UNIVERSITY OF NAIROBI

DEPARTMENT OF COMPUTING & INFORMATICS

FACULTY OF SCIENCE AND TECHNOLOGY

ASSESSMENT OF ICT SYSTEMS ON GREEN GRAM PRODUCTIVITY: A CASE OF KENYA CLIMATE SMART AGRICULTURE PROJECT IN MWALA SUB-COUNTY, KENYA

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P54/36131/2019

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A RESEARCH PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF MASTER OF SCIENCE IN INFORMATION TECHNOLOGY MANAGEMENT, UNIVERSITY OF NAIROBI

AUGUST 2023

DECLARATION

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

Signature.......... ....Date.........**12/09/2023**....................................

Wahito Samson Machohi

Reg No: P54/36131/2019

This research project has been submitted for examination with my approval as the University supervisor.

Signature...Date. 12 September, 2023 ....

Dr. Wanjiku Nganga

University of Nairobi.

DEDICATION

This work is dedicated to my family for their encouragement and bearing with me during the course of my studies.

ACKNOWLEDGMENT

To begin with, my gratitude goes to the Almighty Lord for the wisdom He has bestowed upon me. Second, I thank my supervisor, Dr. Wanjiku Nganga, for her assistance during this research project. Secondly, I want to thank my current employer, the Kenya Agricultural and Livestock Research Organization (KALRO), and the World Bank through the Kenya Climate Smart Agriculture Project (KCSAP), for funding my studies. My thanks also go to the Machakos County personnel for support they accorded me during data collection, the enumerators I worked with to collect data, and the farmers in Mwala Sub-County who agreed to be interviewed. Also, my sincere appreciation extends to my family members for their constant backing and encouragement.

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ABSTRACT

Despite agriculture's economic importance, levels of production and productivity are still low, and access to agricultural information remains a challenge especially for smallholder farmers. Also, while agricultural extension services are an important tool for knowledge transfer, in Kenya, the desirable extension staff to farmer ratio should be 1:400 but the current ratio is 1:1000 which makes follow up of farmers difficult leading to low impact of training which further leads to low productivity. The Kenyan Government's (GoK) policy framework on agricultural extension points out the possibilities for ICT to enhance the quality and speed up the conveyance and sharing of information to farmers. Most research in the existing literature have only analyzed the impact on markets and prices, and even then, the conclusions are varied. There are few reports on the effect of ICT activities on technology adoption and productivity. Therefore, this research study adopted the Technology Acceptance Model (TAM) to carry out an assessment of ICT systems on green gram productivity in Mwala Sub-County, Kenya, to check if these ICT systems have been helpful to the smallholder farmers. The researcher managed to interview 128 farmers from a sample size of 142, with a 90 percent response rate. To analyze the data, the researcher used version 25 of the SPSS software. Findings from this study indicate that ICT systems have helped farmers in Mwala increase their productivity of green grams as the output/yield from green grams has increased. ICT systems have also helped to decrease the cost of production of green gram farming and also helped to increase the income they get from green gram farming. The study additionally demonstrates that a farmer's perceived ease of use, attitude and perceived usefulness towards an ICT system or platform will affect how farmers adopt and actually use the ICT systems in farming.

LIST OF ABBREVIATIONS / ACRONYMS

ASALs: Arid and semi-arid areas

CPCU: County Project Coordination Unit

DAT: Disruptive Agricultural Technologies

FAO: Food and Agriculture Organization

GSMA: Global System for Mobile Communications Association

ICT: Information and Communication Technology

ICT4D: ICT for Development

GDP: Gross Domestic Product

GOK: Government of Kenya

KALRO: Kenya Agricultural and Livestock Research Organization

KCSAP: Kenya Climate Smart Agriculture Project

NASEP: National Agricultural Sector Extension Policy

SMS: Short Messaging Service

SPSS: Statistical Package for Social Science

UNDP: United Nations Development Program

USAID: United States Agency for International Development

USSD: Unstructured Supplementary Service Data

DEFINITION OF TERMS

AGRO-ENTERPRISE: a small-scale business venture that can be conducted on-farm or as a service that can be utilized to support other businesses.

DISRUPTIVE AGRICULTURAL TECHNOLOGIES (DAT): These include technological and digital innovations which allow agribusiness entrepreneurs and farmers to move beyond conventional techniques to increase efficiency, productivity, competitiveness, enabling market access, boosting nutrition, and increasing climate change resilience whilst fostering long-term economic growth.

ICT SYSTEMS: A set-up consisting of hardware (the device), software (the system/program used), data and the people who use them

INFORMATION AND COMMUNICATION TECHNOLOGY (ICT): These are tools, gadgets, or apps that allow data to be exchanged or collected via interaction or transmission. It encompasses everything from radio broadcast, satellite images, mobile phones and electronic cash transactions.

PRODUCTIVITY: refers to a measure of quantity of output produced with a given quantity of inputs.

SOCIAL INCLUSION: the process of improving the conditions whereby groups and individuals participate in society by boosting the opportunity, potential and status of individuals who feel excluded.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Kenya's agriculture sector is the country's mainstay (GOK, 2017). It accounts for over thirty percent of entire Gross Domestic Product by offering a source of income for 80 percent of the inhabitants, primarily smallholder farmers. Agriculture significantly contributes to the national economy, reflecting for 26% of GDP directly as well as another 25% indirectly. Furthermore, it provides employment for millions of people.

Despite agriculture’s economic importance, levels of production and productivity are still low, and access to agricultural information remains a challenge (Kiptum, 2016). Agricultural extension services are key in transferring knowledge, educating and advising farmers on new practices and technology, and encouraging appropriate agricultural developments (Fu & Akter, 2016). In Kenya, the guidelines and standards for advisory services and agricultural extension indicates that the appropriate extension staff to farmer ratio should be 1:400 but the current ratio stands at 1:1000 in accordance to National Agricultural Sector Extension Policy (NASEP, 2012). This makes follow up of farmers difficult leading to low impact of training which further leads to low production (NASEP, 2012). Furthermore, Alila and Atieno (2006) and UNDP (2012) note a variety of difficulties that impede the research and extension system, such as weak links between research, extension, and farmers, limited funding, and a high rate of scientist turnover.

To progress farming, smallholder farmers require adequate accessibility to knowledge, information, as well as other services in a timely and quality manner (Fu & Akter, 2016). Farmers in rural areas, on the other hand, are left out mainly because of a lack of infrastructure. Farmers have an actual need for land records, market information, information on farm management, and knowledge on disease and pest control, pesticide management and use, (Cole and Fernando, 2012).

The Kenyan Government's (GOK) strategy framework on public extension in agriculture (2011) put emphasis on the possibilities of ICT in boosting the quality of information distribution and exchange to all the farmers. Consequently, ICT is prioritized, chiefly as a means for boosting research extension (Kiptum, 2016). ICT in agriculture is not a new concept (Akuku, Haaksma, & Derksen, 2019).

ICT stands for information and communication technology, encompassing the Internet, mobile phones and computers. The phenomenal proliferation of mobile phones in developing-country rural regions has aroused hopes for their potential benefits to timely top-notch extension service delivery (Fu & Akter, 2016).

Kim et al., (2020) indicate that Disruptive agricultural technologies (DAT), have the ability to help address numerous challenges facing the agri-food systems. These innovations encompass both digital and non-digital that enable farmers to overcome present limits in order to boost efficiency, production and competitiveness, while also enhancing market access, resilience to climate change and nutritional outcomes. According to Akuku et al. (2019), ICT utilization in agriculture is widely regarded as a crucial component that can disrupt and revolutionize the agricultural sector with the goal to make it more climate smart and assist feeding the worldwide populations in the coming decades.

Despite agriculture's economic importance, it faces some challenges, including high levels of rural poverty, illiteracy among farmers, researchers, and extension personnel, and a low-level of ICT readiness among in the developing countries, research and extension organizations (Showole & Hashim, 2016). On the other hand, there are advantages of using ICTs in agricultural information dissemination over traditional methods which include: it is a less expensive way of communicating relevant information to rural farmers, it is simple to use for delivering education and training programs, it allows farmers to access markets and agricultural credit, and it empowers them to bargain for better prices (Kiptum, 2016).

ICT-based technologies are game changers in agricultural sector because they offer farmers with data, knowledge and information, to equip themselves with current technology in agriculture and act appropriately to boost the cultivation of higher value crops, increase selling price, decrease production expenses, and use less pesticides on their farms (Das et al., 2016). However, in developing nations, a shortage of information distribution in the agricultural sector is a key challenge. ICT may benefit smallholder from the broadcasting of agricultural information. The easy accessibility of agricultural information using information and communication technologies can benefit smallholder farmers.

Krell et al. (2020), indicate that some of the ICT based tools being used in Kenya's agriculture sector include mobile-based applications, web portals, and the use of big data analytics. Examples of ICT services being used to reach information to farmers include USSD, mobile applications (apps), SMS, call centers. These services can be accessible by phones with and without internet connectivity, depending on the electronic media stored (Krell et al., 2020). While some of these services do not charge to use, others might charge a fee to access additional features. These technologies are capable of assisting farmers in gaining access to simplified and personalized information for use in farming activities.

