

**INFLUENCE OF ICT FACTORS ON MANGO VALUE CHAIN IN MAKUENI COUNTY,  
KENYA**

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**A PROJECT SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR  
THE AWARD OF MASTER OF ARTS DEGREE IN MONITORING AND EVALUATION  
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DECLARATION AND APPROVAL

Declaration

This thesis project is my original work and has never been presented for any academic award in any institution.

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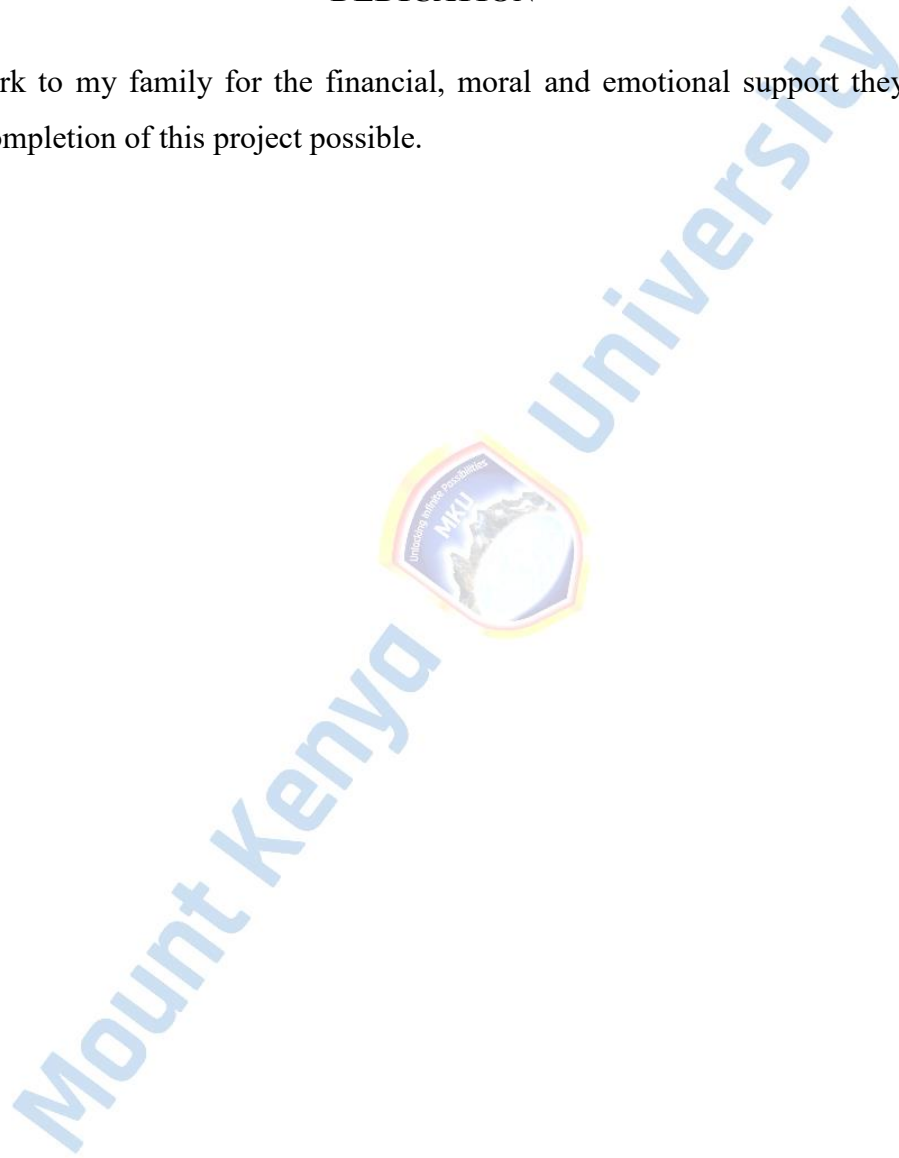
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## **DEDICATION**

I dedicate this work to my family for the financial, moral and emotional support they offered to me which made the completion of this project possible.



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I take this opportunity to thank God for strength, good health, sobriety and provisions during this course. Am grateful to my family for creating a conducive working environment for me that made the research work possible. I appreciate Joseph Kiselu farm for providing valuable information on mango value chain that was helpful for this study.

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## ABSTRACT

This study assessed the extent to which ICT is used in Makueni county by the people involved in the mango value chain. ICT use improves effectiveness of communication and access to services in agriculture. This research will help the county administrators to know which ICT gadgets are popular, why and how they can implore upon stakeholders in the value chain to improve on their application. The researcher focused on the factors such as cost, availability of ICT infrastructure, farm factors, personal factors affecting the use of ICT and sought find out whether there are inhibiting issues that influence its application in the value chain. The study also focused on the extent ICT is used by the county government to reach stakeholders and support them and investigated whether personal factors affected use of ICTs and the effect they have on performance of the value chain. During the study PRA&ME approach was used with a structured questionnaire to reach to the respondents who narrated the challenges that prevent beneficial use of ICTs in the value chain. Stakeholders such as farmers, marketers, distributors, transporters, processors, the county government agricultural policy makers as well as other researchers were involved. The study used descriptive research where the main tool used to collect data was a structured questionnaire. Alongside the questionnaire, other methods including face-to-face interviews, observation and documentary reviews were used to complement the questionnaire. The researcher sampled 387 respondents; including 378 respondents involved in the value chain and 9 agricultural extension officers from the nine sub counties from Makueni county. Once the questionnaires were completed, they were scrutinized for accuracy, validity and consistency. The follow up after the administration of the data collection tool was done keenly to ensure their return rate was high. Data analysis was done using SPSS to obtain the descriptive statistics including the mean, standard deviation, frequencies, comparison of means and percentages. The hypothesis was tested at 95% and ascertained the validity of the premises made, that use of ICTs in the value chain improved incomes and profit levels. The use of ICT assisted in accessing information on availability seedlings, access to farm chemicals, agricultural extension services and transport services of mangoes to the markets. It was also established that it helped to access information on price levels in the markets easily, faster and globally. The researcher also established that the county was widely covered with ICTs network & had sufficient ICTs infrastructure. Notably ICT cost factors were not too prohibitive to the participants in the value chain and stakeholders procured ICTs for use in their roles in the value chain, it was found out that 100% of the respondents possessed the electronic gadgets. The extensive use of ICTs influenced the levels of output, incomes and profitability in the value chain positively. It was realized that older respondents used older technology gadgets, more females were involved in the value chain and less educated respondents were involved in it than the more educated were. The reports and narratives were presented using tables and graphs to guide the researcher on the decisions and conclusions made based on the findings from the data collected. The researcher also deduced from the responses given by the agricultural extension officers as key informants that ICT application was affecting mango value chain positively, improving production, incomes and profitability. They also indicated that the stakeholders are receptive to the new technologies. Additionally, it was found that

county government and ICT department supported stakeholders and it was the reason for more application of the ICTs in the value chain.

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## **LIST OF ABBREVIATIONS AND ACRONYMS**

**ASK-** Agricultural Society of Kenya

**CAO-** County Agricultural officer

**CAK-** Communications Authority of Kenya

**CBA-** Cost Benefit Analysis

**CE-** County Executive

**ERP-** Enterprise Resource Planning systems.

**FAO-** Food and Agricultural Organization

**FTF-** Feed The Future

**GDP** – Gross Domestic Product

**GIS-** Geographical Information System

**GoK** – Government of Kenya

**GPRS-** Geographical Positioning and Remote Sensing

**GPS-** Global Positioning System

**HCDA-** Horticultural Development Authority

**ICT-** Information communication Technology

**ICT4D-** Information Communication for Development

**ICTs** – Information communication technologies

**IoE-** Internet of Everything

**IoT-** Internet of Things

**KALRO-** Kenya Agricultural and Livestock Research Organization

**KIPPRA** – Kenya Institute of Public Policy Research and Analysis

**KMs-** Kilometers

**KNBS** – Kenya National Bureau of Statistics

**M&E-** Monitoring and evaluation

**MIS-** Management Information Systems

**MMS-** Multi Media Service

**NGOs-** Non-Governmental Organizations

**PA-** Precision Agriculture

**PRA-** Participatory Rural Appraisal

**R&D** – Research and Development

**SDGs-** Sustainable Development Goals

**SMS-** Short Mail Service

**SPSS-** Statistical Package for Social Science

**USAID-** United States Agency for International Development



# CHAPTER ONE

## INTRODUCTION

### 1.1 Background of the study

Agriculture is becoming knowledge intensive and therefore farmers around the world need to use ICT to easily and broadly access information about markets, extension support services, finances, farm machinery & implements, fertilizers, pesticides, herbicides etc. Since mangoes are highly prone to insect infestation and are highly perishable the farmers will find ICT handy to use in the value chain. The farmer through use of ICT will be able to integrate local and hyperlocal knowledge in the mango value chain. Generally, Information Communication for Development (ICT4D) is recommended for use in all sectors of the economy to improve effectiveness and efficiency of service delivery.

ICTs have increased in terms of modes and connectivity they are popularly used because they improve speeds service delivery, improves accuracy of transactions, makes services delivered to increase in volumes, it enables communication to a wide range of farmers and other stakeholders concurrently and it promotes personalization of agricultural extension services support. Over the past four decades information communication technology (ICT) has proven to be a tremendous accelerator of economic and social progress. ICTs include; mobile phones, Radios, GPS & GIS equipment, Televisions, faxes, fixed line telephony, Emails, social media.

With the wide spread of mobile telephony networks, use of ICT in the agricultural sector is happening. The increased application of ICT in production of mangoes increases efficiency and speed of service delivery, makes decision making process fast and effective, increases access to markets and reduces costs of operation. Today the world is using technologies such as cloud computing, data warehousing, big data, internet of things (IoT) and internet of everything (IoE) to increase efficiency and effectiveness through remote controlling of machines and implements.

Agricultural production needs to increase to guarantee food security and eradicate poverty among the population all over the world. The world population is expected to grow to 9 billion by 2050, according to [www.geopoll.com](http://www.geopoll.com), this means the level of food production including fruits and food crops will have to increase to cater for the rapidly growing populace. The world governments are working together in programs such as feed the future (FTF) to ensure the global population is fed and it is food sufficient.

Fruits and food crops are important in the food value chain. During the study, it was found out that mango was first domesticated in India over 4,000 years ago. Scientific fossils available also indicate that the fruit existed in India 25 to 30 million years ago ([Http://www.The better India](http://www.ThebetterIndia.com)). The fruit has a large hard seed and it can only rely on the human being to propagate it from place to place. It is a common food crop consumed across the world today due to its flavor and fragrance. Mango production is increasing by 1.9% annually, it was expected to be at 58.3 metric tons by 2021 and 65 metric tons by 2026 (Mango market outlook 2022)

Globally, mango production increased from 25 metric tons to 65 metric tons from the year 2000 to the year 2019([https://www. World statistics/world mango production.com](https://www.worldstatistics.com/world-mango-production)). The world population consumes mango in large quantities as it is a popular fruit with a variety of flavours. It is consumed in the form of fruit, pulp or juice. In Kenya, in the year 2012, the population was 41.92 million and they produced and consumed 532,000 Metric Tons of mango, it was expected that by the year 2022 with an expected population of 52.742 million 1,006,000 Metric Tons of mango will be consumed (Gok, Investor 2012).

Kenyan citizens own more than one mobile phone, therefore by 2020, mobile subscribers were 61.41 million ([www.geopoll.com](http://www.geopoll.com)). ICT has opened up new channels for service delivery in areas such as E-commerce, E-government, E-education, etc. The number of mobile phone subscribers have increased from 11.35 million to 54.56 subscribers from 2007 to 2019 this implies that more citizens possess mobile phones and are using them in their day-to-day activities.

In Kenya, Agriculture is an important sector in the economy contributing 26% of Gross Domestic Product directly, it also contributes to another 27% of Gross Domestic Product through indirect linkages with other sectors (www.fao.org2020). The agricultural sector supports 80% of Kenyan livelihoods. The production of food and fruits in Kenya is aligned with the vision 2030 with a lot of emphasis on sustainable agriculture. In line with Sustainable Development Goals (SDGs), the FAO is aiming at reducing losses along the fruit and food value chain losses. The world population ought to adopt sustainable food consumption patterns that reduce food and fruit wastage; by improving on personal eating habits the world can save on food.

Kenya exports agricultural trade products including; tea, coffee, pyrethrum, flowers, fruits and vegetables. In terms of crop export in tonnage, flowers are leading followed by fruits with 142 metric tons and 103 metric tons respectively (Fresh produce exporters association of Kenya, 2020). In terms of financial earnings, fruits, flowers and vegetables were significant contributors to revenues in 2020, fruits contributed Kshs 18.3 million following after flowers which earned Kshs 108.7million.

Farmers and other stakeholders in the mango value chain in Makueni County need to access fast agricultural extension support services that they may be through USSD (Unstructured Supplementary Service Data), Short Messaging Services (SMS), Multimedia Messaging Services (MMS), through YouTube videos, WhatsApp messages, Tik Tok videos and through main stream media such as television, radio, print media etc. Through these communication channels the farmers are able to access a wide range of agricultural services and support. The farmers and other people involved in the value chain would like to access to a wider range of information on farming globally.

In Makueni county, stakeholders involved in the mango value chain, including; farmers, marketers, distributors, middlemen/brokers, exporters and processors are assisted by the Government and local organizations such as HCDA, KALRO, KTDA alongside other

international organizations such as FAO, USAID etc. to ensure that their products are maintained at high quality levels and reach the consumers in good condition.

In the County farmers are sensitized on the importance of using ICT and trained on its use through farmer-to-farmer discussions, peer to peer education and through exhibitions during the Agricultural Society of Kenya (ASK). The county has also organized field tours in the county to see successful mango farmers organized by the ministry of agriculture county executive (CE), through workshops and seminars and benchmarking with other counties involved in mango production.

The farmers in Makueni county are also trained on how to adapt to climatic change particularly addressing this through irrigation dependent farming using ponds, boreholes, shallow wells as well as deep sunken boreholes. The people involved in the value chain have also been trained how to cope with price shocks and global economic depression and mitigating measures to cushion themselves against devastating global warming effects.

In this study, monitoring was used since it is descriptive in nature and it gives information on the progress of a project is at any given time relative to respective targets and outcomes (Nyonje, Ndunge, & Mulwa, 2012). The targets are based on generic parameters namely; ICT cost factors, ICT personal factors, farm factors and ICT infrastructure factors to assess the influence of these factors on the use of ICTs in the mango value chain. The researcher evaluated the effects of the use of ICTs in the mango value chain with the specific focus to the cost, personal, farm and infrastructure factors.

