**Constraints**	**Type of ICT equipment and service**	**Likert-scale**	
			Yes: 1	**No: 2**
1.	Tool availability	Mobile phone		
		Computer		
2.	Irrelevant content	Internet search		
		E-commerce/market information		
3.	Cost of software/equipment/services/ bandwidth	Voice communication		
		SMS		
		Internet search		

		E-commerce/market information		
		Email		
		Networking with other farmers		
4.	Competency/skills	Voice communication		
		SMS		
		Internet search		
		E-commerce/market information		
		Email		
		Networking with other farmers		
5.	Lack of electricity/batteries	Voice communication		
		SMS		
		Internet search		
		E-commerce/market information		
		Email		
		Networking with other farmers		
6.	Language barrier	Voice communication		
		SMS		
		Internet search		
		E-commerce/market information		
		Email		
		Networking with other		

		farmers		
7.	Technology infrastructure limitations (Network, Insufficient bandwidth)	Voice communication		
		SMS		
		Internet search		
		E-commerce/market information		
		Email		
		Networking with other farmers		
8.	Usability/user friendliness	Voice communication		
		SMS		
		Internet search		
		E-commerce/market information		
		Email		
		Networking with other farmers		
9.	Geographic remoteness/accessibility	Voice communication		
		SMS		
		Internet search		
		E-commerce/market information		
		Email		
		Networking with other farmers		
10.	Lack of trust/ Legal uncertainties	Voice communication		
		SMS		

		Internet search		
		E-commerce/market information		
		Email		
		Networking with other farmers		

SECTION 3: ICT USE FOR INNOVATIONS

Objective 3: To compare ICT users and non users among banana farmers in Kimilili.

3.1 Please specify whether you use the mobile phones and computers as major sources of information on bananas or not and,

a) Mobile phones: Used{ } Not used { }

b) Computers: Used { } Not used { }

3.2 For those who use, indicate what service you use them for on the specified topics (innovations) below? For those who have not used, please to number 3.1.

Type of information	**Information Source.** **(Code) A**(choose tool below)	**Means of accessing information.** **(Code) B** (choose service below)
Tissue culture banana		
Banana planting		
Banana pruning		
Banana disease/pest control		
Application of fertilizer/manure		
Market information		
Banana utilization		

Code A (tools used)
1. Mobile phones
2. Computers
3. Others (specify)

Code B (services offered
1. Internet searching information
2. E-commerce/market information
3. Email
4. Networking (social networks)
5. SMS
6. Voice
7. Others (specify)

3.3 How relevant was the information received in improving your banana yields

1. Highly relevant { }
2. Moderately relevant { }
3. Not relevant { }
4. Not applicable { }

3.4 What proportion of the recommendations have you applied?

1. None { }
2. Less than half { }
3. More than half { }
4. All { }
5. Not applicable { }

Thank you for taking your time to answer above questions

Appendix 2: Letter to the farmers groups

03/03/2013

Name…….. (Name of group)…….

Chairperson…….

Sub location……..

PARTICIPATION IN A SURVEY ON: "THE CONSTRAINTS IN INFORMATION AND COMMUNICATION TECHNOLOGIES (ICT) USE".

My name is Metrine Muricho. I am a Masters student at the University of Nairobi. I am carrying out a Study on constraints in ICT use by banana farmers of Kimilili Sub County in the months of March and April 2013.

I am glad to inform you that your group has been selected to take part in the Study. Some of your group members will be selected to take part in a scheduled interview on various dates between 8th April 2013 to 19th April 2013. The purpose of this letter is to let you know and inform the members of your group to cooperate during the exercise. I assure you that the information obtained will entirely be used for study purpose and not for any other gain. The results of the Study may be availed to you on request.

Looking forward to your cooperation.

Metrine Muricho

Appendix 3; Letter to the District Agriculture Officer

03/03/2013

District Agricultural Officer

Kimilili Sub County

ASSESSMENT OF CONSTRAINTS IN INFORMATION AND COMMUNICATION TECHNOLOGY USE BY BANANA FARMERS IN KIMILILI, KENYA

My name is Metrine Muricho. I am a Masters student at the University of Nairobi. I am carrying out a Study on Constraints to ICT use in banana production in Kimilili Sub County during the months of March and April 2013.