Kenya Climate Smart Agriculture Project (KCSAP)

In 2017, the Kenyan government, through the Ministry of Agriculture, Livestock, Fisheries, and Co-operatives, and the World Bank, launched the Kenya Climate Smart Agriculture Project (KCSAP). KCSAP's developmental goal was to boost the productivity of agriculture in addition to promote climate change resilience/copying mechanisms among Kenya's target pastoral communities and smallholder farms. It also aimed to provide an effective and immediate response if there is an Eligible Emergency or Crisis. KCSAP is being implemented in 24 Kenyan counties spanning five years (2017-2022).

Under the KCSAP project, one of the project components was supporting advisory services, agro-weather and market with the aim to improve agro-meteorological forecasting and monitoring, develop an integrated information system on weather and market and build technical and organizational capacity. Under this component, several ICT systems and applications have been developed for smallholder farmers, which include Kenya Agricultural Observatory Platform (KAOP), which provide farmers with weather forecasts, agronomic advisories and agricultural insights, KALRO selector, which provides information to farmers on what is the best to grow or keep on their land. Other ICT services developed under the Agro-weather, Market, and Advisory Services include the Call Center where farmers call and are given advice regarding crops and livestock, mobile applications. These ICT applications are accessible to farmers in form of Mobile applications, Short Messaging Services (SMS) and USSD service.

Green grams is among the value chains supported under the KCSAP project in Mwala Sub-County, Machakos County (KALRO, 2019). Over the last decade, there has been a surge in interest in interventions that enhance the development of high-value drought-tolerant crops such as green grams in warm, arid areas of Eastern Kenya in various counties including Machakos, Makueni and Kitui mostly grown by smallholder farmers. Green gram is not only a drought resistant and low-input crop but also a vital income creating agro-enterprise in arid and semi-arid areas (ASALs) (KALRO, 2019). Farmers growing green grams in Mwala Sub-County have been trained on the ICT systems that have been developed under KCSAP project to help them improve the production and productivity of their crop.

Green gram production in Kenya faces varied constraints with the main one being low number of extension officers to adequately serve the green gram farmers, which make follow up difficult leading to low impact of the knowledge and hence low production. The decreased production is also ascribed to the usage of low yielding varieties because farmers are unaware of and unable to get superior/improved varieties. Other factors are pest and disease invasion and poor crop management practices. However, there is high demand for green grams by buyers since it causes less flatulence compared to other legumes (The National Treasury and Planning, 2020).

1.2 Statement of the Problem

While agricultural extension systems were created to fill information gaps for less fortunate farmers, in particular those with poor access to alternative sources that provide data such as land lines, radios and newspapers, one of the most noticeable changes that have taken place recently has been an upsurge in mobile phone adoption and coverage (Aker, 2011).

In Africa, the number of efforts offering agricultural advice and extension support based on ICT is growing. Nonetheless, no comprehensive research based assessment of ICT use in agriculture has been conducted (Kiambi, 2018). The bulk of studies in the present literature have entirely explored the effect on markets and price, and the results are mixed. There are few studies that look at the assessment of IT-related operations on technology adoption and productivity.

This is supported by Kiarie (2020) who indicate that there is lack of sufficient research in regards to smallholder farmers' uptake of ICT systems in Kenya. Therefore, it was essential carry out an assessment of ICT systems on green gram productivity in Mwala Sub-County, Kenya to check if these ICT systems have been helpful to the smallholder farmers.

1.3 Research Objectives

1.3.1 General Objective

To assess ICT systems on green gram productivity using a case of Kenya Climate Smart Agriculture Project (KCSAP) in Mwala Sub-County in Machakos.

1.3.2 Specific Objectives

i) To assess agricultural advisory of ICT systems on green gram productivity

ii) To assess access to market of ICT systems on green gram productivity

iii) To assess social inclusion of ICT systems on green gram productivity

1.4 Research Questions

i) Does agricultural advisory and extension using ICT systems affect green gram productivity?
ii) Does access to market using ICT systems affect green gram productivity?
iii) Does social inclusion using ICT systems affect green gram productivity?

1.5 Significance of the Study

Kenya's agriculture sector is critical to the country's economy, accounting for more than a quarter of GDP (KALRO, 2019). Kiambi (2018) claims that there is minimal substantial evidence-based assessment of ICT use in agriculture. This study purposes to seal this gap by providing insights on the assessment of ICT systems on productivity by determining whether adopting and using ICT systems has helped smallholder green gram farmers in Mwala Sub-County increase productivity.

1.6 Study Limitations

This research study solely concentrated on smallholder farmers growing green grams under Kenya Climate Smart Agriculture Project (KCSAP) in Mwala Sub-County, Kenya. Other limitations included the strict timelines for conducting the research within the period stipulated by the University for conducting research for the master's degree program. Distance to the field was also a challenge from Nairobi to Mwala Sub-County, Machakos where the green gram farmers are located. To deal with the challenge of language barrier during data collection, the researcher worked with the relevant authorities and engaged local research assistants.

CHAPTER TWO

LITERATURE REVIEW

2.1 Need for ICT systems in Agriculture

Agricultural extension services are a key tool for information and knowledge transmission, advising and educating farmers about recent agricultural technology and practices, and encouraging desired agricultural advancements (Fu & Akter, 2016). Despite the economic importance of agriculture, levels of production and productivity are low, and access to agricultural information remains difficult (Kiptum, 2016). According to Braimok (2017), ICT use in agriculture is commonly viewed as a key aspect that can disrupt and revolutionize the sector making it more climate smart and feed the globe in the coming decades.

2.2 ICT systems used in Agriculture

Heffernan et al., (2013) categorize ICTs into three categories based on how they have been in use and what the ICT has been used for. The first category is new ICT which are based on digital technologies which include mobile phones, the Internet, computers, satellites and wireless communication. The second category is the Traditional (old) ICTs which depend on analog technology and they include radio, television, landline telephones and telegraph. The third category is the very old ICTs which have been in existence for a number of hundreds of years and they include newspapers, books and libraries.

Mallalieu & Rocke (2007) similarly identified three types of ICTs but from an access approach and these are access technologies, access device technologies and technology applications. Access technologies play a key role in ICTs penetration into groups of people that are digitally poor. These technologies include mobile phones, radio and television. The second and third types of ICTs are important to community participation in the acceptance of ICTs. Application technologies are the end-user capabilities enabled by ICTs and they include web browsers and email. This study focused on the new digital technologies ICTs and access device technologies; mobile phones and mobile applications.

Mobile phones

The Communication Authority of Kenya (2022) point out there were an estimated 60.7 million mobile phones linked to mobile grids as of September 30, 2022, in Kenya, with 32.9 million being basic mobile phones and 27.9 million being smartphones. As a percentage of the entire population, feature phones and smartphones had penetration rates of 66.5 and 56.4 percent, respectively. Furthermore, Kenya's mobile market grew as demand for ICT services surged due to an activity increase across mobile network platforms during the busy election season. As a result, active mobile subscriptions (SIM Cards) increased by 1.2 percent from 64.7 million to 65.5 million in the previous quarter from July to September 2022. This resulted in mobile (SIM) 132.5 percent penetration level (CA, 2022). This is show in the Figure 1 below.

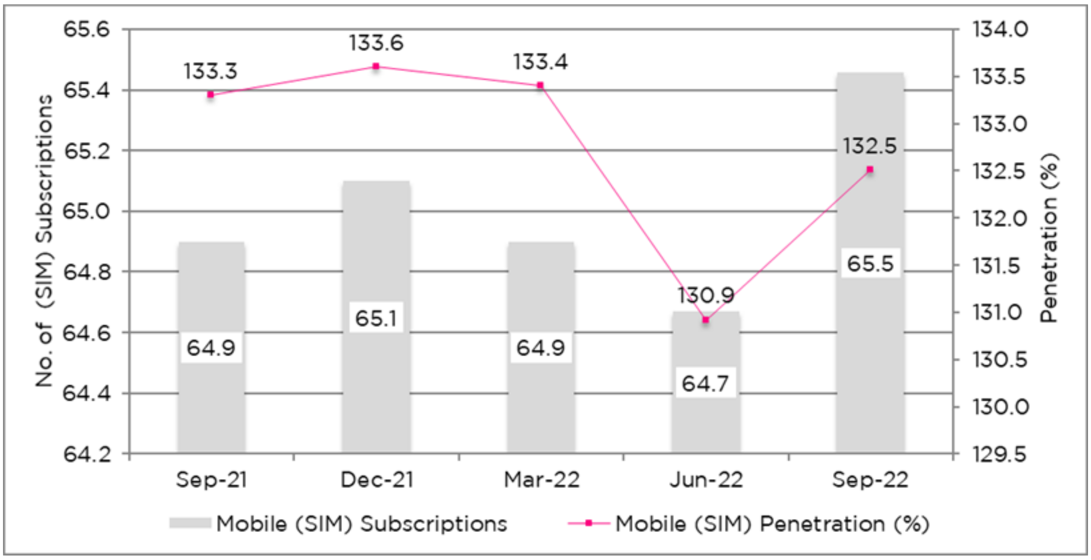

Figure 1: Mobile penetration and subscriptions levels in Kenya

Source: Communications Authority

2.3 Theoretical Review

The Technology Acceptance Model (TAM) guided and was used in this research project.