By establishing the specific issues facing the population using PRA, the researcher as well as the county Government would purposefully empower the poor to be independent and self-sustaining as they exploit the potential of using ICT in agriculture and in particular in the mango value chain.

The processes involve preparation of the farms, acquisition of the seedlings, planting them in the farms, tending them to maturity, harvesting and selling them locally or globally.

According to Khan 2012, monitoring was integral in the study Monitoring as it helped to explain the results of the findings. In projects continuous communication is important and to all stakeholders. Participatory Rural Appraisal where stakeholders were extensively involved helped to identify problems, their causes and suggest their solutions. In this research, the study established that ICTs were available and accessible, they were being used with respect to the sizes of the mango farms and generally the study established that there are effects of using the ICTs in Makueni County mango value chain. In this case, M&E was used to establish whether ICT is being used in the mango value chain, to what extent it is being used, if not why, then suggest ways of improving ICT use in the mango value chain in Makueni county. According to Kusek Et al (2014), M&E is one of the most powerful tools that influence the performance of a project/program and it helped assesses the quality of the project deliverables based on the Key Performance Indicators (KPI) versus the planned and expected outputs or outcomes (Shapiro 2014).

Monitoring and Evaluation assisted the researcher to generate information about the use of ICT in mango value chain in Makueni County. The results of this research may be used by the government academicians and policy makers to improve the use of ICTs so as to improve mango production, reduce post-harvest losses and increase farmers' earnings from mangoes in Makueni County as well as elsewhere where the research findings will be found applicable.

To achieve higher levels of ICT adoption in Agriculture and in mango value chain, the Makueni County government is working with the national government, the civil society, philanthropists, goodwill ambassadors, the media and Non-Governmental Organizations in the area. The County government has trained 4890 residents in ICT during the financial years 2018/2019/2020 and 2021 as indicated in the County Statistical Abstract, Makueni (2023). Since the training was done, ICT hubs have been established in the Sub-County headquarters. It is important to follow

up and establish usability of these skills in agriculture which is the major economic in Kenya as well as in Makueni.

Makueni County is divided into Mbooni East, MboniWest, Kilungu, Nzaui, Makueni, Makindu, Mukaa, Kibwezi West and Kibwezi East sub-counties. According to the Makueni County statistical abstract data, 2017-2021 mango is the leading earner of revenue in the county among the top horticultural products over the said period.

Farmers and other stakeholders of the mango value chain in Makueni County need to access fast agricultural extension support services that they do through USSD (Unstructured Supplementary Service Data), Short Messaging Services (SMS), Multimedia Messaging Services (MMS), through YouTube videos, social media and through main stream media such as television, radio, print media etc. Through these communication channels the farmers are able to access a wide range of agricultural services and support locally and globally.

To ensure that ICT is adopted in Agriculture and in mango value chain, the Makueni County government is working with the national government, the civil society, philanthropists, goodwill ambassadors, the media and Non-Governmental Organizations in the area.

## **1.2 Statement of problem**

Unveiling controversies by Ruth Betha et al (2024), explains the factors that inhibit the use of ICTs in agriculture despite the benefits stakeholders may attain for employing them in agricultural production. In their book they explained that despite the benefits derived ICTs application attracted controversies such as widening the digital divide, high costs, poor infrastructure, social economic implications, poor governance and policy gaps etc. Therefore, for one to successfully implement ICTs a delicate balance has to be struck on these controversies.

Currently farmers world over are facing challenges such as poor agricultural practices, poor quality inputs, extreme adverse weather conditions, lack of or inaccessibility to right seeds, inaccessibility to credit and markets for their products. Attributable global warming there is significant change of pests and disease patterns with some developing resistance to pesticides etc. These problems face mango value chain stakeholders in Makueni, Kenya and globally. These problems culminate to a gap that use of ICTs would solve as the ICTs would open up markets globally, improve research, access to information & sharing and reduce losses to farmers.

ICT is an enabler in the world today applied in many sectors of the economy; despite this it has not been used in agriculture widely. There is growing need for Kenyan farmers to increase the use of ICTs in agriculture so as to increase productivity and reduce post-harvest losses and damages. It is important to adopt the use of ICT but some factors delimit and affect the use of it in Agriculture and in the mango value chain. Makueni being the largest producer of mango in Kenya, extensive ICTs application would be a game changer for farmers that would decrease costs of production, increase output levels and increase profitability.

Overtime the government of Kenya has purposefully endeavored to guaranteed food security to its people by aligning policies such as; the sessional paper no. 10 of 1965, on securing people freedom from hunger, the vision 2030 in the economic pillar as well as with the Big 4 agenda of 2018 on food security, by the Jubilee Government. Therefore, it would be in the interest of the government for such research as this to be done and recommendations implemented.

Agriculture is one of the major economic sectors in Kenya that support the people for sustenance and for commercial food production. Introduction of ICTs in the mango value chain will increase efficiency and ensure farmers gain more from their farms. Therefore M&E in use of ICTs will be used to manage efficiency of investments in agricultural projects in mango farming in Makueni. Using PRA as a tool of M&E will enable policy makers to access relevant, timely, accurate and useful information (John R Campbell 2001).

While in projects M&E are very important, in Kenya most institutions carry it out because donors and financiers of projects demand it so as to continue funding the projects, this should not be the case, Agricultural officers and extension officers in Makueni as well as in other parts of Kenya should carry out M&E because of its benefits and strengths as a management tool (Babbie & Mouton, 2010) especially using PRA which involves active participation of stakeholders. In fact, every Government department should establish a functional M&E department to constantly report on the progress and effects/impacts of Government projects.

The government of Kenya has made tremendous efforts to ensure the populace is food sufficient with the H.E Uhuru Kenyatta, purposefully stipulating the Big 4 Agenda development commitment during his tenure (2018- 2021) in tandem with the Vision 2030 (M&E directorate 2020). In the same spirit counties have emphasized on Agricultural support services to ensure they improve effectiveness and efficiency of the food and fruit value chain to ensure Government objectives are achieved.

Makueni county has endeavored to train locals in ICT from 2018 to 2022 in totals of 794,346, 461,216, 940 each year. This is an impressive commitment by the Makueni county government although the extent application of the same especially in mango farming is yet to be established.

### **1.3 Purpose of study**

This study aimed at establishing the influence of ICT factors on mango value chain in Makueni county, Kenya. The approach used in the study is Participatory Rural Appraisal, which involved stakeholders giving their views in the field using questionnaires, interviews, observation, documentary reviews and sampling. The results of the study will be used by stakeholders to guide in improving the performance of the value chain.

#### **1.4. Specific objectives of the study**

This study had the following specific objectives

- i) To establish the influence ICT personal factors on enhancing performance of mango value chain in Makueni County Kenya.
- ii) To determine the effects of ICT infrastructural factors on enhancing performance of mango value chain in Makueni County Kenya.
- iii) To establish the effects of ICT cost factors on enhancing performance of mango value chain in Makueni County Kenya
- iv) To explore the effects of ICT farm factors on enhancing performance of mango value chain in Makueni County Kenya

#### **1.5 Research questions**

The study sought to answer the following research questions:

- i) What are the personal factors affecting the use of ICT on enhancing performance of mango value chain in Makueni County Kenya?
- ii) How do ICT infrastructural factors influence use of ICT on enhancing performance of mango value chain in Makueni County Kenya?
- iii) How do ICT cost factors influence the use of ICT on enhancing performance of mango value chain in Makueni county?
- iv) What are the ICT farm factors affecting its use on enhancing performance of mango value chain in Makueni County Kenya?

#### **1.6 Justification**

ICT is an enabler of development in all sectors. Globally ICT is a driver in both social and economic development and it is therefore applied in mango value chain in Makueni it will definitely propel production output levels, profitability and multi-sectoral multiplier gains from the mango value chain associated sectors of production.

In Kenya, 7 out of 8 provinces produce mangoes but the Eastern province produces 61% of all mangoes in the country. Specifically, mangoes are grown in Murang'a, Thika, Taveta, Lower Embu, Machakos, Makueni and Kitui. According to, Horticulture-2015-2016 validated-report 3, mangoes were leading income earner for the county, followed by bananas. Therefore, this means mango is an important contributor to many citizens' livelihoods hence the interest to study it and know how best to improve the value chain through use of ICTs, zeroing in on the factors that influence the application of ICTs in the chain.

In the same report, Makueni county was the leading producer of mangoes in Kenya and also earned the most income from the same during the same period. It is worth noting that the fruit does not occupy a lot of space and that where it is planted it can be intercropped with other plants and food crops. The same area can also be used for grazing since the plant grows more than four (4) above the ground, cattle can feed on the farm without any harm.

The study was possible because the County is accessible due to a well-developed communication and transportation network. The stakeholders in the value chain were accessed easily through door-to-door visits and through County agricultural extension officers who may organize for a meeting between the researcher and the various stakeholders.

### **1.6.1: Success cases of ICTs application in agriculture**

Suguna poultry farm in India adopted an Enterprise Resource Planning (ERP) software to manage its operations with utter success. They were able to record data, process orders, track stocks, communicate both internally and externally and hence improved their efficiency and profitability.

Research conducted by USAID in 2009(USAID Manual 2009) established that some countries in the Sub-Saharan Africa were using Management Information Systems (MIS) to improve on communication, record keeping, monitoring of field activities, distribution of inputs and

traceability of logistical issues in the product value chain. It was also established that a software known as “Fresh Connect” developed in India as a suite for handheld devices was extensively used in agricultural value chain for different products. Esoko, which was formerly called Trade-Net was also commonly used in Sub-Saharan Africa for SMS services to inform framers on market prices, introduction of new herbicides and pesticides etc. In Kenya mobile applications used by farmers include; Mkulima young, Myfugo, Mbeguchoice, Sokoyetu and Farm Kenya App.

Ghanaian pineapple exporters use Geographical Information Systems (GIS) to track their products from the farm to their market destinations effectively. The pineapple companies were also able integrate an ICT system that facilitated an effective online payment system. Homegrown Kenya Limited an Agri-business based in Kenya uses Quick-Fire, which is a system audit software to maintain standards of its over 1,000 farmers by checking that all of them are authorized, audited and certified.

Rockefeller and Belinda Gates are currently funding research to develop an agricultural system integrating Geographical Information Systems (GIS), Geographical Positioning System (GPS), Geographical Positioning and Remote Sensing (GPRS) and ERPs to make management of the agricultural value chain easier, effective and more efficient. So far, such technology has successfully been used in fencing of farms with sensors but no physical fences, such a technology definitely brings the costs of fencing down.

## **1.7 Significance of the study**

### **1.7.1 Government officers**

The officers in ministry of ICT will be guided by the findings of this research to promote use of ICTs in the mango value chain and in the ministry of agriculture. The ICTs will be used as an enabler in the value chain eg. in farming of mango, marketing, collection and distribution of mangoes, in processing and in export of the mango products such as juices, puree, powders etc.

Since mango production is extensive in this county, it is a significant contributor to the county revenues and also contributes significantly in creating employment in the value chain, this research findings will be used to make helpful decisions by the government. The ministry of agriculture will be able to assist stakeholders the mango value chain as well as other agricultural interest groups to increase output levels and their profit levels.

This research work would be of significance to policy and decision makers in the agricultural sector in Makueni County for identifying reasons for poor adoption of ICT use in mango value chain and take measures to improve on the use of ICT in mango value chain as well as in others Counties in Kenya.

### **1.7.2 Farmers**

This research work will be significant to farmers who are expected to be the beneficiaries of the improved quality of mangoes, better priced fruits with an effective value chain as well as having a seamless marketing process which avoids/reduces loss of the final product through wastage and rotting. The county has already established a processing plant in Nguu ward in Kibwezi East Sub- County which is able to process 4,000 metric tons of mangoes daily. The target markets for the puree are Delmonte Company Limited and export markets.

The information about markets for mangoes, fertilizers, pesticides etc will be accessed through trainings by the county agricultural officers. The information will be accessed through the mass SMS to farmers form the officers.

### **1.7.3Academicians**

The study will add more information to the body of knowledge and research; the findings will be used by more researchers to carry out further research.

## **1.8 Scope of the study**

This study was carried out in nine sub-counties; Makueni, Nzau, Kilungu, Mbooni East, Mbooni West, kibwezi East, KibweziWest, Mukaa and Makindu. It focused on how use of ICT has affected performance of the mango value chain. Farmers and the sub-county agricultural officers will participate with the ward agricultural officers being the key informants.

The research used the Participatory Rural Appraisal (PRA), where the rural farmers participated freely in providing information about the influence of cost factors, personal factors, farm factors and ICTs infrastructure factors on use of ICTs on enhancing performance of the mango value chain in Makueni County.

According to the Makueni County statistical abstract data, 2017-2021 mango is the leading earner of revenue in county among the top horticultural products in the County over the said period.

The data collection for this research was carried out from 21<sup>st</sup> September to 21<sup>st</sup> October 2024, the sources of secondary data referenced range from years 2015 to 2023.

## **1.9 Limitations of the study**

The research process faced the challenge of farmers and other stakeholders in the value chain not willing to provide information such as their revenues and profits earned, ownership details about their land etc. The researcher assured them and guarantee confidentiality on such information. Accessing the stakeholders was also a challenge due to long distances between them which necessitated good planning so that those located in the same region were interviewed on the same day before moving to the next region/sub-county.

The costs had been planned for but in the long run the cost of questionnaire administration was higher due to more time taken in the question- answer sessions for those respondents who were available to respond. Some questionnaires were dropped and picked later so the face-to-face interview was not done for all respondents.

To ensure that respondents were free to express themselves and provide sufficient information the data collection instrument i.e. the questionnaire contained both open ended and closed ended questions. The questionnaire contained predetermined questions appropriately targeted for the topic under study. Moreover, the respondents were reassured protection of information they provided.

The other challenge faced during data collection was lack of documented evidence on use of ICT in agriculture, specifically amongst the mango farmers this means that the study does not have a lot of empirical evidence from the area of study. However, in cases where such data was not available narration from key informant, the local leaders and the agricultural extension officers was used to draw some logical conclusions.

#### **1.10 Assumptions of study**

The study was carried out under the assumption that the respondents were available and that they would give honest truthful and responses, all the expected respondents were available and responded well providing adequate data. The study assumed that all respondents were literate and that they had good understanding of the extent to which ICTs were applied in Agriculture sector, specifically in the mango value chain in Makueni County.