The purpose of this letter is to request for your assistance to enable me collect secondary and primary data from your office and from banana farmer groups in your Sub County. The farmer groups are those working with your Ministry and KARI in promotion of banana production. I will also need to use your field extension officers as enumerators for this exercise

Thanking you in anticipation

Metrine N. Muricho

Appendix 4: Check list for the Interview Schedule

Checklist for village elders as key informants

1. Computer services in area such as cyber café for email and internet search.
2. Network for communication: Prevalent…….Not prevalent……
3. Any communication boosters for telecommunications……..
4. Computer shops…….
5. Mobile phone shops…….
6. Shopping centers in the area: Number……..Distance to most homes……
7. Any organizations promoting bananas…….
8. The nearest market for bananas: Name……Distance…….
9. Road network: Number of tarmacs'……Murram road……..…..Feeder roads…….

   Foot paths……
10. Commonly used means of transportation for bananas……
11. Institutions in the village……
12. Electricity supply: Yes…….No……Mains only or supplied to homes…….
13. What % of farmers have electricity or solar power or any other source……

Appendix 6: Regression analysis output

Testing the influence of constraints on ICT use

```
      Source |       SS       df       MS              Number of obs = 135
-------------+------------------------------           F( 10,   124) =
4.91
       Model |   9.0004578    10   .90004578       Prob > F      =  0.0000
    Residual |  22.7328755   124  .183329641       R-squared     =  0.2836
-------------+------------------------------       Adj R-squared =  0.2259
       Total |  31.7333333   134   .23681592       Root MSE      =  .42817

------------------------------------------------------------------------------
----
         ICT |      Coef.   Std. Err.      t    P>|t|     [95% Conf.
Interval]
-------------+----------------------------------------------------------------
----
availability |  -.3114257    .092886    -3.35   0.001    -.4952731   -
.1275784
  irrelevant |   .0417765    .222843     0.19   0.852    -.3992923
.4828452
        cost |  -.0325314   .4279447    -0.08   0.940    -.8795537
.814491
   competent |   .0373666   .3232344     0.12   0.908    -.6024048
.677138
    lackelec |   .0488002   .1198863     0.41   0.685    -.1884883
.2860886
    language |  -.1996307   .1073041    -1.86   0.065    -.4120155
.0127541
infrastruc~e |  -.3060599   .1191934    -2.57   0.011     -.541977   -
.0701427
  userbility |  -.0081514    .332148    -0.02   0.980    -.6655654
.6492625
   geography |   .5216642   .1789429     2.92   0.004     .1674861
.8758424
       trust |  -.2435244   .1889201    -1.29   0.200    -.6174503
.1304014
       _cons |   .5558947   .4587345     1.21   0.228    -.3520694
1.463859
------------------------------------------------------------------------------
-
```

Testing ICT use, yield and age against adoption of TC banana.

ICT use, age, and yield against adoption of tissue culture

```
Source |       SS       df       MS              Number of obs =     121
-------------+------------------------------       F(  3,   117) = 6.95
       Model |   4.5588827     3  1.51962757       Prob > F      = 0.0002
    Residual |  25.5898776   117  .218716903       R-squared     = 0.1512
-------------+------------------------------       Adj R-squared = 0.1294
       Total |  30.1487603   120  .251239669       Root MSE      = 0.46767

------------------------------------------------------------------------------

adoption |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
---------+--------------------------------------------------------------------
         ict |   .1955769   .0888694     2.20   0.030     .0195758
.3715781
       yield |   .0011838   .0003312     3.57   0.001     .0005278
.0018398
         age |  -.0052876   .0028357    -1.86   0.065    -.0109035
.0003284
       _cons |   .6118232   .1594392     3.84   0.000     .2960622
.9275841
------------------------------------------------------------------------------
```

Appendix 6: Photo gallery

Training of enumerators

Figure 14: Training of the enumerators

Farmer in her orchard

Figure 15: A farmer in her ochard of tissue culture bananas

Bananas in transit

Figure 16: Bananas being transported by bicycle to the market

Bicycle is the most commonly used means of transport to the market

Bananas in Kimilili market

Figure 17: Loading bananas on to a bus for ferrying outside the sub county

Bananas in Kimilili market being loaded on to a bus to Kitale