2.3.1 Technology Acceptance Model (TAM)

Davis (1989) developed the Technology Acceptance Model (TAM) as a study model to forecast each user's usage and acceptance of ICT systems. TAM has been well researched and supported by multiple studies that investigate an individual’s technology acceptance habits across a variety of information system structures.

Two fundamental elements: perceived ease of use and perceived usefulness, are both relevant in computer use patterns in the TAM model. According to Davis, perceived usefulness is a consumer's subjective belief that using a certain application or platform might enhance their overall performance. In contrast, perceived ease of use (EOU) denotes how easily a system user presumes the system in question to be easy to use. External influences have an effect on these two variables. The main external factors include cultural, social and political factors. Social aspects include skills, language and aiding conditions. Political aspects mainly effect the technology use during political crisis and politics. Attitude toward using deals with the consumer's evaluation of the desire of engagement with a specific application or information system.

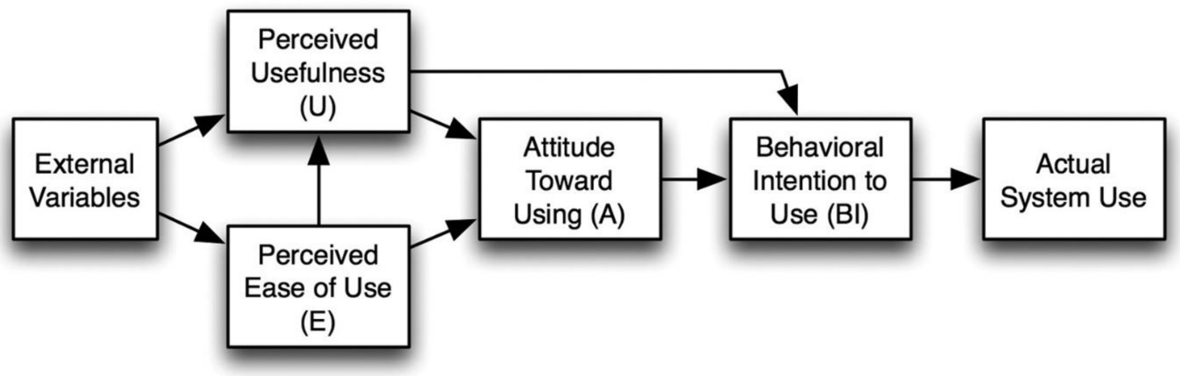

Figure 2: Technology Acceptance Model (TAM)

2.4 Empirical Review

2.4.1 ICT Agricultural Advisory and Extension

Public extension services in evolving countries is frequently regarded obsolete in an era of continually changing and modernizing farming systems (Bell, 2015). Government extension organizations are frequently inflexible, and their services may not be able to stretch to all smallholder farmers or make available latest and specialized information to satisfy the farmers' needs. According to FAO recommendations, ratio of assignment of extension agents to farmers should be 1:400 (Batchelor et al., 2014). This is however not the case in Kenya as the National Agricultural Sector Extension Policy highlights the ratio currently stands at 1:1000 respectively (NASEP, 2012). It is nearly impossible to serve farmers with information using extension agents only without the use of ICTs.

Bell (2015) indicate that ICT's increasing prevalence in emerging and developing economies may provide a promising remedy to this issue. The agricultural sector will benefit from this advancement, and there is hope that ICT will cover the hole that government's extension is unable to fill, as farmers are frequently poor in resources and insufficient extension personnel to serve all smallholder farmers. Mobile technology, for example, has been utilized to expand the agricultural extension services' reach through facilitating farmers to interact with hotlines for professional guidance on agriculture or information on markets, such as where markets are located and pricing (Aker & Mbiti, 2010). ICT's spread in emergent countries allows users to send and receive essential information, particularly for rural individuals and groups (Aker, 2011). Conversely, due to the extremely localized character of agriculture, this all hang on the whether ICT is affordable and the information produced customized especially to distinct scenarios (McNamara et al., 2011; Bell, 2015). Cole and Fernando (2016) discovered that introducing a free of charge hotline where farmers could ask agricultural specialists' questions drastically improved cotton and cumin yields amongst farmers in Gujarat, India.

Farmers in Mauritius suffer major constraints such as pests, diseases, theft, and shortage of water, marketing, weed management, labor, and delayed embrace of agricultural technological innovation. As a result, understanding agricultural information as well as having access to extension services constitute the major criteria for minimizing farmer challenges, which can be achieved by boosting effective extension services (Central Statistics Office, 2017).

Smallholder sugarcane farmers in Kenya who received SMS texts with agronomic information had 11.5 percent higher yields than a control group that were not receiving the messages (Casaburi et al., 2014). Also, Fu & Akter (2016) discovered that in Madhya, a mobile phone-based multimedia invention connected to expert advice services amplified farmers' consciousness and knowhow of explicit resolutions to their agricultural production limitations.

Weather forecasting with ICT is critical in agricultural output. It has a significant impact on yields, development, crop growth, yields, pest occurrences, disease occurrences, fertilizer requirements, and water requirements owing to variations in nutrient absorption caused by water stressors, as well as the effectiveness and adequacy of cultural operations and crop prophylaxis. ICT plays is important in all stages of agriculture, from detection, modeling, forecasting to early warning and localization (Singh, 2015). Overall, the study found that farmers' access to agricultural solutions was improved by the use of ICTs.

2.4.2 Access to Market using ICT

Chhachhar et al., (2014) noted that radio, the internet, mobile phones in addition to television were the greatest essential modes of communication for farmers seeking agricultural expertise and information. In remote locations, radio was a popular mode of communication, broadcasting many agricultural programs, while television also played an essential part in distributing agronomic knowledge countries which are developing. Use of mobile phones bridged the divide between buyers and farmers. Farmers engaged with customers directly and obtained market prices for their produce. The internet also distributed information on the price and sale of goods, and farmers from all over the world received information in minutes. In Taiwan, Mahmud & Ahsan (2016) investigated the role of ICTs on agriculture development and governance. Findings showed that usage of ICTs spared farmers from brokers and resulted in the greatest benefits them.

Halewood & Surya (2012) noted that advantages of adopting ICTs to promote access to information price in Africa increased farmers' and traders' revenue by nearly 36 percent in Kenya, Uganda, Morocco and Ghana. The Ethiopian Commodity Exchange established a virtual marketplace which could be accessed online using via phone and SMS, which enhanced farmers' proportion of revenue by providing clearness on prices, demand and supply (McKinsey, 2013).

According to a Ugandan study, market participation increased with access to mobile phones (Muto & Yamano 2009). Aker (2010), noted that grain price disparities in Niger fell by 20 percent, scarce resources were deployed better, search expenses by traders' decreased by 50 percent, and shoppers paid 3.5 percent reduced amount for grain. In Tanzania, Agnes (2010) discovered that farmers' ICT usage was substantially connected to amount produced, income level, crop gender and type marketed. Farmers who used ICT to acquire market information received better prices than their counterparts.

Complex marketing distribution systems for agricultural produce is a major problem in Indian agriculture. Farmers are not kept up to date on goods pricing, inputs marketplaces in addition to consumer trends. To realize optimal advantage, ICT offers the huge potential to broaden farmers' selling horizons right to customers or other consumers. Farmers can have direct communication with many individuals and learn about up-to-date goods pricing, thus accessing markets without leaving their homes. Furthermore, the middleman's profit is reduced, thereby benefiting farmers. Through this, farmer's revenue source is increased and farmers are empowered to make sound judgments regarding right future commodities and crops; and provide marketing channels for farmers to market their produce while acquiring inputs (Singh et al., 2017).

2.4.3 Social Inclusion using ICT systems

Meso et al., (2005) found out that age, education level and gender are among the aspects that influence technology acceptance and use. Farmers are on average sixty years old worldwide. World Farmers' Organization (2017) highlight that the youth are gradually pursuing careers outside of agriculture not like their parents and grandparents. The Sub-Saharan Africa, which has ten of the sphere's undeveloped countries, populations are getting younger (Hutt, 2016). Many countries could capitalize on youth tapping on their innovative and entrepreneurial energies to help boost and rejuvenate local economies. In agriculture sector, new founded technologies in addition to creative agriculture production techniques can aid to escalate productivity and effectiveness (Hutt, 2016). Krell et al., (2020) noted that women are unlikely to use information and communication technology (ICT) services than males. The variations in average age and education level for women's ICT service use, and men to a lesser extent, highlight the significance of these factors to determining use of ICT services (Krell et al., 2020).

Due to technical literacy, attitude and time needed to pick up how to navigate the Internet, rural women's mobile use and accessibility to ICT services remains limited. To enable inclusive rural transformation, proactive efforts to enhance rural women's capacity in the use of digital tools may be required (Wahiu, Lohento, & Koutchade, 2020). Youths are frequently more prepared and motivated to learn new technology and put them to practice in agriculture in order as a means of boosting productivity and address problems (World Farmers' Organization, 2017). Simultaneously, the said technologies can aid in proving to the youth how agriculture can be a sustainable and lucrative profession, improving the popularity of careers choices related to agriculture over alternatives that youth may otherwise seek.