The researcher also assumed that the respondents understood the influence of cost factors, personal factors, farm factors and ICTs infrastructure on the use of ICTs on enhancing performance of the mango value chain. It was also assumed that officers in the County departments would co-operate, provide honest and accurate data in the process.

The data collected was normally distributed. The normality of data was tested using Shapiro test and found to be normally distributed.

### 1.11 Operational definitions of key terms

**Evaluation-** it is the process of critically examining the performance of a project/program. It involves analysis of data on the program/project based on which outcome judgements are made.

**Information Communication and Technology-** is the infrastructure and components that enable modern computing. It involves use of computers and other electronic gadgets to collect, process, store, use and transmit data/information.

**Information Communication Technology** – Means the integration of computers and communication devices that accept data input, processes data, stores or dispatches information.

**Monitoring-** it involves observing, surveillance and checking the progress or quality of a project/program overtime.

**Participatory Rural Appraisal-** Is monitoring and evaluation approach that involves stakeholder during investigation to ensure their views are captured during data collection and the whole M&E process.

**Personal factors** – are factors that relate to the respondent, they include; age, sub county name, gender, years involved, level of education, level of operation and willingness to use ICTs.

**Infrastructural factors** – these are factors related to the infrastructure available in the area, including factors such as; possession of gadget by the respondent, skills the respondent possessed, type of gadget, electronic network covered, services used by the respondent.

**Cost factors** – these are factors related to the cost of the gadget used such as; acquisition cost, availability, ease of use, convenience, maintenance, security, enhanced features, utility cost.

**Farm factors** – these are factors related to the farm, including farm size, number of trees, mangoes sold, access to information about various farm inputs such as seedlings, fertilizers, farm chemicals, implements etc.

**Performance factors** – the factors that were used to estimate performance included input levels, output levels and profit levels.

**Performance** – this is the level of outputs as compared to input levels, hence profitability levels.

**Value chain** – is the range of activities involved in the process of farming the mangoes, distributing them, marketing, processing them and delivery to the final consumer.

## CHAPTER TWO

### LITERATURE REVIEW

#### 2.1 Introduction

This chapter focuses on theories on the study under theoretical review and empirical review of literature based on specific objectives of the study, summary, research gaps and conceptual framework of the study. The literature review provides an assessment of literature on PRA M&E in relation to the influence of cost factors, personal factors, farm factors and ICTs infrastructure factors on ICTs use in the performance of the mango value chain.

The study reviewed relevant literature in order to identify pertinent information and debates that are applicable to the topic, as advocated for by Reid (2000) and Mouton (2001). The literature review enabled the researcher to concentrate on her efforts where information is insufficient rather than duplication of similar efforts by other researchers. Further this research work provided a conceptual background for study and quest for further investigation.

Makueni County is the leading producer of mangoes in Kenya (Horticulture Report 3-2015/2016). The mango value chain in Makueni includes the processes and activities that add value to the mango fruit during the stages of production, marketing, processing and the aftersales services. Mangoes farmers in Kenya add value to their produce, 65.25% of them add value either individually or in groups (Agricultural extension *Vol 24*). According to Department of Trade, Marketing, Industry, Culture and Tourism (2023) in Makueni county, there are 1170 registered

co-operatives operating at different sectors of the economy. There is no documentation on the number of mango farmers and other stakeholders involved in the value chain.

In line with high levels of mango production and other perishable products in the County, the County has increased cold storage facilities from zero in the year 2017 to 13 in the year 2021. Agricultural production processors have increased from 10 in 2017 to 55 processors in 2021, ICT companies the county have increased from 2 in 2018 to 40 in the year 2021 (County Statistical Abstract, Makueni 2023).

### **Mango varieties in the world**

The botanical name for Mango is *Mangifera indica* and it belongs to the Anacardiaceae flowering plant family. The Mango plant consists of 30 species. It grows best in warm tropical climate with a dry season of about three months followed by rains. Mango plants require a dry period during flowering and adequate heat during the ripening period. Makueni county has a suitable climate for the growth of mangoes. Mangoes are used for fresh juices, puree, can be canned, kachari and also for jam. The fruit is rich vitamins and essential minerals such as thiamine, calcium, niacin etc.

Common varieties grown in Makueni include; Apple, Kent, Tommy Atkins, Ngoo, Vandyke, Keitt, Sensation, Maya, Haden etc. A picture of some of the mango varieties grown in Makueni county is represented in Figure 2.1 below:



**Figure 2.1 Mango varieties in Makueni County**

### **2.1.2 Participatory rural appraisal M&E approach**

Participatory rural appraisal approach was considered appropriate for this research because it provides an opportunity for the public to freely participate in developmental issues by providing information on the position of the issue. In the case of Makueni mango farming the farmers provided information on the use of ICT in relation to farming of mangoes in the county other stakeholders provided information about their roles in the value chain and the influence of ICT factors which affect application of ICTs in the value chain enhancing the output levels and profitability.

Based on the findings, policy makers and implementers will be guided on how best to apply ICTs as an enabler in communication, marketing and value addition of mangoes in the county,

which information can be replicated elsewhere globally to improve performance in agriculture or any other production sector.

## **2.2 Theoretical framework review**

### **2.2.1 New determinants of trade**

International trade theory advocates for the importance of technological innovation in explaining competitiveness of a country or region in business, in this case the county. Traders and economists have treated technological development as exogenous to the business conversely technological advancements and the effects to the business thereof are endogenous meaning the use of ICT in a business impacts directly to the business. In the contemporary business world, ICTs are no longer supposed to be treated as support services or departments but as a pertinent and vital part of the business.

According to Fagerberg (1997), technological advancements can never be ignored in fact he recommended that businesses should invest more in Research and Development to take advantage of new trending innovations. This is not the case in most developing countries who commit dismally in R&D from their Gross Domestic Product (GDP).

When ICT is employed in a business in this case mango value chain the efficiency of the chain will improve, leading to more access to information by the farmers, less fruits losses, faster distribution to factories and therefore it is expected that profitability will increase. Since ICT is an enabler that is temporal-spatial non-bound its use will promote free trade accessing to more information as well as markets for the mangoes from Makueni County.

Different countries have different technological endowments and capabilities. According to Loungani (2002), developed and developing countries have a heterogenous levels of technological advancement, as such the more developed countries are able to scale down and solve the problems of distance and cost that are serious challenges in trade. This means with the

use of ICTs in trade distances and costs of doing business are reduced significantly, basically use of ICT renders businesses time and space independent.

### **2.2.2: Disruptive innovation theory**

In Makueni County the mango value chain has been extensively manual. This study will focus on the use of ICT which is a new innovation. According to Clayton Christen (2016), Disruptive innovation theory which describes innovation as the process of creating a new market and value network while disrupting an existing market and value network by unseating established market leaders and alliances.

Use of ICT in the mango value chain could act as a disruptor from the norm by stakeholders in the mango value chain. It is expected that in the areas where ICT is engaged the mango value chain is likely to be more profitable. The county government as well as the national governments have put efforts and initiatives to increase of ICT uptake in the agriculture sector more so in the mango value chain in Makueni county where this crop is largely farmed.

Doing business differently from her peers who may not have adopted ICT, Makueni county will disrupt known markets for her products and edge towards gaining ground in new markets. This move is expected to raise her competitive edge, increase trading volumes and be more profitable. Moreover, this may provoke the interest and involvement of the younger population in agriculture who normally despise it in favor of blue color jobs and especially having more affinity for employment rather than self-employment.

### **2.2.3: Value chain model**

Heeks in the year 2010, advocated for the value chain model for rural development. Among the best propellants of rural development was ICT4D (Information Technology For Development) where he said that processes must be linked to resources. Since at the time of development of this proposal mobile telephony had not been widely adopted by rural poor communities, he suggested

that ICTs would be used to reduce the “haves” and “have-nots” i.e. economic divide as well as digital divide.

According to Heeks (2010), for ICTs to be adopted by the populace there are three important drivers; namely preparedness, availability and uptake. He said that preparedness requires policy frameworks that are supportive, necessary infrastructure should be established and necessary support for skills to be acquired. Additionally, the technology must exist and supply of the same, more importantly the government or project managers should be ready to implement the ICTs program. The uptake and usage of the ICTs will depend on the demand for the same. As is common in developing countries ICTs are not widely applied in agriculture value chain to enhance revenues and profitability hence this model is helpful in sensitizing both communities and governments to embrace ICTs. Implementation of ICT in agriculture will be propelled if there is adequate support by government and if adequate demand is created for the agricultural products, in this case the mango fruit, juices and pulp.

Through the use of common ICTs among the people in Makueni county the government will manage to support people involved in the mango value chain as well as ensure that helpful information is transmitted to the stakeholders seamlessly hence improve on the effectiveness and efficiency of the mango value chain in Makueni county.

#### **2.2.4: Bottom-up model**

According to International Telecommunication Union (ITU), ICT absorption and use especially the mobile telephony in Kenya, Africa and the world was 30.8 million, 650 million and 7.95 billion by 2022. This situation should be exploited for development initiatives. Lund and Sutinen (2010) advocated for a bottom-up approach to ICT4D where they proposed that since the rural poor who comprise of the most population in the society can be used to boost development by use of ICT.

They advocated that the needs of the people should be identified, their willingness to use ICT established and then involve experts to design tailor made appropriate solutions for them. This would ensure that the solutions are owned by them and commitment is harnessed. Bottom-up model works the same as the participatory rural approach where members of the community who are beneficiaries of a project are involved through-out the project lifecycle.

The benefit of applying this model in this study is that agriculture is done by the masses in most countries. Once the masses are involved in the uptake and implementation of ICTs in the value chain chances of success will be high. Kenyan economy highly depends on agriculture which is done by a large population, Makueni county is also heavily reliant on agriculture specifically leading in mango production. Therefore, adoption of ICTs by masses is likely to enhance productivity, increase profitability and improve the peoples' standards of living.

## **2.3 Empirical literature review**

ICTs used in the world include mobile phones, Radios, GPS&GIS equipment, Televisions, faxes, fixed line telephony, Emails, social media etc., they provide solutions to people's lives and make livelihoods more comfortable. There are challenges associated with their use and application in the various sectors but their benefits outweigh the shortcomings. Below is the empirical literature review on the factors affecting ICT use on improving the performance of mango value chain in Makueni county.

### **2.3.1 Influence of infrastructural factors on performance**

According to Lukman et al (2022), an established ICT infrastructure led to improved agricultural productivity indicates that agricultural profitability was also enhanced. In this article, Lukman recommended that physical ICT layout was important in increasing productivity but more importantly the policy regulation of ICT was necessary to guarantee sustainability in the sub-Saharan region.

The infrastructural factors that were considered in the study included; possession of an electronic gadget, the possession of the required skills to use the gadget, type of gadget owned, the extent network coverage of the area where the respondent lived and the services the respondent used. Today the population of Kenya possess telephony gadgets, most people have more than one gadget according to the subscriptions (CAK 2020). Haseen (2016) discovered that in China and Pakistan, citizens were using mobile phones 100% but less of this use was used in agriculture with citizens owning despite the fact that citizens owned more than one mobile phones.

The skills to use these gadgets was an important consideration in this study. In Kenya, digital divide is significant in specifically having the rural people being less equipped with the ICTs technology and skills ([Http://www.cigionline>DPH.PDF](http://www.cigionline.org/DPH.PDF)). This divide is also pronounced between those involved agriculture and the office workers, favor of the office workers.

The consideration of the type of gadget possessed by the respondents was important, in the market there were smart phone which are network enable and others that are not network enabled. The respondents would therefore choose to buy the gadget that met their specific need. For these gadgets to function as expected and improve on the performance of the value chain network establishment, layout and installations was necessary. The gadgets used by the respondents had the ability to access various services such as SMS, Email, Skype, Online chatting etc. as the stakeholders would choose depending on their requirement.

Information and Communication Technology (ICT) is important to stakeholders in the value chain in supporting them to access to markets and other services through the internet globally. The farmers are facilitated to access information on real-time basis on availability of markets, market prices, weather forecasts, information on pests and pest control, improved seed varieties, planting and farm tending techniques (Ogotu et al., 2014).

### **2.3.2 Influence of personal factors on performance**

In this study personal factors that were investigated included the age, gender, level of education, number of years involved in the value chain i.e. how long one has been in the mango value chain etc. to establish whether they have influence on the performance of the mango value chain.

The age of those involved in the mango value chain was considered. Those who were involved in the data collection were all above 18 years. It was noted that, the total number of mobile subscribers by 2019 were 8.3 billion, in Kenya in 2017, 80% of the adult population owned mobile phones, of which 30% owning smart phones and 50% owning ordinary phones. (www.geopoll.com), mobile networks have gained ground, covering over 65% in Kenyan land mass with over 56% of the population using mobile phones .

Gender is the consideration of sex, female or male based on social and cultural differences rather than on biological ones. In agriculture the female gender is more involved and extensively it is considered as a female role in the society. But recently because of the advocacy for commercial agriculture, more men are starting to get into it for financial gain rather than for subsistence.

Level of education was considered; it is common to get more educated people in office white color jobs than in menial jobs such as agriculture. It is so because of the myriad challenges that face the agricultural sector including poor road infrastructure, inaccessibility to markets for their products, low incomes from the sale of their products, losses occasioned by pest infestation and crop diseases etc. The more educated should be encouraged to be more engaged in the value chain since they are more likely to operate more professionally due to the learned skills and ICTs know-how.

The study also considered how long the respondent was involved in and the role they played in the chain. In agriculture, most products are not processed and therefore no value addition is done

on them. In the county, only one processor was found meaning that all the mango fruit produced was consumed in its raw form, denying it longevity on the shelves and rendering it lowly priced.

From this information it clearly indicates that the Kenyan population has subscribed to different mobile phone companies with some people having more than one mobile phone and more than one telephone number. It is expected that by 2025, more 7 million people will buy new phones, especially because of the need to keep up with new technology advancements(www.geopoll.com) and the need to access to business information globally.

Over 40 % of the global population is connected to the internet while 70 % of all families worldwide own mobile phones. The global population therefore can access to services through ICT.

However, data on how many people have phones in Makueni county was not available.

Yassen et al(2016) discovered that personal factors affected the extent to which ICTs are applied in agriculture generally but they did not study the value chain. This study concentrated on the mango value chain so that the effects of ICTs can be assessed along the whole mango value chain.

### **2.3.3 Influence of farm factors on performance**

This research focused on farm factors such as the size of farm in acreage, the farm ownership, the number of trees in the farm, types of mango varieties, ownership of the farm etc. to establish whether these factors have any influence in the output levels and incomes to the mango value chain participant.