ICTs have the potential alleviate the gender gap within the agricultural sector by endowing girls and women to boost sustainable output, operate farms and agribusinesses in an efficient manner, as well as improve gender equal opportunity across the value chain of agriculture. However, the "triple divide" consisting of digital, rural, and gender difference that women go through in agriculture, poses hurdles in gaining access to and using ICT tools (FAO 2018). GSMA (Global System for Mobile Communications Association) latest data point out that women have likeliness not to own a mobile phone at a rate of 10 percent. The data also highlight that 390 million women are fully disconnected across low and middle-income countries (GSMA, 2019). As a result, a majority of the women globally are still not capable to fully benefit from ICT use in agriculture. Unfortunately, no statistics on females' use of ICT tools and engagement in agriculture is available. The implementation of ICT solutions in agricultural development has been lauded as a means of improving possibilities for all farmers' genders. Conversely, it cannot be believed that ICTs diminish gender inequality intrinsically (Manfre, 2011).

If ICTs are developed to accommodate both genders diverse opportunities and talents, they have the potential to become of benefit in promoting women's performance and admission in agricultural development (Manfre, 2011). Also, women have a global shortage of accessing labor, agricultural production inputs, loans, information and training resources (USAID, 2012). Especially, when it comes to accessing ICTs, this is true as there are numerous barriers to overcome, including advanced technology levels in addition to linguistic illiteracy amongst girls and women, cultural standards that dissuade females from technology use, as well as technology ownership shortage and control of the technology (Manfre, 2011). Regarding high illiteracy rates, for example, ICT interventions should concentrate on video and audio-based technology. (Manfre, 2011) highlight a couple of other challenges limiting ICT systems contributions to growth of agriculture to contribute to gender equality. These include the notion of ICTs being gender neutral, and women and men having equal access to, usage of, and influence.

These obstacles are discouraging, but when removed, the potential for impact is enormous. ICTs might help women gain right of entry to agricultural services that are productive and educate themselves. They can also strengthen communication with value and supply networks, better access to markets, price, and information on crops. Food and Agriculture Organization (FAO) indicate when women have similar access to resources of productivity, production from farms can increase between 20 to 30 percent, leading to an increase in the output of agriculture between 2.5 to 4 percent in countries that are developing as well as decreasing hunger globally between 12 to 17 percent which is about 100 to 150 million people (USAID, 2012; FAO, 2011). ICTs access therefore serves as a vital component in eliminating gender disparity.

2.5 The Conceptual Framework

Mugenda & Mugenda (2013) ascertain that a conceptual framework helps the reader to easily understand the relationship among the various variables in a research study. This research study's conceptual framework was guided by Technology Acceptance Model (TAM) to assess ICT systems on green gram productivity focusing on a case of Kenya Climate Smart

Agriculture Project in Mwala Sub-County, Kenya. It consists of three independent variables (Perceived ease of use, Attitude towards using system and Perceived usefulness), one intermediate variable (Behavioral intention) and the dependent variable (Actual system use). This is represented in the Figure 3.

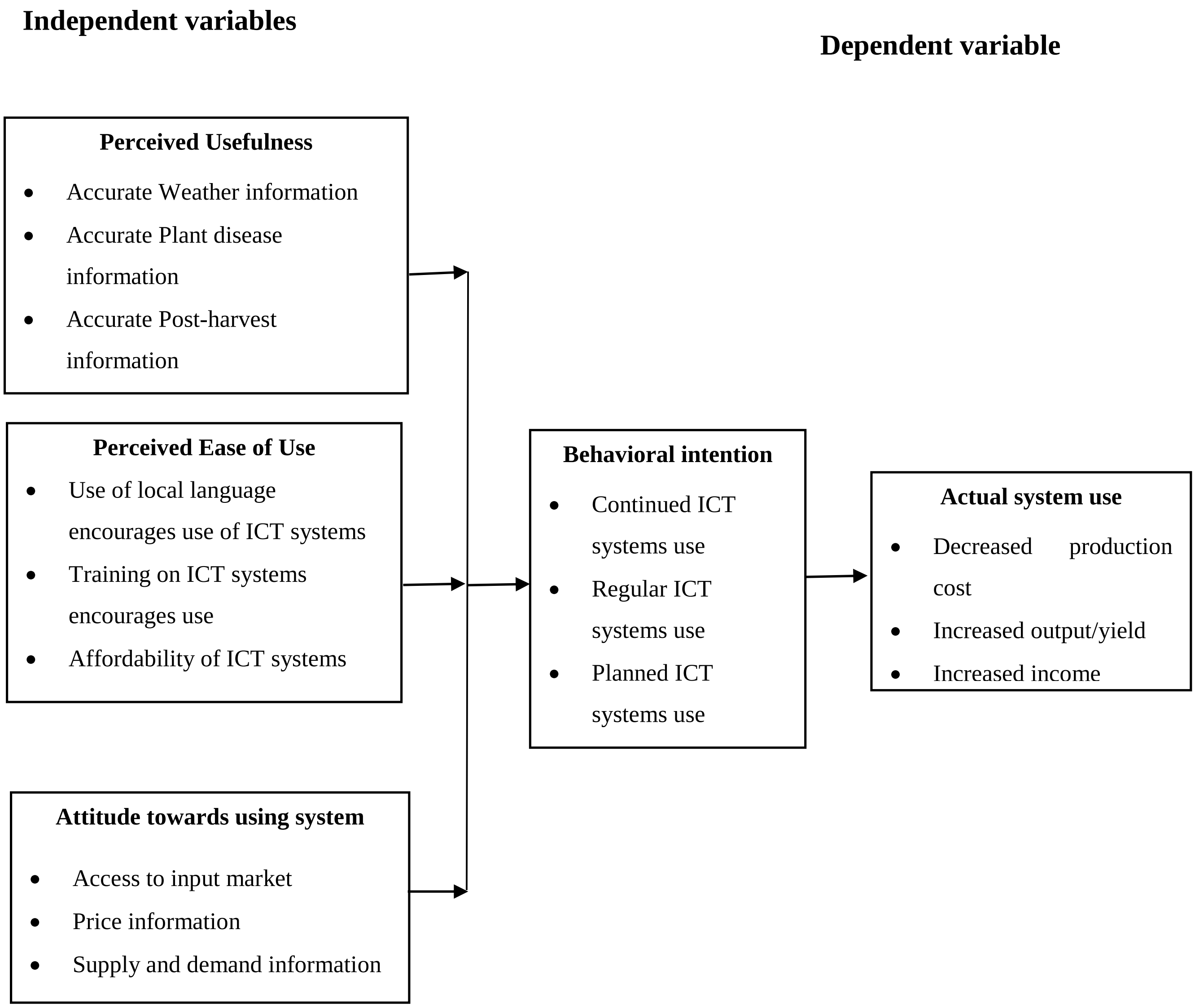

Figure 3: Conceptual Framework

Source: Author (2023)

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Research Design

Descriptive research design was embraced in this study using both quantitative methodologies and qualitative methodologies. Qualitative approach was suitable for this study because it described a prevailing occurrence by inquiring individuals' commitment, creativity and self-efficacy and socio-economic factors. Quantitative approach was utilized aiming at quantifying the hypothesized link amongst the different study variables.

3.2 Location of the Study

Mwala Sub-County, Kenya was the study location. This location was chosen because of availability of smallholder green grams' farmers and these farmers have been acquainted with the usage of ICT platforms thus are inclined to give an informed response.

3.3 Target Population

In Mwala Sub-County, the number of households practicing agriculture are 39,928 (KNBS, 2020). The number of households practicing green gram farming in Mwala sub-county is 16, 227 (KNBS, 2020). The number of small scale green gram farmers in Mwala trained and are using ICT systems developed under the KCSAP project are 473, who were the target population (KCSAP, 2020).

3.4 Sample Size and Sampling Procedure

Orodho, (2002) delineate sample size as a population's subgroup from which the scholar seeks to extrapolate the findings. Any assertions made about the sample must also apply to the population. Mugenda & Mugenda (2003) indicate that a population having less than 500, a 30 percent sample size is deliberated representative. The justification of 30 percent is that it reduces redundancy and duplication in data collection and is considered sufficient to complete data collection.

$30 \div 100 \times 473 = 142$

For this research a total of 142 respondents was used as the sample size.

3.5 Data Collection Method

The main data gathering method used for primary data were questionnaires subjected to individual farmers who are growing green grams in Mwala Sub-County, Machakos County.

Questionnaires collected specific information from the green gram farmers. Questionnaires included both closed and open ended question types. To administer the questionnaires, the Open Data Kit (ODK) smartphone application was used. ODK application is a freely available set of tools for collecting and capturing digital data with mobile devices. The main advantage of using it is that it drastically minimizes the human paperwork of printing, carrying, and manually inputting questionnaire data, it allows for intense monitoring of the collecting process and data collection immediately after the survey in a format ready for analysis. Qualitative data was captured through use of the questionnaire. Furthermore, data gathered via questionnaires can be examined more objectively and scientifically using a statistical software package such as SPSS, and the results can be rapidly and simply communicated.

3.6 Research instruments Validity

Heale and Twycross (2015), denote validity as the correctness and significance of inferences from a derivation of the research findings. It is the extent to which data analysis results accurately depict the topic under examination. The questionnaire's validity was obtained by a panel comprised of the supervisors supervising the researcher who are specialists in the field by verifying the questionnaire to be utilized in acquiring appropriate data.

3.7 Research instruments Reliability

According to Wood et al. (2006), the research instrument’s reliability is the magnitude to which the research tool provides the same result on recurring measures. The goal of reliability testing is to correct errors in the instrument, ensuring they measure what is required.

3.8 Data Analysis

Questionnaires were reviewed if they were complete and coded into the computer software to be used. Using SPSS version 25, the data was examined using descriptive statistics. A multiple linear regression model was utilized to find out the association between the independent and dependent variables. F statistics at a 95% confidence level and analysis of variance were used to assess the model's overall significance. To demonstrate the independent variables impact on the dependent variable, R^2 coefficient of determination was used. This study employed the below regression model equation.

$Y= \alpha+\beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4 + \varepsilon$

Where: Y = Actual system use (Dependent variable)

α = Constant term, normally distributed to a mean of 0 for computation purposes

X_1 = Perceived usefulness (Independent variable 1)

X_2 = Perceived ease of use (Independent variable 2)

X_3 = Behavioral intention (Intermediate variable)

X4 = Attitude towards using system (Independent variable 3)

β = Beta Coefficients of the variable X_1, X_2, X_3 and X_4.

ε = Error term (standard error)

3.9 Ethical Consideration

During the analysis, the researcher considered issues of ethics such as anonymity of the participants. The University of Nairobi granted the researcher permission to perform the research. The researcher would also gain respondents' consent by making to them known the research data obtained was purely for academic purposes. They were assured that any confidential information gotten from them would not be make known to any unauthorized parties.

CHAPTER FOUR
RESEARCH FINDINGS

4.1 Introduction

Findings from the data obtained from the respondents are presented in this chapter in tables and in figures. This chapter investigates the properties of the data employed in this study by conducting descriptive statistics of green gram farmers' demographic information, an analysis of the variables, so as to understand the relationships among variables. Also, the data series are tested by correlation analysis to check for relationship among variables, for better understanding of how the study variables are related. To get the independent variables effect on the dependent variable, a linear regression model was used.

4.2 Research Response Rate

Based on the sample size, 142 questionnaires were disseminated to respondents for filling. Out of these, only 128 were dully filled and thus deemed fit for use for analysis. This represented a 90% response percentage. Mugenda & Mugenda (2003) recommend that from the survey response, 50% response proportion and above is satisfactory and that 70% is excellent. For this study, a 90% response rate was deemed sufficient for statistical analysis.

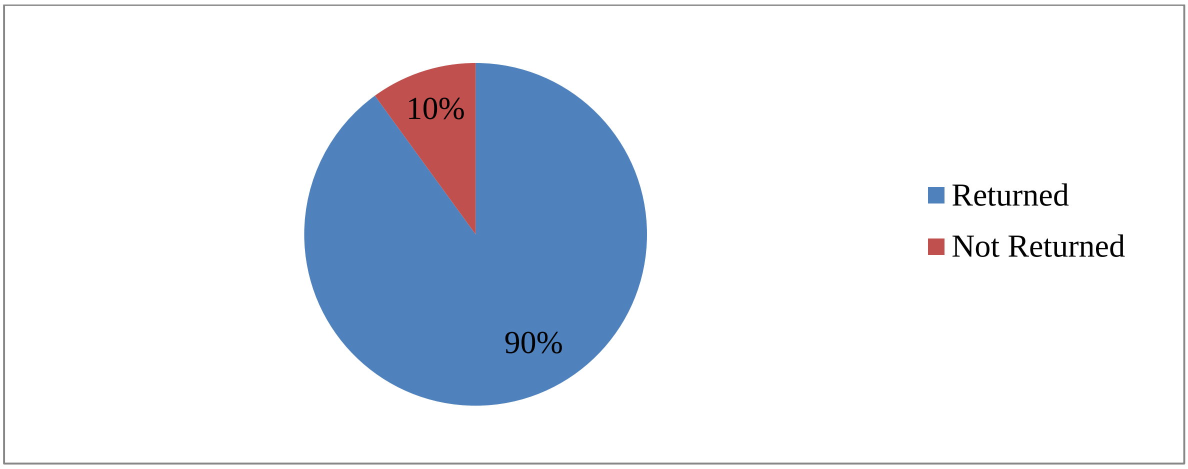

Figure 4: Pie Chart representing Questionnaire Response Rate

4.3 Reliability Statistics

To perform a reliability statistics on the study variables, the researcher used the Cronbach's Alpha coefficient. This technique of evaluating reliability compares the level of shared variance or covariance, amongst the different items that consist of a research instrument to the aggregate of overall variance. For the research instrument to be credible, there ought to be a lot of covariance in the midst of the items in relation to the variance. Cortina (1993) indicate that a Cronbach's alpha of .70 and above is considered good, .80 and above is considered better, and .90 and above is considered excellent. The Cronbach's Alpha value was established to be 0.883. This is a good value and it was acceptable.

Table 4.1: Reliability Test

Variable	Number of Items	Cronbach's Alpha	
PerceivedEaseofUse	3	.863	Good
BehavioralIntention	3	.791	Acceptable
Attitude	3	.725	Acceptable
PerceivedUsefulness	3	.714	Acceptable
ActualSystemUse	3	.768	Acceptable

4.4 Validity Test

A valid instrument is one that can measure what is intended to be measured or desired. This study's research instrument was a questionnaire. One dependent variable was predicted using three independent variables and one intermediary. Pearson Product Moment Correlations in SPSS were used to test the research instrument's validity. The Product Moment Pearson Correlations validity test was performed by connecting each item in the questionnaire with the total score. The significance level was 5%. The table below shows the results. According to Azwar (2001), the questionnaire is valid if the items formed a single entity. Pearson Product Moment is interpreted as valid if the Pearson correlation value on each item > 0.3. In this study, the correlation score on each item with a total score were in the range 0.540 to 0.614

Table 4.2: Validity Test

Criteria	R Counted N = 128
PerceivedEaseofUse	0.540
BehavioralIntention	0.614
Attitude	0.575
PerceivedUsefulness	0.580
ActualSystemUse	0.558

4.5 Demographic Information

Demographic data regarding green gram farmers was collected in this study. The results are given below.

4.5.1 Gender of Respondents

The data results brought out that most of the green gram farmers in Mwala were female with a representation of 84 farmers being female while 44 farmers were male. This information is represented by 66% female representation while male was only 34%. This is due to the fact that there are more women involved in agriculture in Kenya than men. This is evident in the study carried out by World Bank (2011) where they found out that more than 80% as table represents.

Table 4.3: Gender of the Respondents

Gender	Frequency	Percentage
Male	44	34
Female	84	66
TOTAL	**128**	**100**

4.5.2 Age of Respondents

From the findings, the researcher found out that the least representation were farmers aged between 18 to 24 years with that age group being represented by only 7% (n=9). This is evident in that a lot of youth in the country or in the area do not engage in farming as an activity. Farmers aged between 25 to 35 years were represented by 25% (n=32), while the bigger percentage was farmers aged between 36 to 45 years old 55% (n=70). This is the age at which most people would consider green gram farming not only as a way to make money but also because they need to feed and sustain their families. Farmers above 46 years were represented by 13% (n=17). This is because at that age green gram farming is very time consuming and tiresome for people above that age to participate in. The information is represented below.

Table 4.4: Age of the Respondents

Age	Frequency	Percentage
18-24 Years	9	7
25-35 Years	32	25
36-45 Years	70	55
Above 46 Years	17	13
TOTAL	**128**	**100**

4.5.3 Green Gram Farming

The study aimed to investigate how long the farmers had participated in green gram farming. The study results disclosed that most farmers had practiced green gram for five to ten years. This represented almost half of the population with 43% (n=56) of the farmers falling under this category. This is because most of the farmers Mwala started growing green grams recently after the popularization of green grams in the country. Farmers who had farmed green grams between 0 to 5 years were represented by 37% (n=47). Farmers who had farmed for 10 to 15 years were represented by 16% (n=20) and lastly only 4% (n=5) of the farmers had farmed for more than 15 years as represented below.

Table 4.5: Green Gram Farming

Years	Frequency	Percentage
0-5 Years	47	37
5-10 Years	56	43
10-15 Years	20	16
Over 15 Years	5	4
TOTAL	**128**	**100**

4.5.4 Education Qualification of Respondents

The results indicated that most farmers had education up to primary level and this was represented by 35% of the total population while farmers with education up to secondary level were represented by 31%. This is because less expertise is needed in green gram farming. Farmers with a certificate or a diploma were represented by only 17% while farmers with education up to undergraduate level were represented by 11%. The least representation was from farmers who had education qualifications of up to post-graduate level with only a 6% of the population representing this as shown below.