Yaseen 2016, discovered that the size of the farm, the type of ownership of the farm was significant, 0.999 i.e. 99.9% in influencing the use of ICTs in agriculture. However, researchers including Yaseen have admitted that application of ICTs in agriculture is a complex phenomenon

to study because it is influenced by multifaceted socio-economic factors. According to Yaseen (2016), a farmer or any other stakeholder should have a stable ownership of their farms or premise since some crops including mangoes take long to mature and bear fruits.

The size of the farm owned should be large enough to make economic sense. The farmer should have a large number of trees on his farm so that the investment will make sense. Agriculture investments are expensive especially when ICTs are involved hence a cost benefit analysis should be done. When the investment is not cost effective the use of ICTs may be in futility. Hence, Yaseen (2016) recommended that more sensitization was necessary to ensure that people used the ICTs in more innovative way to ensure food security, sustainable agriculture and livelihood.

The mango varieties grown in Kenya and the world are varied. Some of the mango fruits are sweeter than others and their flavors vary. Due to this some are preferred for consumption in their raw state while others such as the tommy and apple varieties are preferred for puree.

The farm factors were considered in the research; they were studied to find out the extent to which they influenced the use of ICTs in the mango value chain in the county.

#### **2.3.4 Influence of costs of ICTs on the performance**

The researcher investigated the influence of costs such as the acquisition costs, costs of maintenance, ICTs utility costs e.g. airtime, phone charging, costs of accessories such as spare parts, repairs etc., user friendliness, security, enhanced features and convenience of use will have influence on the application of ICTs in the value chain. The study also focused on investigating whether the ICTs' application in the value chain enhanced levels of productivity and the profitability in the mango value chain.

Studies have found out that the costs of ICTs negatively affect the willingness of farmers to use them in agriculture, however due to convenience, compatibility with their other devices, user friendliness, agility and social influence associated with them, stakeholders in the agricultural sector still find the benefits outweighing the costs.

For instance, in the Precision Agriculture (PA) project where Denmark, Switzerland and Italy participated a Cost Benefit Analysis approach was used to help farmers gauge their costs versus benefits in their agricultural activities where the costs captured direct farm inputs and other operational costs such as ICTs. Aaron et al, January 2024, used cost benefits analysis in agricultural projects as they sought to help economists understand the best methodologies to estimate costs and benefits. Agricultural production found to be an effective tool to reduce poverty, according to Christiansen et al, (2018), it has the potential of reducing poverty two times faster and more effectively than other sectors of the economy.

Costing especially apportioning costs such as for ICTs may be complex. In the PA project which is still under development, it is seeking to factor financial performance and risks involved, agricultural impact to the economy, costs of field operations, social and externality costs together for have a single key performance index that can be used in CBA.

However, in this study, the researcher directly engaged the stakeholders in the mango value chain through the PRA to establish how much they use in acquisition, maintenance and utilization of the devices e.g. in airtime voice call, internet bundles, charging of battery etc. since according to CAK, (2022) and ITU (2016), in Kenya mobile phone absorption is over 100% with in this study, the researcher sought to establish influence that cost related factors affected the use of ICTs in Makeni county mango value chain.

## 2.4 Conceptual framework

According to Aotes (2006), a conceptual framework is a map of the complete research process. It consists of 6Ps, the purpose, products, process, participants, paradigm and presentation of the research. The research is guided by well framed research questions. The conceptual framework presented the dependent variable Y and Independent variable X relationship as well as the intervening factors in the process.

### 2.4.1 Conceptual framework flowchart

The study was guided by a conceptual framework as shown below in Figure 2.4.1. The independent variables consisted of personal factors, available ICT infrastructure, costs of ICTs and farm factors. The dependent variable for effect of ICT use on profits and incomes while the moderating variable was government regulations & policies as well as people's attitude.



## INDEPENDENT VARIABLES

## DEPENDENT VARIABLES

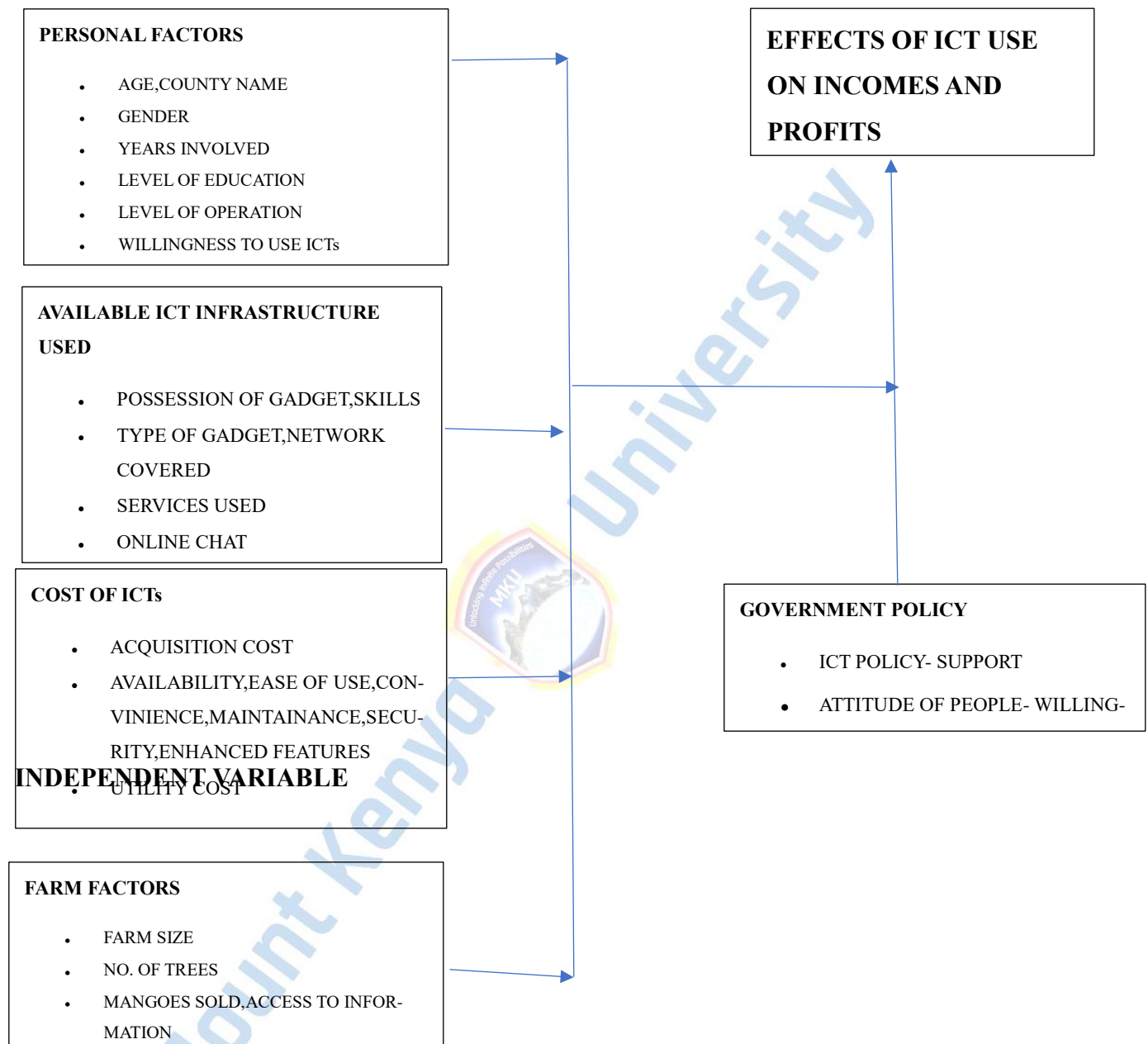


Figure 2.4.1 Conceptual framework

## 2.5 Recap of literature review

There is concern that ICT is an enabler in many aspects of life today globally but it may not have been employed adequately in Agriculture globally, in the Country as well as in Makueni County.

The Government of Kenya had endeavored to establish ICT hubs in the country. Makueni county government has also established an ICT hub in each sub-county. The study targets at establishing this gap in the agricultural sector, where farmers may not have embraced ICT in their operations.

The study sought to establish whether the farmers have adopted ICTs as an enabler in the value chain and if they have adopted it, investigate to what extent ICTs are being applied in the sector and the ICT factors that influenced the use of ICTs. More importantly, the research established various interventions the Ministry of ICT has implemented with a view to enable farmers to succeed in farming of the said crop and increase crop yields and profitability. These investigations aimed at finding out whether use of ICT had improved output of mangoes and the incomes in the value chain.

This study explored the extent these ICT hubs and ICT gadgets held by stakeholders are facilitating to enhance agriculture with a particular focus on the mango value chain in Makueni county.

## CHAPTER THREE

### RESEARCH DESIGN AND METHODOLOGY

#### 3.1 Introduction

This chapter comprises of research design, target population, sampling design, sample size, data collection instruments, methods and procedures, preliminary study, data collection procedure, data analysis, ethical considerations. According to Korean Society of anesthetists 2017, if a preliminary study is carried out successfully and the sample is chosen correctly, it plays as an accurate reflection of the reality on the ground. The research carried out afore the main research helped the researcher gather responses, comments and suggestions from 20 mango value chain stakeholders in the area and improve on the research tool. As explained by Orodho (2005), this was meant to identify any flaws and correct them.

#### 3.2 Research methodology

The study adopted a descriptive and explanatory research design. According to Kothari ,2004 descriptive research design is recommended for studies that are concerned with specific predictions and predictable outcomes, with narration of traits and behaviors concerning persons, groups or situations. The data collected in this study was descriptive in nature where respondents were allowed to give information on ICTs use in the county.

The design was used as it enabled the researcher to gather valid information regarding the study variables; personal factors, farm factors, cost factors and ICTs infrastructure factors were clearly identified. Descriptive research involves gathering data that describes characteristics of the variables under study in a qualitative manner. For instance, the costs involved were described as low, medium and high, farm factors were descriptive where farms were described as small, medium sized or large.

However, descriptive statistics may not answer questions about how, when, why a phenomenon occurred. Descriptive statistics in this research answered the question, “what” i.e., what are characteristics of the population or situation being studied in Makueni County with regard to the subject under study, how the ICTs are used, when they are used and for what purpose. Descriptive research design was also applied because ICTs are not widely used in agriculture generally and it is most likely that in the target area data may not be readily available. Therefore, such an area where research has not been widely done, combining both methods would yield more success.

Alongside the questionnaire to be administered, the researcher additionally observed, carried out documentary reviews, engaged the respondents in a face-to-face interview among specific focus groups to extract more information to be used for the analysis.

### 3.3 Research design

The study focused on the County and clustered the respondents into nine sub-counties with 42 respondents each, also expected to respond were the nine sub-county agricultural extension officers, the total sample was 387 respondents. A questionnaire was used to collect descriptive data for the purpose of this research, focusing on the personal factors, cost factors, farm factors and ICTs infrastructure factors. The respondents were picked randomly from the sub counties. However, the researcher ensured that they are reasonably spatially dispersed to avoid collecting data that would duplicate the characteristics and amplify homogeneity hence make no statistical sense after analysis.

The total number of mango farmers and other respondents in Makueni county is not known and is not documented and therefore the Cochran’s sample size formula was used to decide on the size of the sample, n;

$$n = \frac{Z^2 \times P(1-P)}{z}$$

### **3.4 Location of the study**

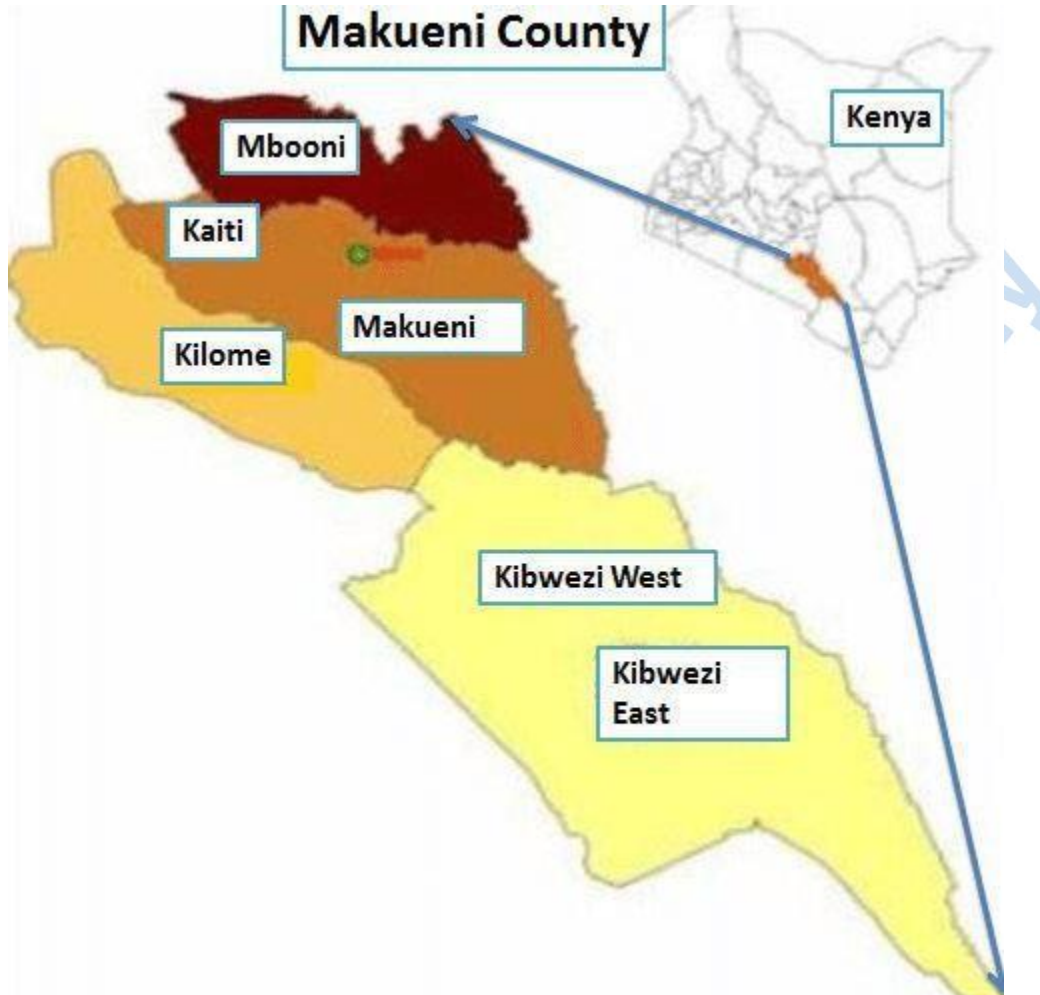
#### **Topographical position of Makueni County in relation Kenya**

The Makueni is located in the South Eastern part of Kenya. It borders Machakos to the North and Kitui to the East, Kajiado to the West and Taita Taveta to the West. It is located  $1^{\circ} 47' 21.483''$  south and  $37^{\circ} 37' 16.7502''$  East. The county measures  $8,009 \text{ KM}^2$  while Kenya,  $580,367 \text{ KM}^2$ . The ecological position places the county in a good position economically serving Nairobi and Mombasa cities by harboring Mombasa Road which interconnects these two major economic hubs in Kenya.