Table 4.6: Education Qualifications of Green Gram Farmers

Qualification	Frequency	Percentage
Primary	45	35
Secondary	40	31
Certificate/Diploma	22	17
Undergraduate	14	11
Post-Graduate	7	6
TOTAL	**128**	**100**

4.5.5 ICT Devices Owned and Advisories

The study asked respondents what ICT devices they owned or used to facilitate information receiving regarding green gram farming. The results revealed that most green gram farmers own mobile devices with an 83% representation (n=106), 4% (n=5) owned a desktop computer, 9% (n=12) of the farmers owned laptops while 4% (n=5) of the farmers in the region owned a tablet.

The farmers were also asked if they receive any extension information or agronomic advisories regarding green gram production. The results showed that only 74% (n=95) received extension information and or agronomic advisories regarding the produce of green grams. From the 74% who received information on green gram production most farmers noted that they receive information through SMS at 42% (n=40), radio at 32% (n=30), television at 16% (n=15), WhatsApp 7% (n=7) and website 3% (n=3). This is because many agricultural firms find it appropriate to advertise and share information through Radios and TVs because they can reach a lot of farmers through that.

KSCAP has also over the years implemented bulk SMS systems to send messages to farmers. This in turn has promoted adoption of mobile phones. Green gram farmers in the region receive information through the use of SMS. This is possible because of the bulk SMS systems being used by some agricultural firms and companies to reach their customers and clients. Few farmers accessed information via website and WhatsApp due to internet connections issues and the fact that there exists a language barrier between the farmer and the broadcasting of information through websites. Most farmers indicated they would like to receive the advisories and information in languages that they can comprehend easily that's why most suggested wanting to receive the information through their native language 47% (n=45), although that was made possible because of radio and TVs because most spoke the native language. Few farmers suggested that they would like to receive the information in English and Kiswahili at 35% (n=33) and 18% (n=17) respectively.

Lastly farmers were asked the frequency of receiving these advisories/ extension services. Most farmers reported receiving them weekly at 43% (n=41) and once in two weeks 33% (n=32). This is as a result of the advertisement costs which would make it impossible for daily sharing of information. A small group of farmers reported receiving monthly, 13% (n=12) or once in two months 11% (n=10) information and these are the farmers who would only receive information through planned seminars or planned mass education forums on green grams production as the table represents.

Table 4.7: Use of ICT Platforms

		Frequency	**Percentage**
ICT Device Owned	Mobile phone	106	83
	Desktop Computer	5	4
	Laptop	12	9
	Tablet	5	4
Receiving Extension Information	Yes	95	74
	No	33	26
Method of receiving	SMS	40	42
	Radio	30	32
	Television	15	16
	WhatsApp	7	7
	Website	3	3
Challenges Encountered	Internet connectivity	40	42
	They charge to access information	25	26
	Language barrier	30	32
Language Preferred	English	17	18

	Kiswahili	33	35
	Native	45	47
Frequency of Receiving	Weekly	41	43
	Once in two weeks	32	33
	Monthly	12	13
	After 2 months	10	11

4.6 Perceived Usefulness

Results on perceived usefulness of the ICT systems use by green gram farmers in Mwala is shown in below table.

Table 4.8: Perceived usefulness of ICT systems

	N	Mean	Std. Deviation
Using ICT systems has enabled you easily access accurate weather information?	128	4.2031	1.42176
Using ICT systems has enabled you easily access accurate plant pest and disease information?	128	3.8125	1.37325
Using ICT systems has enabled you easily access accurate post-harvest information?	128	4.2969	1.48143
Valid N (listwise)	128		

From the table farmers agreed to the statement that using ICT systems has enabled them to easily access accurate weather information with a mean of 4.2031 and a standard deviation value of 1.42176. Farmers were also questioned on how ICT systems had helped them easily access accurate plant pest and disease information. The responses represented agreement with a mean value of 3.8125 and a standard deviation value of 1.37325. Lastly farmers were asked to respond to how ICT systems had enabled them to access accurate post-harvest information. The farmers’ responses were represented by a mean of 4.2969 and a standard deviation value of 1.48143 which showed agreeing to the statement.

Table 4.9: Perceived Usefulness and Actual System Use

		PerceivedUsefulness	ActualSystemUse
PerceivedUsefulness	Pearson Correlation	1	.784**
	Sig. (2-tailed)		.000
	N	128	128
ActualSystemUse	Pearson Correlation	.784**	1
	Sig. (2-tailed)	.000	
	N	128	128

**. Correlation is significant at the 0.01 level (2-tailed).

The study also established the impact of perceived usefulness on the actual use of ICT systems using Pearson's correlation. The correlation coefficient was established to be 0.784. This means that perceived usefulness of an ICT system by the users will have a 78.4% effect on the actual implementation and use of the ICT system.

4.7 Perceived Ease of Use

Responses on perceived ease of use of the ICT systems farmers used in Mwala were encoded into SPSS and are shown as below.

Table 4.10: Perceived Ease of Use of ICT Systems

	N	Mean	Std. Deviation
Use of local language encourage youth and women use ICT platforms	128	4.3203	1.53661
Training on use on ICT systems encourage youth and women use ICT platforms	128	3.1797	1.50293
Making ICT equipment affordable encourage youth and women use ICT platforms	128	4.1687	1.54174
Valid N (listwise)	128		

It is evident in the table above that farmers agreed that the use of local language encourage youth and women to use ICT platforms. This statement was represented by a mean of 4.3203 and a standard deviation value of 1.53661. Farmers were also questioned if training on how to use ICT systems encouraged youth and women to use the ICT systems. This statement was represented by a mean value of 3.1797. This means that farmers were undecided on the statement. This is because of other constraints that would limit the use of the ICT platforms like illiteracy and internet connectivity issues. Lastly farmers were questioned on if making the

ICT equipment affordable would encourage youth and women to use ICT platforms. Farmers in Mwala were in agreement to this which returned a mean value of 4.1687 and a standard deviation value of 1.54174.

Table 4.11: Perceived Ease of Use and Actual System Use

		PerceivedEaseofUse	ActualSystemUse
PerceivedEaseofUse	Pearson Correlation	1	.860**
	Sig. (2-tailed)		.000
	N	128	128
ActualSystemUse	Pearson Correlation	.860**	1
	Sig. (2-tailed)	.000	
	N	128	128

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation coefficient was established to be 0.860 as shown in the table above. Perceived ease of use therefore has an 86% impact on actual use of a system.

4.8 Behavioral Intention

The researcher also asked the farmers if they intended to continue using ICT platforms in green gram farming through the study results shown below.

Table 4.12: Behavioral Intention of ICT Systems

	N	**Mean**	**Std. Deviation**
I will continue to use ICT systems in the future	128	2.1797	1.57457
I would use ICT systems anytime in my farming	128	2.9609	1.45484
I plan to use ICT platforms anytime in my farming	128	3.1328	1.13103
Valid N (listwise)	128		

The results from the study showed that farmers disagreed on whether they will continue to use ICT systems in the future represented by a mean value of 2.1797 and a standard deviation value of 1.57457. Farmers were however neutral to the use of ICT systems at any time in their farming activities represented by a mean value of 2.9609 and a standard deviation value of 1.45484. Lastly farmers were undecided on whether they plan to use ICT platforms in their farming activities represented by a mean value of 3.1328 and a standard deviation value of 1.13103.

Table 4.13: Behavioral Intention and Actual System Use

		BehavioralIntention	ActualSystemUse
BehavioralIntention	Pearson Correlation	1	.324**
	Sig. (2-tailed)		.000
	N	128	128
ActualSystemUse	Pearson Correlation	.324**	1
	Sig. (2-tailed)	.000	
	N	128	128

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation coefficient was established to 0.324. This means that Behavioral intention will impact actual system use at 32.4%. This is evident as shown in the table above.

4.9 Attitude towards use of ICT Systems

The results from farmers on their attitude aspects were towards ICT systems in enhancing productivity of green grams are summarized table below.

Table 4.14: Attitudes towards the use of ICT systems

	N	**Mean**	**Std. Deviation**
Using ICT systems has helped you access input markets easily	128	4.4531	1.48409
Using ICT systems has helped you to get better prices for your green grams	128	3.2656	1.31906
Using ICT systems has helped you access supply and demand information of green grams easily	128	3.0938	1.50818
Valid N (listwise)	128		

The farmers agreed that the use of ICT systems has helped them access input market easily. This statement was represented by a mean value of 4.4531 and a standard deviation value of 1.48409. Farmers were however undecided with the statement that ICT systems have helped them get better prices for their green grams displayed by a mean value of 3.2656 and a standard deviation value of 1.31906. Farmers were also undecided with the statement that using ICT systems has helped them access supply and demand information on green grams easily represented by a mean value of 3.0938 and a standard deviation value of 1.50818.

Table 4.15: Attitude and Actual System Use

		Attitude	ActualSystemUse
Attitude	Pearson Correlation	1	.630**
	Sig. (2-tailed)		.000
	N	128	128
ActualSystemUse	Pearson Correlation	.630**	1
	Sig. (2-tailed)	.000	
	N	128	128

**. Correlation is significant at the 0.01 level (2-tailed).

The Pearson correlation coefficient between Attitude and actual system use was 0.630 meaning. This means that the attitude towards an ICT system will affect actual system use at the rate of 63%.

4.10 Actual Use of ICT Systems

Lastly the farmers were required to answer questions how using the ICT systems had impacted productivity of their green gram farming in the region and responses are presented as below.

Table 4.16: Actual Use of ICT Systems

	N	**Mean**	**Std. Deviation**
Using ICT systems has helped decrease cost of production of green gram farming	128	4.1016	1.53613
Using ICT systems has helped increase output (increase yield) of green grams	128	4.3594	1.39591
Using ICT system has helped increase the income you get from green gram farming	128	4.0076	1.45721
Valid N (listwise)	128		

From the table above, the research concluded that farmers agreed that the use of ICT systems has helped decrease the cost of production of green gram farming with a returned mean value of 4.1016 and a standard deviation value of 1.53613. Farmers in Mwala also agreed that use of ICT systems facilitated them increase the output or yield of green grams by a mean value of 4.3594 and a standard deviation value of 1.39591. Lastly the farmers agreed that the use of ICT systems has helped increase the income generated from green gram farming represented by a mean of 4.0076 and a standard deviation value of 1.45721.

4.11 Regression Analysis

To find the relationship amongst the study variables, a multiple linear regression model was used.

Table 4.17: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.900[a]	.809	.803	.51003

a. Predictors: (Constant), Attitude, PerceivedUsefulness, BehavioralIntention, PerceivedEaseofUse

The model summary presents the independent variables impact in predicting the dependent variable. The R value is 0.900 which shows the relationship amongst the dependent variable and the independent variables. The summary returned an R squared value of 0.809. Therefore, the three independent variables and one intermediary variable in this study can explain an 80.9% of the dependent variable variation. Thus, the attitude towards the use of ICT systems, the perceived usefulness of the ICT systems and platforms, the behavioral intention of the farmers concerning use of ICT platforms and the platform or system's perceived ease of use shall have a substantial effect on the actual use of the ICT platform or system.

Table 4.18: ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	135.949	4	33.987	130.656	.000[b]
	Residual	31.996	123	.260		
	Total	167.944	127			

a. Dependent Variable: ActualSystemUse

b. Predictors: (Constant), Attitude, PerceivedUsefulness, BehavioralIntention, PerceivedEaseofUse

From the results above, the P value which is 0.000 demonstrates the significance level. This means that the significance level is <0.05 and therefore, the study results are relevant. The F value is 130.656 which is greater than 1. This signifies an improvement in the variable prediction by fitting the model after bearing in mind the inaccuracy present.

Table 4.19: Coefficients Table

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	.231	.152		1.520	.131
	PerceivedUsefulness	.288	.055	.317	5.229	.000
	PerceivedEaseofUse	.666	.068	.632	9.771	.000
	BehavioralIntention	-.168	.043	-.198	-3.875	.039
	Attitude	.132	.064	.130	2.082	.000

a. Dependent Variable: ActualSystemUse

The following model was adopted $Y= \alpha+\beta_1X_1+ \beta_2X_2+ \beta_3X_3+ \beta_4X_4 + \varepsilon$

Where: Y = Actual system use (Dependent variable)

α = Constant term, normally distributed to a mean of 0 for computation purposes

X_1 = Perceived usefulness (Independent variable 1)

X_2 = Perceived ease of use (Independent variable 2)

X_3 = Behavioral intention (Intermediate variable)

X4 = Attitude towards using system (Independent variable 3)

The following equation was established from the study results

Y= 0.231+0.288+0.666+ (-0.168) + 0.132

The Table 4.19 above shows the study's variables correlation coefficients with the results displaying the relationship strength. From the results the p values for the variables were perceived usefulness was less than 0.05 meaning the variable is significant in predicting actual system use. The p value of perceived ease of use was also less than 0.05 and this showed that the variable was significant in predicting the dependent variable. The p-value of behavioral intention was above 0.05 and this means the variable was not significant in predicting the dependent variable. The p value of attitude was less than 0.05 in and this meant that the variable was significant predicting the dependent variable.

From the results the value of perceived usefulness of ICT systems has a noteworthy impact on the actual use of ICT systems. This is due to the fact that significance is below 0.05. An improvement in perceived usefulness of ICT systems will help improve the actual use of ICT systems by 0.288. This means that perceived usefulness would have a 0.288 impact on actual system use. A research conducted by Teo et al. (2008) where the study found out that people viewed ICTs as beneficial in carrying out their jobs when they perceived the time spent on their jobs could be reduced and job performances improved using ICTs.

An improvement in the ICT systems perceived ease of use would cause an improvement in the actual use by a value of 0.666. This would impact actual system use by 0.666. Eze et al., (2021) study in Nigeria discovered a positive significant relation between ICT support and use. Teachers' attitude, perceived usefulness and perceived ease of use are positive partial mediators to ICT support and use. Daryanto et al., (2019) study brought out that ICTs ease of use perception indirectly affected stakeholder services quality in West Java Region Vocational High Schools.

A study conducted in Bangladesh about application of the TAM model assessing ICT preferences and use amongst field-level extension officers by Habir et al., (2022) found out that factors like ICTs perceived usefulness had a positive influence on the extension employees' intended use of ICT-based IT systems. Attitude affects the dependent variable at 0.132. This shows that an improvement in attitude in would impact actual use of systems at that value. This means that attitudes significantly impact actual system use. Previous studies have been conducted about attitude and actual system use. Wu et al., (2017) study found out that both teachers and students yearn using ICT devices in the classroom. Millennials are acquainted with ICT tools and do not need any instructions on using them. Teachers must frequently capitalize on time and effort when incorporating ICTs with teaching (Baron & Harrari 2005). Teachers anticipate to receive supplementary workplace training curricula that feature ICTs use in class (Kalogiannakis, 2010). Enhancing teachers' beliefs and confidence in ICTs use in class is considerably crucial (Prestridge, 2012).

Bariu & Chun (2022) study on teachers' attitude on implementation of ICT in Kenyan universities. The study discovered that attitudes among teachers influenced ICT deployment significantly. As a result, instructors require encouragement and support by providing suitable refresher training courses and infrastructure providing them with skills and knowledge, which ultimately impacts their attitude towards ICT. Sánchez et al. (2012) evaluated in-service teachers from kindergarten through high school opinions concerning ICT and its use in the classroom. The findings showed that participants had favorable sentiments towards ICT use of as a teaching instrument. These findings are consistent with Yu and Yang's (2006) earlier research findings. The high tendency to use technology divergences to the actual ICT use in the classroom, where teachers report hardly ever using them on a frequent basis.

CHAPTER FIVE

RESEARCH SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The chapter brings out the summary of the research study findings, provides conclusions drawn from the study findings and gives recommendations to farmers and ICT experts.

5.2 Summary of Study Findings

The research aimed to assess ICT systems on green gram productivity using a case of Kenya Climate Smart Agriculture Project (KCSAP) in Mwala Sub-County, Kenya. Most of the green gram farmers in the region were female with a representation of 84 farmers being female while 44 farmers were male. This information was represented by 66% female representation while male was only 34%. The study also found out that found out that the least representation were farmers aged between 18 to 24 years with that age group being represented by only 7%. Farmers aged between 25 to 35 years were represented by 25%, while the majority were between 36 to 45 years old with a representation of 55%. Farmers above 46 years were represented by 13%.

Results from the study showed that most farmers had practiced green gram for five to ten years. This represented almost half of the population with 43% of the farmers falling under this category. Farmers who had farmed green grams between 0 to 5 years were represented by 37%. Farmers who had farmed for 10 to 15 years were represented by 16% and lastly only 4% of the farmers had farmed for more than 15 years. Most farmers in Mwala had education up to primary level and this was represented by 35% of the total population while farmers with education up to secondary level were represented by 31%. Farmers with a certificate or a diploma were represented by only 17% while farmers with education up to undergraduate level were represented by 11%. The least representation was from farmers who had education qualifications of up to post-graduate level with only a 6% of the population representing this.

The study also found out that only 74% (n=95) received extension information and or agronomic advisories regarding the produce of green grams. From the 74% who received information on green gram production most farmers noted that they receive the information through SMS at 42% (n=54), radio at 32% (n=41), television at 16% (n=20), WhatsApp 7% (n=9) and website 3% (n=4).

The study results revealed that the biggest percentage of farmers used mobile devices with an 83% representation (n=106), 4% (n=5) owned a desktop computer, 9% (n=12) of the farmers owned laptops while 4% (n=5) of the farmers in Mwala Sub-County owned a tablet. The research results also showed that farmers would like to receive the advisories and information in languages that they can comprehend easily a most suggested wanting to receive the information through their native language 47% (n=60), with those who preferred Kiswahili 35% (n=45) and English 18% (n=23). The study also found out most farmers reported receiving them weekly at 43% (n=55), once in two weeks 33% (n=42), monthly 13% (n=17) and 11% (n=14) once in two months information.