Data was collected in Makueni county. The county has nine sub counties in total. It produces large quantities of mango and the farming is wide spread across all the sub counties. Alongside mango farming the people are also involved in production of other fruits such as bananas, oranges, guavas, avocados etc. The county is classified as a semi-arid area. According to KIPPRA, 2024, The population growth rate in the county is 1.4% per annum and the poverty level is 39.7%, this means the population is capable of affording devices as per the data collected. The mobile telephony companies established ICTs infrastructure with 96.6% of the area network covered.

The study used stratified sampling of the area based on the geographical and administrative boundaries of the county therefore have 9 strata from which 42 elements will be randomly picked. Sub counties were used to cluster the homogenous data geographically as; Makueni, Nzau, Kilungu, Mbooni East, Mbooni West, kibwezi East, Kibwezi West, Mukaa and Makindu sub-counties. Using the simple stratification and random selection, each element in the sample frame had an equal chance of being selected and therefore avoided bias.

## Map of Makueni county



**Figure 3.4.1 Map of Makueni county**

The map shows Makueni sub counties; Makueni, kaiti,mbooni, kilome, kibwezi East and Kibwezi West that were used in the study. In addition, were have Nzai, Mbooni as mbooni east and west and kilungu.

### **3.5. Target population**

The study targeted nine sub-counties in Makueni County where mango cultivation is widely practiced. The targeted respondents were 378 where respondents will be 42 from each sub-county, it also comprised of nine agricultural officers who were the key informants from the respective sub counties. Therefore, the total respondents will be 387. Even though the county has

1170 registered co-operatives as indicated by Makueni county Government, (2023), from the data it was not indicated how many of these co-operatives were only dealing with mango farmers, therefore this research study only collected data on ICTs use among mango farmers only whose sample size was calculated using Cochran's sample size formular. Using explanatory research design, member farmers who specifically farm mango and play specific roles in the mango value chain were isolated.

In the county there are other fruit famers as well as farmers of other crops. The interest of the researcher was only focused on the mango value chain and those involved in it. The reason for the interest was because from other researchers, agriculture has not employed use of ICTs despite the benefits associated with the use of ICTs. In the study data was collected and analyzed about farmers, pickers/transporters, middlemen/brokers, marketing/distribution, exporters, processors and agricultural officers.

**Table 1.1a: Specific respondents per county**

<b>Sub- county name</b>	<b>No. of respondents</b>	<b>CAO</b>
Makueni	42	1
Mbooni East	42	1
Mbooni West	42	1
Kibwezi West	42	1
Kibwezi East	42	1
Makindu	42	1
Mukaa	42	1
Nzau	42	1

Kilungu	42	1
<b>TOTAL</b>	<b>378</b>	<b>9</b>
<b>GRAND TOTAL</b>		<b>387</b>

**Table 2.1b: Specific respondents per their role in the value chain**

FARMER	299	75.3
PICKER & TRANSPORTER	30	7.6
MIDDLEMAN/BROKER	30	7.6
MARKETING & DISTRIBUTION	8	2.0
EXPORTER	10	2.5
PROCESSOR	1	.3
AGRICULTURAL OFFICER	9	4.8
Total	378	95.2
Total	397	100.0

From table 2.1b, farmers are more, 299 while exporters are 10 with only one processor in the county. From the study a lot mangoes went to waste because access to the markets was a challenge due to poor road infrastructure, poor access to market information, presence of too many, 30 middlemen/brokers in the value chain but less, 8 marketers. Farmers were targeted in large numbers because they play a major role in the value chain. The other stakeholders are critical especially help in elevating losses to the farmers through marketing, distributing, processing and exporting the fruit.

### **3.6 Sampling size determination**

In this paper sampling design provided a detailed explanation of the issues to be involved in research and how they were selected from the target group (Kombo & Et al 2006), Kombo Et al, in 2006, further explained that selecting a sample is an important exercise in research work. To get the sample size the Cochran's sample size formular was used ([Http://www.researchgate.net](http://www.researchgate.net)>post).

The sampling frame used was the list of stakeholders involved in the value chain in the county according to the ward agricultural officers' record, a sample of 378 stakeholders were picked randomly from all 9 sub counties and 9 key informants were interviewed. When the sample is appropriately selected the researcher can authoritatively make conclusions and inferences about the population based on the findings emanating from the sample (Kombo Et al 2006. Therefore, from the sample frame used, it is expected that the sample was adequately representative to be used logically to infer conclusions about the population.

However, according to Mugenda and Mugenda, (1999) where the target population is small then selecting a sample would be meaningless, the elements of the whole population should therefore be studied, in the case of Makueni. In this research paper, the mango farmers as well as other stakeholders in Makueni county are many, thus a sample of 378 mango farmers was selected from the population in the nine sub-counties where mango growing is evidently more intense.

### **3.7 Sample design, procedures and techniques**

A sample is used to conduct a study where the population is large and it is difficult to include each element/member of the population in the data collection process. The sample size affects the reliability and validity of the study results (Frankline 2021). In this study a target farmer and stakeholders' sample of 378 and nine Subcounty agricultural extension officers was picked.

According to Mugenda and Mugenda, (1999), the researcher should concentrate on the area, phenomenon or situation that will provide the characteristics in which they are interested and yet providing adequate information to form a basis for inference.

### **3.8 Construction of research instruments**

The researcher focused on the farmers and other stakeholders in the value chain individually but not registered under co-operatives or other groups operating in the county. This was because they were likely to face challenges in the value chain and are likely to operate under a natural business environment than those under controlled and structured co-operatives or groups.

In the study data was also collected about other stakeholders in the value chain such as agricultural extension officers, marketers and distributors, mango pickers, middlemen/brokers, exporters and mango processors. From each sub-county 42 respondents were involved as well as 9 agricultural extension officers from each county. More farmers were involved in the process because they are the majority in the value chain, they were randomly picked from the sub-counties. Other respondents were also randomly picked from the research area, Makueni county.

### **3.9 Testing for validity and reliability(truthfulness)**

#### **3.9.1 Analysis of research instrument validity**

Validity is a measure used to establish whether research findings present are a true and trusted view of the research work. Simple checks of validity that were done included; checking for existence of variables and values, limit check, range checks, format checks, consistence etc. Quantitative research uses numerical and statistical measurements to validate and verify data while qualitative research relies on subjective interpretation for validation and verification (Zikmund 2013). According to Zikmund, 2013 qualitative data collection should be followed by a confirmatory study to avoid wrongful decision making by people who may use the findings of a researcher with poor or inaccurate interpretations.

Zikmund (2013), explains that for research results to be validated, if the study is repeated by different researchers with different respondents following the same methods and the same interpretation is drawn. He further advised that data may be affected negatively if there are cyclical occurrences in the organization that may be active at the time of data collection or respondents may intentionally give wrong information if they suspect the results may be used to victimize or undermine them (Sanders et al 2009).

During the research, the data was collected keenly to avoid careless errors that may lead to too much senseless occurrences recorded, to ensure that there are minimal outliers. After the data was assessed for quality through the physical validation and verification, internal consistency was checked using SPSS, to find the Cronbach 'salpa to see how responses relate across different objectives.

### **3.9.2 Analysis of research instruments reliability**

Reliability is the level of consistency expected to e achieved over numerous repetitions of a tests of data. The questionnaire will be tested through a pilot study carried in Makueni county on 20 participants to determine whether it is consistent enough to be used for the research.

The questionnaires were administered in different sub-counties in an interval of 2 weeks with the questionnaire questions interchanged for the consecutive instances of data collection. The results from the two instances were correlated using SPSS application to establish their reliability coefficient. The coefficient was more than 0.5 and was acceptable.

### **3.10 Data collection methods and procedures**

The main data collection tool was the questionnaire that was administered to the respondents. The questionnaire was chosen as a data collection method because of its benefits; it is easy to administer, cheap, controlling respondents is easy and ensure they remain focused to the objectives of the researcher, the researcher can scale the questionnaire to fit respondents easily,

the responses received conform to the desired format. The questionnaire was prepared, administered, data collected, sorted, cleaned for any irrelevant data, processed and analyzed using data analysis tools.

The questionnaires were administered to respondents by the researcher assisted by 9 research assistants. Each of the 9 assistants reached out to 42 stakeholders, issue the questionnaires explain to them. If the respondent accepts to respond the questionnaire was filled immediately or left behind with the respondent and collected after one week. The respondent was free the mail the filled-up questionnaire to the research assistant.

The data analysis tool used was be Statistical Program for Social Sciences (SPSS). This program has the data manipulation capability aided with multiple embedded statistical formula, great statistical analysis ability which can be displayed visually using charts present in the program. The researcher used descriptive data which the application was able to accommodate.

### **3.11 Data analysis techniques and procedures**

Statistical Program for Social Scientists (SPSS) was used for data analysis. Since one of the assumptions made were that the data was normally distributed, normality was tested using the binomial distribution curve with data tested at 95% confidence levels and the Shapiro-wilk values were negative, indicating that the data was normally distributed and skewed to the left.

The expectation was that 95% of the observations will be normally distribution without excessive outliers. The research assistants ensured that the mean lies at 50% and that the difference between the mean and the mode is minimal, tending to zero. The Analysis of variance (ANOVA) was done on the data to find the difference between the means. The normality can also be seen when a linear regression is drawn, further the collinearity was measured using a Pearson's correlation coefficient.

The researcher proceeded to carry out a preliminary sampling of 20 farmers from the nine sub counties. From the findings of this research, the researcher sought to establish whether use of ICT affected performance of the respondents based on personal factors, infrastructure, costs and farm factors and whether it also affected profit levels of respondents in the value chain.

### **3.12 Ethical considerations**

After all the requirements by the University were met, the researcher sought for clearance from the institute. The researcher applied for the ethics and review clearance certificate from the ERC office in MKU, then requested for an introduction letter to be used to apply for approval from National Commission for Science, Technology and Innovation (NACOSTI).

The researcher used personal identity to access Makueni county offices and the respective subcounty offices for the study, communicating effectively to the authorities to ensure that necessary co-operation was accorded. The researcher also conducted self with dignity and followed the guidelines that were issued by the county authorities. During the process professionalism, transparency and courtesy was observed.

Further, it was ensured that all respondents are safe and their rights are observed and that they were not exposed to physical, emotional or health risks. The respondents were expected to participate in confidence and were reassured that their data was not be divulged to other people and it was not to be used for other purposes other than this research. However, the respondents were voluntarily involved in this survey and they were allowed to disengage at will as they deem fit. The researcher always ensured that all advisory guidance by the supervisor was incorporated to the research work.

## **CHAPTER FOUR**

### **RESEARCH FINDINGS, ANALYSIS AND PRESENTATION**

#### **4.1 Introduction**

This part contains the report on data collection, findings and analysis. The study focused on 387 respondents, including 378 stakeholders in the mango value chain and 9 subcounty agricultural extension officers.

This report consists of question sections on personal factors, farm factors and cost factors that influence the use of ICTs in the mango value chain. It also has an analysis of the responses of interviewees on the influence of using ICTs hence how it enhances the performance of the value chain. The researcher also researched on the influence of government policy on the use of ICTs in the value chain. The perspective, concerns and the rationale of the key informants was also captured in the report.

#### **4.2 Presentation of findings**

The aspects being presented in this section include the following:

##### **Personal factors**

Personal factors included gender, age, subcounty of residence, years involved in the role and education level of the stakeholder. The data shows that there were 174 males and 204 females involved in the various roles in the value chain i.e. 46% and 54% respectively, as shown in gender statistics table. The respondents involved in this research included ages from 18 years to

above 45 years, from the data more older people were more involved in the value chain than the younger ones, where people below 35 years were 29.9%, 36-above 45 years were 70.1% as shown in age statistics table.

**Table 4.2.1 Gender statistics**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MALE	174	43.8	46.0	46.0
	FEMALE	204	51.4	54.0	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

Table 4.2.1 shows that more females are involved in the value chain than men at all levels of operation. This means that the mango value chain is a significant income generator for women who were 52% of the population according to KNBS census 2019. This implies that if more focus and support is given to the value chain where losses of the product will be reduced more women will be empowered and poverty levels reduced a great deal in the county and in the country as well since the production of mango fruit is wide spread in the country.

**Table 4.2.2: Age statistics**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BELOW 18 YEARS	11	2.8	2.9	2.9
	19-25 YEARS	24	6.0	6.3	9.3
	26-35 YEARS	78	19.6	20.6	29.9
	35-45 YEARS	159	40.1	42.1	72.0
	ABOVE 45 YEARS	106	26.7	28.0	100.0

Total	378	95.2	100.0
Total	397	100.0	

The data in table 4.2.2 shows that older people are more involved in the value chain than the younger ones. Probably because youthful populace would prefer white color jobs and employment rather than manual agriculture. From observation in the area of study the mango value chain was not mechanized implying that most jobs/tasks were performed manually and obviously they were laborious.

**Table 4.2.3: Period involved**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BELOW 2 YEARS	43	11.4	11.4	11.4
	3-7 YEARS	62	16.4	16.4	27.8
	8-15 YEARS	51	13.5	13.5	41.3
	15- 20 YEARS	133	35.2	35.2	76.5
	ABOVE 20 YEARS	88	23.3	23.3	99.7
	7	1	.3	.3	100.0
	Total	378	100.0	100.0	

All the nine sub counties had 42 stakeholders interviewed plus 1 subcounty agricultural extension officer. Below 7 years of involvement in the value chain were 27.8%, while 72.2% were 8 years and above in their role in the value chain, as shown in period involved table. In relation to table 4.2.2 on age, table 4.2.3 implies that people involved in the value chain were consistent and especially older people getting more involve the value chain. Those above the age of 35 years were 265 while those who were consistently involved in the practice for more than 15 years were 221. This implies that the practitioners are committed and persistent hence with more county government support their performance, income levels and profitability will be enhanced.

**Table 4.2.4: Level of education**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	BASIC LEVEL	317	79.8	83.9	83.9
	DIPLOMA	34	8.6	9.0	92.9
	BACHELORS DEGREE	13	3.3	3.4	96.3
	MASTERS	6	1.5	1.6	97.9
	DOCTORATE	8	2.0	2.1	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

The data indicated that 83.9%% of all respondents included in the sample held basic education, while 16.1% held Diploma, bachelors' degree, masters' degrees and doctorate qualifications, as shown in the education level table 4.2.4. Clearly from the findings more educated people did not engage in the activities of the value chain, it was left for the less learnt. Since this is a source of income, the county government should motivate even the more educated residents to be involved in the value chain. However more relevant helpful information should be provided to empower those interested this venture.

**Table 4.2.5: Gadget use willingness**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	MODERATELY WILLING	67	17.6	17.7	17.7
	HIGHLY WILLING	97	25.5	25.7	43.4
	VERY HIGHLY WILLING	214	56.2	56.6	100.0
	Total	378	99.2	100.0	
Total		381	100.0		

Respondents were readily willing to use the electronic gadgets, none of them indicated as not interested and willing to use the ICTs as seen in table 4.2.5. There were 17.7% moderately willing, 25.7% highly willing and 56.6% very highly willing to use the gadgets in the roles in the value chain as shown in table 4.2.5. This was likely because of the benefits derived from the use of ICTs in the value chain for instance, faster services, more access to relevant information, timely responses to clients, more sales, more incomes, enhanced value chain performance hence more profits in their roles in the value chain.

**Table 4.2.6 Personal factors descriptive statistics**

		GENDER	AGE	COUNTY NAME	PERIOD INVOLVED	EDUCATION LEVEL	ICT USE AFFECT PROFIT LEVELS
N	Valid	378	378	378	378	378	378
Mean		1.54	3.86	5.00	3.40	1.29	3.51
Std. Deviation		.499	.993	2.585	1.334	.791	1.141
Variance		.249	.986	6.684	1.780	.626	1.301
Skewness		-.160	-.828	.000	-.429	3.213	-.354
Std. Error of Skewness		.125	.125	.125	.125	.125	.125
Kurtosis		-1.985	.429	-1.230	-.909	10.449	-.674
Std. Error of Kurtosis		.250	.250	.250	.250	.250	.250
Sum		582	1459	1890	1286	488	1326

Table 4.2.6 shows descriptive statistics for personal factors. Gender had a mean of 1.54 as the lowest while age had a mean of 3.86 being the highest, the profitability mean was 3.51, meaning that these personal factors positively influenced profitability. The standard deviation for gender was 0.499 which was almost neutral while age indicated 0.993 high positive influence on profitability. From the data the kurtosis shows normal distribution with age having -1.985, 0.429 for age and -0.674 for profitability levels, however kurtosis for education level was 10.449 on the left tail basically most of those involved in the mango value chain possessed low levels of education while very few possessed Diplomas, bachelors' degrees and above.

**Table 4.2.7 Regression of profitability levels on personal factors (Model summary)**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	ANOVA			Sig. F Change	Durbin-Watson
						F Change	df1	df2		
1	.179 <sup>a</sup>	.032	.019	1.130	.032	2.456	5	372	.033	2.264

a. Predictors: (Constant), OPERATION LEVEL, AGE, PERIOD INVOLVED, GENDER, EDUCATION LEVEL

b. Dependent Variable: ICT USE AFFECT PROFIT LEVELS

From table 4.2.7 the adjusted  $r^2$  was 0.019 meaning 1.9% of the total variance in profitability levels would be explained by the variation in personal factors indicated as the independent variables while the remaining 98.1% would be explained by other factors which are not determined by mere chance. The Durbin correlation coefficient was 2.264 which is positive meaning when personal factors are favourable profitability levels increased, research shows that access to ICTs increases access to business information globally hence enhanced profits (www.geopoll.com)

### ICT infrastructure

All the respondents interviewed had electronic devices, 69.6% had smart electronic gadgets while 30.4% had keyboard electronic gadgets as shown in table 4.2.8.

**Table 4.2.8 Gadget type**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	SMART TOUCH SCREEN	263	66.2	69.6	69.6
	KEYBOARD GADGET	115	29.0	30.4	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

According to data shown in table 4.2.9 the respondents accessed basic electronic services as shown; SMS/MMS 68.4%, Voice call 22.8%, Email 1.1%, Skype 0.0%, Whatsapp 5.3%, online chats 0.3

%, Radio 0.5%, Print media 0.0% and 0.8% MIS while ERPs were 0.5%. Clearly from the findings, respondents interviewed largely accessed and used simple ICT services having more complex services such as MIS and ERPs to only 0.5%.

**Table 4.2.9 Service often accessed**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	SMS/MMS	258	67.7	68.4	68.4
	VOICE CALL	86	22.6	22.8	91.2
	EMAIL	4	1.0	1.1	92.3
	SKYPE	1	.3	.3	92.6
	WHATSAPP	20	5.2	5.3	97.9
	ONLINE CAHTS	1	.3	.3	98.1
	TELEVISION	1	.3	.3	98.4
	RADIO	1	.3	.3	98.7
	MIS	3	.8	.8	99.5
	ERPs	2	.5	.5	100.0
Total		377	99.0	100.0	
Total		381	100.0		

As observed in table 4.2.10, respondents operating as farmers, pickers & transporters, marketing & distributors used the gadgets more in terms of their percentage, 87.0% while those involved in other roles in the value chain used gadgets to the tune of 13.0%, being brokers, exporters and processors, these categories of roles in the value chain are so few, most likely the reason mango fruit yield is lost through decay, pest infestation and damage due to weather extremes. It was observed that 7.9% of those included in this research were brokers, these acted as intermediaries between the farmers and marketers as well as processors. Farmers claimed that for the mango

product to reach the marketer and processor there was delay and costs increased due to the brokerage. This implies that there was time wastage and unnecessary expenditure attributable to the brokerage which should be avoided by shortening the distribution channel from production to the sale of the final product.

**Table 4.2.10 Operation level**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	FARMER	299	75.3	79.1	79.1
	PICKER & TRANSPORTER	30	7.6	7.9	87.0
	MIDDLEMAN/BROKER	30	7.6	7.9	95.0
	MARKETING & DISTRIBUTION	8	2.0	2.1	97.1
	EXPORTER	10	2.5	2.6	99.7
	PROCESSOR	1	.3	.3	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

The respondents who possessed smart gadgets were 69.6 from table 4.2.8 while the rest owned keyboard gadgets. As observed in table 4.2.11, 45.0% were multimedia while those who were not skilled were 55.0%, therefore more training on ICTs and especially use of such media was necessary to boost performance of the value chain. The county government was making an effort to train the residents but during this research it was not clearly established how many of the respondents benefited from such training.

From table 4.2.10, more people were involved in the farming and less in picking and marketing. This is most likely the reason for mango fruit losses realized at the farm level clearly because more mangoes are produced than would eventually reach the market and/or reach the processors. In the value chain most, stakeholders only used basic ICTs services such as SMS/MMS and voice call, noted in table 4.2.9. The local radio channels are effective in PRA & ME but as indicated it was not exploited effectively.

**Table 4.2.11 Possess multimedia skill**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	170	44.6	45.0	45.0
	NO	208	54.6	55.0	100.0
	Total	378	99.2	100.0	
Total		381	100.0		

From table, 4.2.12, respondents said that the county was widely covered with telephony networks i.e 96.6% with only 3.4% respondents reporting that major telephony networks in Kenya were not stable but only for those areas that had terrestrial challenges such as hills and valleys.

**Table 4.2.12 Telephony network coverage**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	365	95.8	96.6	96.6
	NO	13	3.4	3.4	100.0
	Total	378	99.2	100.0	
Total		381	100.0		

**Table 4.2.13 ICTs infrastructure descriptive Statistics**

	GADGET USE WILL- INGNESS	OPERA- TION LEVEL	POSSESS ELECTRONICC GADGET	GADGET TYPE	SERVICE OFTEN AC- CESSED	POSSESS MULTIMEDIA SKILL	TELEPHONY NET- WORK COVER- AGE	ICT USE AFFECT PROFIT LEVELS
N Valid	378	378	378	378	378	378	378	378
Mean	3.39	1.42	1.00	1.30	1.69	1.55	1.03	3.51
Std. Deviation	.771	.950	.000	.461	1.811	.498	.182	1.141
Variance	.594	.902	.000	.212	3.281	.248	.033	1.301
Skewness	-.795	2.470		.854	4.674	-.203	5.130	-.354
Std. Error of Skewness	.125	.125	.125	.125	.125	.125	.125	.125
Kurtosis	-.873	5.700		-1.277	25.232	-1.969	24.451	-.674
Std. Error of Kurtosis	.250	.250	.250	.250	.250	.250	.250	.250
Range	2	5	0	1	13	1	1	4
Sum	1281	537	378	493	639	586	391	1326

The data in table 4.2.13 shows that, the mean for willingness to use an electronic gadget was highest at 3.39, gadget type owned was 1.30 while telephone coverage was 3.51 meaning for the three variables in ICT infrastructure respondents strongly agreed that they influenced profitability positively which had a mean of 3.51. The standard deviation of willingness to adopt ICTs in the value chain was significant at 0.771, operational level was 0.950 while profitability levels standard deviation was 1.141 far from the mean. Data distribution was normal, with the level of

skewness being between -0.795 on the left and 4.674 on the right, meaning more respondents strongly agreed that use of ICTs positively influenced profitability levels.

**Table 4.2.14 Possess multimedia skills**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	170	42.8	45.0	45.0
	NO	208	52.4	55.0	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

Since possession of ICT gadget and multimedia skills were high, the county government of Makueni needs to train the people involved in the value chain more especially in the use of smart ICT gadgets and internet which would enhance the mango value chain hence improve on profitability levels, notably access to information on training was low with only 31.5% of respondents affirming that they were able to access information on relevant training pertaining their roles in the vale chain, as seen in table 4.2.19.

**Table 4.2.15 Regression of profitability levels on ICT infrastructure (Model summary)**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F			Sig. F Change	Durbin-Watson
						Change	df1	df2		
1	.108 <sup>a</sup>	.012	-.004	1.143	.012	.732	6	371	.624	2.253


a. Predictors: (Constant), TELEPHONY NETWORK COVERAGE, GADGET USE WILLINGNESS, SERVICE OFTEN ACCESSED, GADGET TYPE, POSSESS MULTIMEDIA SKILL, OPERATION LEVEL b. Dependent Variable: ICT USE AFFECT PROFIT LEVELS

From table 4.2.15, the adjusted  $r^2$  was -0.04 meaning 4% of the total variance in profitability levels would be explained by the variation in ICTs infrastructure indicated as the independent variables while the remaining 96% would be explained by other factors which are not determined by mere chance. The Durbin correlation coefficient was 2.253 which is positive meaning when ICTs infrastructure were favourable, profitability levels increased, research shows that access to ICTs increases productivity in agriculture as well as profitability levels Lukman et al (2022).

### Farm factors

Stakeholders in various levels in the value chain accessed information on various aspects, 96.3% admitted that they accessed relevant information for their roles while only 3.7% did not respond in the affirmative, as seen in table 4.2.16.

**Table 4.2.16 Relevant information access**



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	364	94.3	96.3	96.3
	NO	14	3.6	3.7	100.0
	Total	378	97.9	100.0	
Total		386	100.0		

Specific information accessed was on availability of seedlings 89.9% accessed such information in table 4.2.17, 21.4% accessed information on fertilizers, farm equipment & implements table 4.2.18, this is probably the reason why most farms are not mechanized and most of the processes are manual in the value chain. The respondents indicated that extension services and support and training were available but only accessible by 31.5% according to data in table 4.2.19.

**Table 4.2.17 Seedling information**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	340	85.6	89.9	89.9
	NO	38	9.6	10.1	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

**Table 4.2.18 Fertilizer farm equipment & implements**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	81	20.4	21.4	21.4
	NO	297	74.8	78.6	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

**Table 4.2.19 Training information**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	119	30.0	31.5	31.5
	NO	259	65.2	68.5	100.0
	Total	378	95.2	100.0	
Missing	System	19	4.8		
Total		397	100.0		

Training is important for empowering stakeholders and since 100% of all respondents held ICT gadgets the county government should use them to train so as to improve performance of the value chain. This was also collaborated by documented data that Kenyans held ICT gadgets and

especially mobile phones, with some having subscribed to more than one service providers (CAK 2022).

Number of trees and size of the farms were important factors in this study. However, from the data small and medium farms were 93.9%, with less than 80 trees in the farm from tables 4.2.20 and 4.2.21..Larger farms in acreage with more trees used ICTs more, especially SMS/MMS and voice calls most likely because of economies of scale which means costs per unit would be lower if the farms were larger with more trees hence more profits being realized, therefore the users of ICTs increased their outputs, reduced costs and enhanced their incomes and profits.

**Table 4.2.20 Farm acreage**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-3 ACRES	115	29.8	30.4	30.4
	4-7ACRES	125	32.4	33.1	63.5
	8-15 ACRES	82	21.2	21.7	85.2
	15-30 ACRES	30	7.8	7.9	93.1
	ABOVE 31 ACRES	26	6.7	6.9	100.0
	Total	378	97.9	100.0	
Total		386	100.0		

**Table 4.2.21 Mango tree number**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	10-20 TREES	66	17.3	17.5	17.5
	21-40 TREES	81	21.3	21.4	38.9
	41-80 TREES	131	34.4	34.7	73.5

81-150 TREES	84	22.0	22.2	95.8
ABOVE 151 TREES	16	4.2	4.2	100.0
Total	378	99.2	100.0	
Total	381	100.0		

**Table 4.2.22 Farm/venture ownership**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	SELF	190	47.9	50.3	50.3
	FAMILY	188	47.4	49.7	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

All the respondents affirmed that the farms and ventures they were involved in were either owned by self or by the family, as shown in table 4.2.22 none was hired. This means there was permanency and security hence financing of the businesses would be easy even through formal established financial institutions. This permanency is very vital in agriculture as well as in any other commercial venture since it creates visibility and reassures clients in the area where the venture is domiciled.