5.3 Study Conclusions

To conclude, most of farmers in Mwala Sub-County practicing green gram farming are female. This is an outcome of a long feminization process of on the agriculture sector. The study also concludes that most farmers in the region are 36 years of age and above. This is because farming is mostly practiced to sustain and bring up families in the region and across the country. This farming will help families achieve basic needs from consumption of produced goods to selling of produced good to achieve other basic needs. The researcher also concludes that the use of ICT systems to share extension information and agronomic services is helpful to farmers during production of green grams. The use of SMS, Radios and Televisions have proved helpful in disseminating information to green gram farmers in the region and that information has proved very important and as a result has increased productivity of green gram in the region.

Additionally, perceived usefulness of an ICT system or platform by a farmer will affect how farmers adopt and actually use the ICT systems in farming. This means that a farmer has to perceive an ICT system as being useful before he or she embraces using the system or platform. The study also concluded that the ICT system or platform perceived ease of use has an impact on the actual use of a system. This means that how easy a farmer perceives an ICT platform to be easy to use has an effect on how the farmer actually. This means that promoting meaningful actual use of ICT systems will have to start by ensuring that the systems are easy to use. Again the study concludes that the attitude of a farmer will have an impact on how actual ICT systems are used. This means that farmers need to understand what the intended benefits of using ICT systems are. In conclusion the use of ICT systems have helped play a big part in increasing the productivity of green gram. From dissemination of information, to information sharing from experts and agronomists, to having a better understanding of the weather plan and providing better markets for green gram farmers, the use of ICT systems in practicing of green gram farming has proved very important and helpful.

5.4 Recommendations

Green gram farming in the region is among the activities that provide sustainability and support families to achieve basic needs. The study provides below recommendations.

5.4.1 Recommendations to Farmers

The researcher would like to recommend that farmers in the region to encourage the youth to participate in the farming of green grams. The youth in the area are not well represented in the farming of green grams and this is as a result of lack of lands and funds as well as lack of involvement in farming practices. The youth in the area also need to understand that farming is an activity that one can make a living out of so that they can stop diminishing the activity and perceiving it as an old fashioned activity.

The researcher would also recommend to farmers in Mwala Sub-County to embrace ICT systems use in the green grams farming. The use of ICT systems have shown tremendous improvements in the farming sector especially when it comes to increased productivity. The farmers who have integrated ICT systems in farming green grams in Mwala have an increase in green grams productivity after embracing these ICT systems showing that these systems have been helpful to them.

5.4.2 Recommendations to ICT experts

The researcher would like to recommend to the ICT experts to develop systems and platforms that are easy to use so that farmers can have ease of use. Again developers in the ICT field should try and come up with platforms that use native languages to disseminate information to farmers. This would make it easier to break the language barrier that exists between the platforms and farmers. The developers should also conduct trainings in such areas to farmers so that farmers can be trained on how to use the platforms and how to make sure that they maximize the use of these systems to maximize profits. ICT technologies are very dynamic and experts should also try to keep up with the trends in the farming sector.

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APPENDICES

Appendix I: Introduction Letter

Samson Machohi Wahito

P.O BOX 57811-00200,

Nairobi.

Date: ____________

The respondents,

Dear Sir/ Madam,

REF: PARTICIPATION IN RESEARCH

I am a postgraduate student at the University of Nairobi pursuing a Master of Science in Information Technology Management. I am conducting research on the **"Assessment of ICT Systems on Green Gram Productivity: A Case of Kenya Climate Smart Agriculture Project in Mwala Sub-County, Kenya"**

I am kindly asking you to assist me to collect data for the study by filling in the attached questionnaire. Please give your responses as per the questionnaire items and comment in the given spaces where applicable. Do not write your name or identity on this questionnaire.

Thank you.

Yours faithfully,

Samson Machohi Wahito

Appendix II: Project Schedule

The figure below shows a Gantt chart for the project schedule.

Activity 2023	**Jan–March**	**March**	**April**	**May**	**June - July**
Proposal writing					
Proposal presentation					
Data collection exercise					
Data analysis and documentation					
Project presentation					

Figure 5: Project Schedule

Appendix III: Project Budget

The table below shows a budget for the proposed research.

Activity	**Budget (KES)**
Proposal development (Library search, travelling expenditure by researcher)	2,000
Designing research instruments and loading them to ODK	10,000
Research permit	1,000
Pilot study	20,000
Main field data collection process	120,000
Data analysis and interpretation and thesis writing	20,000
Project documentation and printing	25,000
Purchases (Flash disk, Stationery)	4,000
Miscellaneous	5,000
Total	**207,000**

Table 1: Project Budget

Appendix IV: Questionnaire

Kindly answer the following questions by ticking in the appropriate box or filling the spaces provided. Information obtained will be used for academic purposes only and will therefore be handled with the highest level of confidentiality. Your corporation will be highly appreciated.

Section A: Respondent Details and Bio-Data

1. Please indicate your gender
   Male [ ]   Female [ ]
2. Indicate your age bracket

18-24 years [ ]   25-35 years [ ]   36-45 years [ ]   Above 45 years [ ]

3. How long have you been a green gram farmer?

0-5 years [ ]   5-10 years [ ]   10-15 years [ ]   Over 15 years [ ]

4. To date, what has been your highest formal qualification?

Primary School Level [ ]   Secondary School Level [ ]   Certificate/ Diploma [ ]

Undergraduate [ ]   Post graduate level [ ]   Other (Specify)……………

5. Which ICT device(s) do you own?

Smart phone [ ]   Feature phone [ ]   Desktop Computer [ ]
Laptop [ ]   Tablet [ ]   Other (specify)...........................

6. Do you receive any extension information or agronomic advisories regarding green gram production?   Yes [ ]   No [ ]
7. If yes, which method?

SMS [ ]   USSD [ ]   Website [ ]   Mobile apps [ ]   Facebook [ ]   WhatsApp [ ]
Email [ ]   Radio [ ]   Television [ ]   Call Center [ ]   Other (specify)........... Rank priority

8. Which challenges do you face when accessing these systems?

Internet connectivity [ ]   They charge to access information [ ]
Language barrier [ ]   Other (specify) ………………………………

9. Which language do you like to receive agronomic advisories?

English [ ] Kiswahili [ ] Other language (specify)...

10. Frequency of receiving these advisories/ extension services

Weekly [ ] Once in two weeks [ ] Monthly [ ] After 2 months [ ]

Section B: Perceived usefulness

11. To what degree do you concur with these aspects of perceived usefulness of using ICT systems in enhancing green gram productivity? Using a scale from 1 to 5 where 1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree and 5= Strongly Agree.

	Perceived Usefulness Statement	**5**	**4**	**3**	**2**	**1**
i)	Using ICT systems has enabled you access accurate weather information easily?					
ii)	Using ICT systems has enabled you access accurate plant pest and disease information easily?					
iii)	Using ICT systems has enabled you to easily access accurate post-harvest information easily?					

Section C: Perceived Ease of Use

12. To what degree do you concur with these aspects of Perceived Ease of Use of using ICT systems in enhancing green gram productivity? Using a scale from 1 to 5 where 1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree and 5= Strongly Agree.

	Perceived Ease of Use Statement	**5**	**4**	**3**	**2**	**1**
i)	Use of local language encourage youth and women use ICT platforms					
ii)	Training on use on ICT systems encourage youth and women use ICT platforms					
iii)	Making ICT equipment affordable encourage youth and women use ICT platforms					

Section D: Behavioral Intention

13. To what degree do you concur with these aspects of Behavioral intention of using ICT systems in enhancing green gram productivity? Using a scale from 1 to 5 where 1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree and 5= Strongly Agree.

	Behavioral Intention Statement	**5**	**4**	**3**	**2**	**1**
iv)	I will continue to use ICT systems in the future					
v)	I would use ICT systems anytime in my farming					
vi)	I plan to use ICT platforms anytime in my farming					

Section E: Attitude towards using system

14. To what degree do you concur with these aspects of Attitude towards using ICT systems in enhancing green gram productivity? Using a scale from 1 to 5 where 1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree and 5= Strongly Agree.

	Attitude towards using system Statement	**5**	**4**	**3**	**2**	**1**
i)	Using ICT systems has helped you access input markets easily					
ii)	Using ICT systems has helped you to get better prices for your green grams					
iii)	Using ICT systems has helped you access supply and demand information of green grams easily					

Section E: Actual System Use

15. To what degree do you concur with these aspects of Actual system use of ICT systems in enhancing green gram productivity? Using a scale from 1 to 5 where 1= Strongly Disagree, 2= Disagree, 3= Undecided, 4= Agree and 5= Strongly Agree.

	Actual System use Statement	**5**	**4**	**3**	**2**	**1**
i)	Using ICT systems has helped decrease cost of production of green gram farming					
ii)	Using ICT systems has helped increase output (increase yield) of green grams					
iii)	Using ICT system has helped increase the income you get from green gram farming					

Thank you for taking the time to complete this questionnaire!