**Table 4.2.23 Farm factors descriptive statistics**

FARM OR VENTURE OWNERSHIP	MANGO TREE NUMBER	FARM ACRAGE	RELEVANT INFORMATION ACESS	SEED-LING INFORMATION	FERTILIZER FARM EQUIPMENT & IMPLEMENTS	TRAINING INFORMATION	ICT USE AFFECT PROFIT LEVELS
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N Valid	378	378	378	378	378	378	378	378
Mean	1.50	2.74	2.28	1.04	1.10	1.79	1.69	3.51
Std. Deviation	.501	1.114	1.177	.189	.301	.411	.465	1.141
Variance	.251	1.242	1.384	.036	.091	.169	.216	1.301
Skewness	.011	-.058	.763	4.922	2.667	-1.398	-.801	-.354
Std. Error of Skewness	.125	.125	.125	.125	.125	.125	.125	.125
Kurtosis	-2.011	-.823	-.181	22.349	5.143	-.045	-1.366	-.674
Std. Error of Kurtosis	.250	.250	.250	.250	.250	.250	.250	.250
Sum	566	1037	861	392	416	675	637	1326

From table 4.2.23, the distribution is normal with values lying between -0.181 for farm acreage to 22.349 relevant information accessed meaning the curve had extreme spread values. The mean of relevant information accessed was lowest while for number of mango trees was highest with 2.74, the mean of profitability levels was 3.51. the standard deviation for relevant information accessed was 0.301, farm/venture ownership was 0.501 while standard deviation for profitability levels was 1.141 form the sample mean. The variance from the mean for farm/venture ownership was 0.251, for relevant information accessed was 0.189 while profitability levels variance was 1.301.

**Table 4.2.24 Regression of profitability levels on farm factors (Model summary)**

Model	R	R Square	Adjusted R Square	Std. Error of the	F	Significance Statistics	Sig. F	Durbin-
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				Estimate	R Square Change	Change	df1	df2	Change	Watson
1	.122 <sup>a</sup>	.015	-.004	1.143	.015	.801	7	370	.587	2.246

a. Predictors: (Constant), TRAINING INFORMATION, RELEVANT INFORMATION ACCESS, FERTILIZER FARM EQUIPMENT & IMPLEMENTS, SEEDLING INFORMATION, MANGO TREE NUMBER, FARM ACORAGE, FARM OR VENTURE OWNERSHIP

b. Dependent Variable: ICT USE AFFECT PROFIT LEVELS

Table 4.2.24 shows the adjusted  $r^2$  was -0.04 meaning 4% of the total variance in profitability levels would be explained by the variation in farm factors indicated as the independent variables while the remaining 96% would be explained by other factors which are not determined by mere chance. The Durbin correlation coefficient was 2.246 which is positive meaning when ICTs infrastructure are favourable profitability levels increased, research shows that farm factors such as farm/venture ownership, size of the farm, number of trees in the farm are important considerations in productivity in agriculture as well as in enhancing profitability levels. Yaseen,2016 emphasized on the importance of stability of agricultural land ownership, access to necessary information and farm machinery if food sustainability and security was to be achieved.

### ICTs cost factors

The respondents in various roles in the value chain affirmed that they considered specific factors when acquiring the ICTs such as; the prices of the gadgets, availability, user friendliness, convenience though not to large extent. They also reported that both the ministry of agriculture or ICT department did not have any preferred gadget and therefore they procured ICTs and gadgets of their preference based on the cost factors mentioned, from table 4.2.25, 81.2% considered the prices of the gadgets they purchased.

**Table 4.2.25 Gadget price considered**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	307	77.3	81.2	81.2

	NO	71	17.9	18.8	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

According to data in table, 4.2.26, it was discovered that 94.7% considered the availability of the gadget while purchasing 5.3% would purchase any gadget without much search in the market. They also explained that spare parts needed also to be available and affordable 61.9% as per table 4.2.27 ,66.1% considered user friendliness table 4.2.28, 87.8% minding about the convenience as seen in table 4.2.29 while 92.3% reporting that security was vital when choosing the gadget according to data in table 4.2.30.

**Table 4.2.26 Gadget availability**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	358	92.7	94.7	94.7
	NO	20	5.2	5.3	100.0
	Total	378	97.9	100.0	
Total		386	100.0		

**Table 4.2.27 Ease of maintenance**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	234	60.6	61.9	61.9
	NO	144	37.3	38.1	100.0
	Total	378	97.9	100.0	
Missing	System	8	2.1		

Total		386	100.0	
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**Table 4.2.28 User friendly**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	250	64.8	66.1	66.1
	NO	128	33.2	33.9	100.0
	Total	378	97.9	100.0	
Missing	System	8	2.1		
Total		386	100.0		

**Table 4.2.29 Convenience**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	332	86.0	87.8	87.8
	NO	46	11.9	12.2	100.0
	Total	378	97.9	100.0	
Missing	System	8	2.1		
Total		386	100.0		

**Table 4.2.30 Security**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	349	90.4	92.3	92.3
	NO	29	7.5	7.7	100.0
	Total	378	97.9	100.0	
Missing	System	8	2.1		
Total		386	100.0		

**Table 4.2.31 ICTs cost factors descriptive statistics**

	CON- SIDER ANY FAC- TORS	GADGET PRICE	GADGET AVAILABIL- ITY	USER FRIENDLI- NESS	CON- VINIENCE	EASY MAINTEN- NANCE	SECURITY	ICT USE AF- FECT PROFIT LEVELS
N Valid	378	378	378	378	378	378	378	378
Mean	1.00	1.19	1.05	1.34	1.12	1.38	1.08	3.51
Std. Deviation	.000	.391	.224	.474	.327	.486	.266	1.141
Variance	.000	.153	.050	.225	.107	.236	.071	1.301
Std. Error of Skewness	.125	.125	.125	.125	.125	.125	.125	.125
Std. Error of Kurtosis	.250	.250	.250	.250	.250	.250	.250	.250
Sum	378	449	398	506	424	522	407	1326
Skewness		1.605	4.010	.685	2.324	.492	3.194	-.354
Kurtosis		.579	14.158	-1.539	3.417	-1.767	8.242	-.674

All respondents indicated that they considered the various cost factors, mean being was 1.00 and not deviation since all observations fell at the mean. The mean of respondents who agreed to consider price of the ICT gadgets was 1.19 while those who considered security was 1.08. The data was skewed to the right with skewness values ranging from -0.354 on the left to 4.010 to the

right, with kurtosis values for the cost factors ranging from 0.579 to 14.158. The values had variances of 0.0, 0.153 and 0.071 for whether they considered these factors, cost of the ICTs and for security respectively. Respondents agreed that all these cost factors as considered influenced income levels hence profitability levels.

**Table 4.2.32 Regression of profitability levels on ICTs cost factors (Model summary)**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	Df		Sig. F Change	Durbin-Watson
1	.140 <sup>a</sup>	.020	.004	1.138	.020	1.238	6	371	.286	2.244

a. Predictors: (Constant), SECURITY, EASY MAINTENANCE, GADGET PRICE, USER FRIENDLINESS, GADGET AVAILABILITY, CONVINIENCE

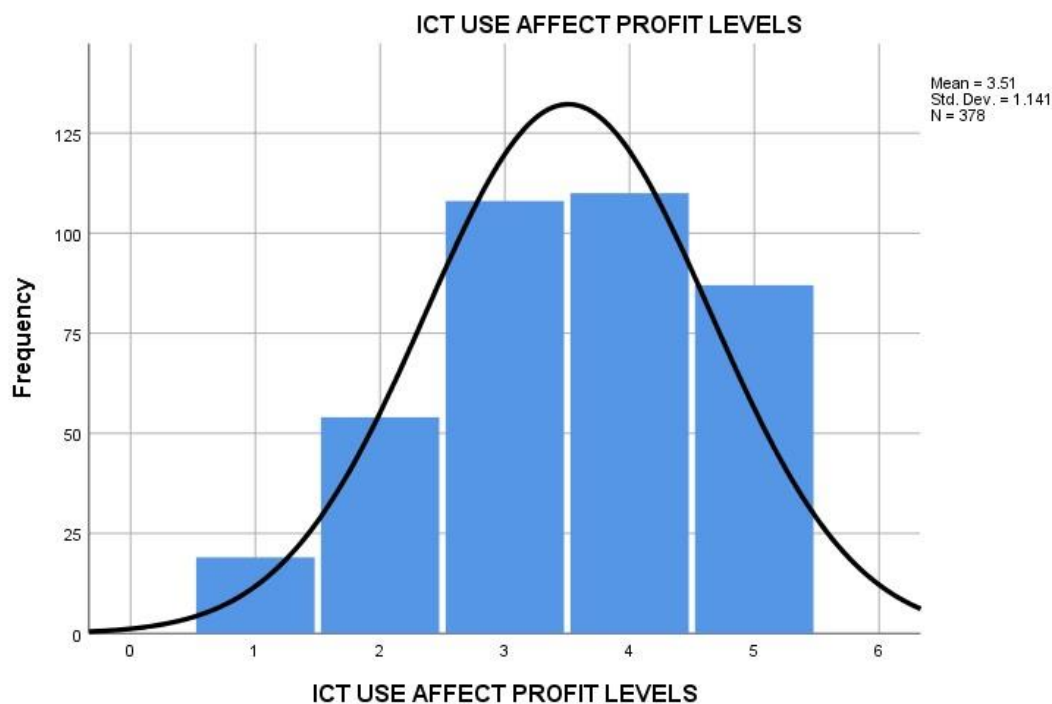
b. Dependent Variable: ICT USE AFFECT PROFIT LEVELS

In table 4.2.32, the adjusted  $r^2$  was 0.04 meaning 4% of the total variance in profitability levels would be explained by the variation in ICTs cost factors indicated as the independent variables while the remaining 96% would be explained by other factors which are not determined by mere chance. The Durbin correlation coefficient was 2.244 which is positive meaning when ICTs cost factors are favourable profitability levels increased, research shows that ICTs cost factors such as security, ease of maintenance, gadget price, user friendliness, gadget availability and convenience are important considerations in productivity in agriculture as well as in enhancing profitability levels. Yaseen, 2016 emphasized on the importance of stability of agricultural land ownership, access to necessary information and farm machinery if food sustainability and security was to be achieved. Aaron et al, January 2024, emphasized on the use of cost benefit analysis methodologies by farmers to ensure that there was enhanced productivity and profitability.

**Table 4.2.33 ICTs use affect profits**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	VERY LOWLY	19	4.8	5.0	5.0
	LOWLY	54	13.6	14.3	19.3
	MODERATELY	108	27.2	28.6	47.9
	HIGHLY	110	27.7	29.1	77.0
	VERY HIGHLY	87	21.9	23.0	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

According to table 4.2.33, respondents' data indicated that 24.3% use of ICTs affected profits very lowly or low but 75.7% felt strongly that ICTs use enhance profitability levels.



**Figure 4.2.1: Effect of ICTs use on profitability**

### Government policy

The current Kenya Government ICTs policy has the following principles; putting ICTs at the centre of national economic agenda, improving access to ICTs especially broadband internet,

using ICTs to improve public services delivery and maintaining an open government (National Information, Communication and Technology policy 2019).

The regional Governments are supposed to implement this national ICT policy tenets. Makueni county has implemented this by ensuring that the locals are trained, that relevant MDAs support the locals and particularly stakeholders in the mango value chain. The county has tried to actualize economic development agenda through availing information on seedlings, fertilizers, extension services and farm machinery through electronic devices prompts and alerts. government information through prompts and alerts was effective and 42.9% acknowledged receipt and appreciated government efforts while 57.1% did not receive them.

Making government services available and accessible was notable during the data collection period, all information the researcher required was availed, the same is also free for access by the publics in Makueni as well as exogenous people. In the data collected, 76.2% of the respondent reported that the county agricultural ministry was supportive with 23.8 %feeling that the support from the ministry was not adequate. Respondents indicated that the ICT department was supportive, with 39.7% to the affirmative and 60.3% dissenting, this means more support by this department to the value chain was needed, there is need for more stakeholders to be trained on multimedia skills especially the use of internet so as to broaden access to information and improve performance of the value chain.

### **Attitude of the people**


Attitude is a feeling or opinion about something or somebody. It can be positive or negative, this may lead to support or opposition respectively to something or somebody. During the research period and interaction with locals in the county, they were clearly positive about the use of ICTs, with 24.1% moderately willing, 31.0% highly willing and 45.0% very highly willing to use the various ICTs at their different levels of operation in the value chain. With more sensitization, the 24% who are moderately willing to apply ICTs in their roles will improve on its uptake.

The locals and external (including exporters and brokers) stakeholders involved in the interview were enthusiastic to use ICTs, although the older people were not using smart phones, they stuck with keyboard phones which they indicated as easier for them to use. However, for both smart and keyboard users they still posted increased outputs and increased profits.

### Effects of the ICTs use

Respondents indicated that generally ICTs use in the value chain reduced operational costs, enhanced incomes and profits those who said ICTs had an effect were 99.5%. Respondents indicated that use if ICTs reduced operational costs, 95.8% affirmed that incomes would increase while 4.2% thought otherwise. Profitability levels were enhanced as reported by 95% while 5% felt that profits did not increase.

**Table 4.2. 34 ICTs use enhancing profits**



		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	VERY LOWLY	19	4.8	5.0	5.0
	LOWLY	54	13.6	14.3	19.3
	MODERATELY	108	27.2	28.6	47.9
	HIGHLY	110	27.7	29.1	77.0
	VERY HIGHLY	87	21.9	23.0	100.0
	Total	378	95.2	100.0	
Total		397	100.0		

Only 24.3% indicated that profits were not enhanced by use of ICTs but 75.7% felt profits improved due to ICTs application in the value chain.

It is also clear from the data in table 4.2.35 that 27% of farms sold very low and low, moderate level incomes were 31.5 %, while only 41.5% said their incomes were high and very high.

**Table 4.2.35 ICT use affect income levels & profits**

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	VERY LOWLY	15	3.8	4.0	4.0
	LOWLY	87	21.9	23.0	27.0
	MODERATELY	119	30.0	31.5	58.5
	HIGHLY	79	19.9	20.9	79.4
	VERY HIGHLY	78	19.6	20.6	100.0
	Total		378	95.2	100.0
Total		397	100.0		

This means there is a lot of loss in the mango fruit, therefore marketers, distributors and processors should be supported so as to improve on their performance to reduce losses in the value chain.

### **4.3 Summary of data analysis**

The collected was analyzed using SPSS software. The data had 4.9% missing system which did not affect the validity of the data or cause any bias in the conclusion made after analysis (Titocan 2021). From the data more females were involved in the value chain than men, it is also indicated that older respondents were involved in the mango value chain than the younger generation. The data was also indicating that more stakeholders in the value chain had lower academic credentials.

As indicated in the data, all respondents had electronic devices that were extensively used for SMS/MMS and voice call i.e. 90.2%, it means the stakeholders carry out simple basic services with their gadgets. The multimedia services eg Email, Skype, print media and MIS would

provide more information and consequently more benefits accruing timely and a wider range of information.



## **CHAPTER FIVE**

### **SUMMARY OF THE FINDINGS, CONCLUSIONS AND RECOMMENDATIONS**

#### **5.1 Introduction**

This part consists of the findings of the research, conclusions and recommendations for further action on the subject under research.

#### **5.2 Summary of findings**

##### **Personal factors**

Personal factors of the respondents included age, gender, county of residence, the period one was involved in the venture in the value chain and education levels of the respondents. From the data it was found out that more elderly respondents were involved in the value chain, with only 12.2% being 25 years and below; all through the value chain from farming to marketing, distribution and processing, probably because the younger people prefer other activities/job other than those in the value chain and basically fearing away from agriculture.

More women ,54% were involved the mango value chain than men at 46%. The respondents were picked from all the nine sub-counties equally i.e 42 respondents from each county. During the research nine (9) agricultural extension officers were interviewed. The respondents had different time periods they were involved in their roles in the value chain. Generally, the respondents agreed that use of ICTs in the value chain enhanced profitability despite their vast heterogeneity of factors considered under personal factors.

### **ICT infrastructure**

ICTs infrastructure factors considered were respondent willingness to use the ICTs, level of operation in the value chain, possession of an electronic gadget, type of gadget, service often accessed in the value chain, possession of multi-media skills and telephony network coverage.

All respondents agreed that they used ICTs in their operations, they were operating at different levels in the value chain including farming, picking/distribution, marketing, brokerage, exporting and in processing. 42.8% possessed keyboard ICTs while 58.2% possessed smart technology gadgets. 66.2% had proficiency in the use of multi-media ICTs while 39.8% did not. Using the ICTs was not a challenge to many since 96.6% was covered with telephony networks, in fact 100% of the respondents were subscribers to various telephony companies, with some users narrating that they owned more than one gadget and had access to more than one USSD services. From this research ,it was found that every respondent had at least one electronic communication device as it was supported in , [www.geopoll.com\(2020\)](http://www.geopoll.com(2020)). The informants data from all the sub counties indicated that 66.7 % of stakeholders were willing to use ICTs in their roles in the value mango value chain. 77.8% of all the stakeholders, according to the key informant agreed that use of ICTs in the value chain enhanced profitability

### **Farm factors**

The farm factors considered included; ownership of the venture, number of mango trees in the farm, farm size in acreage, access to relevant information for the level they operate at, access to

information on seedlings, access to information on farm equipment, tools & implements, access to information on training, etc.

For stability the respondents owned their ventures as individuals and families, none of the operated a farm/venture on rented basis. By and large the farms owned by farmers on which the mangoes were grown were small in size and had a few numbers of mango trees, 63.5% of the farm were below 7 acres, meaning the mango farming was done at small scale hence those involved in the value chain narrated that they did not enjoy the benefits of economies of scale especially when acquiring farm machinery, tools, implements and fertilizers. Although 89.9% agreed to have received relevant information, only 21.4% said they were able to access information on farm tools, machinery and implements.

Despite the vast range of factors considered under farm factors the variable mean ranged from 1.04 to 3.51 and the standard deviations range from 1.89 to 1.141 all indicating a positive relationship and the standard deviation being significant in for variables.

### **Cost factors**

The respondents agreed that they considered ICTs cost factors before acquiring the gadget for their various roles in the value chain. The factors include; the price, availability, user- friendly, convenience during use, ease of maintenance and security of the gadget. Importance to these factors was attached when acquiring the gadgets and during the analysis respondents agreed that after careful emphasis on them output levels increased, income levels improved hence enhancing profitability levels.

### **5.3 Conclusions**

During the research it was found that the mangoes produced in Makueni county are processed minimally in by the local processor that is only able to take 4000 metric tons, others are processed by companies such as Delmonte, Coca cola, pick and peel etc. based in Kenya but outside Makueni county. In the near future the volumes of fruit bought directly by these

companies may reduce since in cost cutting efforts some of those companies, a case in point, Delmonte have 5planted their own mango trees. This points to the need and clarion call to Makueni county government to increase processors of this fruit locally.

At the period of this research, it had not been established the volumes of mango that these companies buy from Makueni. It was also explained by farmers that some raw mango was sold as Kachari albeit in very small quantities. However, observations and narration from stakeholders, especially farmers indicated that a lot of mangoes did not get to the markets from the farms.

From the data collected farmers indicated that more than 50% of their produce is lost through pest infestation and decomposition due to inaccessibility to markets at the time the mangoes are ready for harvesting. The county government should put effort to ensure that such losses are not experienced by farmers.

The government should establish M&E functional units in all MDAs (Ministries, Departments and Agencies) to be issuing regular reports on government projects since it will be easy due to wide spread ICTs country wide, such reports in agriculture will be very helpful to guarantee focus on ICTs mainstreaming in agriculture for sustainable food production and food security. Such reports should use the common media publicity tools e.g. local vernacular radio, print media etc. Vividly, COVID 19 brought a new normal, opening a wide sphere of application of ICTs in many aspects and globally it was awakening particularly at the times of quarantine/isolation and lockdowns when business had to be done online. This phenomenon opened and amplified a new communication frontier, the social media, from this data, 6.7% of the stakeholders used it, as WhatsApp, online chats and Emails.

From the data collected 69.6% of the stakeholders were using keyboard electronic gadgets, probably because a large percentage of stakeholders did not have skills to use multimedia electronic devices with 45% having the skills while 55% did not have the multimedia skills.

Stakeholders narrated that more training on their roles was necessary, they also said that they required more support from the government on availability of services and equipment they require in line of the role in the value chain. They also raised the issue on the presence of brokers in the value chain who were preventing direct access to pickers & distributors, marketers, exporters and processors. Obviously, these middlemen slowed down the processes of the value chain but during this study it was not established to what extent their existence affected the chain in terms of time and cost.

#### **5.4 Recommendations**

##### **i) The authorities for implementation**

From the study, the county government needs to increase communication to farmers especially through ensuring that more internet is installed across the county. From the findings more farmers only utilized their phones for the simple utility features such as SMS and voice call, the multimedia would be more beneficial as it would transmit more elaborate and details information to the value chain stakeholders.

This study established the factors that determine the application of ICTs. In spite of the fact that it will also improve access to information on agricultural products and services. ICT uptake has not been as good as in agriculture as has been employed in other sectors of the economy such as in banking, air transport, governance, geospatial resource mapping & management, weather forecasting etc. Through multi- sectoral approach and inert-governmental collaborations, the Kenyan Government has been putting a lot of effort to ensure ICTs are applied in agriculture.

The county government needs to commit resources to training and also establishment of fiber network infrastructure to promote use of smart phones with more operational features/ capability.

## **ii) Service users/ beneficiaries**

The mango value chain involved farmers, mango pickers and transporters, middlemen/brokers, marketers and distributors, exporters and processors. All these people involved in the value chain relied on one another for the effectiveness of the processes of the value chain.

Farmers supplied quality fruit to the pickers and transporters who delivered to individual mango fruit consumers or processors. From the farms middlemen/brokers were involved in identifying the farms with ready mangoes, they also negotiated the prices mediating between the farmer and the marketer/distributor. At this level it was found out that the brokers would underprice the mangoes leading to losses to farmers since the middlemen/brokers would not be mindful about the production costs incurred by farmers. It was found out that they dominated the market being 30 and rarely would farmers directly access the buyers. It is therefore recommended that these middlemen/brokers leave the chain so that farmers can directly access buyers for more profits.

From the study it was found out that marketers /distributors were 8, the exporters were 10 while the processor was only one in the county. The numbers of these stakeholders were fewer as compared to the farmers; this led to most of the mango fruits not reaching the market hence a lot of spoilage was experienced by farmers. Since this chain has the potential of generating incomes and profits for the stakeholders more of them should join in this venture. This could be done through peer-peer sensitization through ICT4D using local and social media.

## **iii) other stakeholders**

In the value chain there are other stakeholders such as the horticultural products sellers, sellers of fertilizers, seedlings, agricultural extension service providers and agricultural officers. These support services are crucial to the success of the value chain.

From the study it was found out that access to information for especially farmers in the value chain was above 50% but access to training for the stakeholders in the value chain was 30%, the

training needs to be improved so as to improve incomes and profits for stakeholders in the value chain.

### **5.5 Recommendations for further studies**

Future research may be carried on the use of more beneficial technology in agriculture so as to improve on food security in the county and globally. From this study MIS, ERPs, GPS/GIS and skype were not widely applied. Therefore, further research on how better such technologies would be employed in agriculture would be important and necessary. Artificial intelligence is also an important area of applied technology that would assist in agricultural production and food security.

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**APPENDIX I: INTRODUCTION LETTER**

**Introduction Letter**

Mutune Judith Mbete,

P.o Box 15365,

Nairobi.

The Manager .....

Ministry of Agriculture Makueni County-Kenya

P.O Box .....

Dear Sir/Madam,

Re: Research Study:

I am a student at the Mount Kenya University Nairobi Campus, pursuing a Master’s degree in Development studies, specializing in Monitoring and Evaluation. Currently, I am undertaking research on “monitoring and evaluation on the extent of use of ICT in the mango value chain in Makueni county; Kenya.

I therefore request for your participation and free response to the questions in this questionnaire. The questionnaire consists of two sessions and it is self administered. The information provided will only be used for academic purposes and will not be diverged to anyone whatsoever. The questionnaire will be used to carry out research in various subcounties of Makueni county.

Thank you in advance,

Yours Faithfully,

Mutune Judith Mbeti

**MAME, Student Mount Kenya University**



## APPENDIX II: QUESTIONNAIRE

### QUESTIONNAIRE

#### Questionnaire Instructions

Tick [√] where appropriate or fill in the required information on the spaces provided

#### SECTION 1 DEMOGRAPHIC AND PERSONAL FACTORS

1.Gender: Male [ ] Female [ ]

3.Age:

Less than 18 [ ] 19-25 Years [ ] 25 – 35 Years [ ] 36 -45Years [ ] Over 45 Years

4.Name of sub-county

Sub- county name	Tick appropriately
Makueni	

Mbooni East	
Mbooni West	
Kibwezi West	
Kibwezi East	
Makindu	
Mukaa	
Nzau	
Kilungu	

6. How long have you been involved in mango value chain? Less than 2 years  2 – 5 years  6– 9 years  10 and above

7. What is your level of education?

Primary level  Diploma  University Degree  Masters degree  Doctorate

8. Do you have an Electronic communication gadget?

Yes  No

9. Type of Electronic communication gadget Smart  or keyboarded

## SECTION 2: ICT INFRASTRUCTURE INFORMATION

### A. TYPE OF ICT SERVICE AVAILABLE AND ACCESSIBLE TO RESPONDENTS

The statements below relate to the ICT types of communication available and used in the mango value chain by the respondent. The respondent will have five options corresponding to these statements, stating how often they use the type of communication:

KEY: strongly agree (SA)=5, Agree(A)= 4, Undecided (UD)= 3, Disagree(D)= 2, Strongly disagree (SD)=1

STATEMENT	1	2	3	4	5
Mobile phone SMS/MMS					
Voice call					

Email					
Skype					
Whatsapp image					
Online chats					
TikTok					
Video conferencing					
Smart television					
Fax					
Radio					
GIS/GPS					
Print media eg brochures, newspaper, magazines etc					
MIS					

### **B: THE LEVEL OF OPERATION IN THE MANGO VALUE CHAIN**

The statements below relate to the level of operation of the person in the value chain, intending to establish whether ICT types of communication are used at each level in the mango value chain. The respondent will have five options corresponding to these statements, stating how often they use ICTs of communication during their roles in the value chain:

Tick where applicable:

<b>STATEMENT</b>	<b>Tick</b>
Farmer	
Mango pickers and transporter	

Broker	
Agricultural extension support services	
Marketer /distributor	
Exporter	
Processor	

**C: FACTORS INFLUENCING THE EXTENT TO WHICH ICT INFRASTRUCTURE AVIALABLE IS USED IN THE MANGO VALUE CHAIN**

The statements below relate to the factors that influence the extent to which the stakeholder is using available ICT in mango value chain in Makueni county, tick appropriately.

Are you using any ICTs in your role in the value chain? Yes [ ] No [ ]1

STATEMENT	Tick	Yes	No
Is the area covered with your ICT network			
Does the respondent have an ICT gadget			
Does the stakeholder understand how to use the ICT available			
Is the stakeholder willing to apply ICT in mango value chain			
Does the county agriculture ministry supports use of ICT in mango farming			
Does the ICT department support stakeholders to use ICT			

**D: SPECIFIC INFORMATION ACCESSED BY THE PEOPLE INVOLVED IN THE VALUE CHAIN**

The statements below relate to the specific uses/services the people access through the use of ICTs they have in Makueni County. The respondents will have five options corresponding to these statements, tick appropriately:

Do you use your gadget to access information in the mango value chain? Yes [ ] No [ ]

STATEMENT	TICK	Yes	No
To access information on seedlings for planting			
To access information on fertilizers, herbicides and pesticides			
To access information on availability and costs of farm equipment, machinery and implements			
To access to information on extension support services available in the county			
To access information on training through workshops, seminars, peer-to-peer trainings			
To access to information on available markets for mangoes			
For general information and alerts from the ministry of agriculture Makueni county			

### SECTION 3: COSTS OF ICTs

#### COST FACTORS FOR CHOICE OF THE TYPE OF ICT USED BY THE PEOPLE INVOLVED IN THE MANGO VALUE CHAIN

The statements below relate to the factors considered by stakeholders when choosing the ICT modes of communication available to mango farmers in Makueni County and are used in the mango value chain. The respondents will have five options corresponding to these statements, tick appropriately:

Do consider any factors when choosing the ICTs to use when executing your role in the value chain?

STATEMENT	Tick	Yes	No
Affordability			
Availability			

User friendliness			
Convenience			
Preferred by the ministry of agriculture and ICT department in Makueni county			
Easy to maintain			
Security			
More applicable features			



#### **SECTION 4: FARM FACTORS**

##### **FARM FACTORS AFFECTING THE CHOICE OF TYPE OF ICTs USED BY THE PEOPLE INVOLVED IN THE VALUE CHAIN A: SIZE OF THE FARM LAND UNDER MANGO PLANTATION IN ACRES**

The statements below relate to the size of the farm being used for mango growing in Makueni County. Does farm characteristics affect choice of ICTs and profitability? The respondents will have five options corresponding to these statements, tick appropriately:

STATEMENT	Tick	Yes	No
Very small (2- 3 acres)			
Small (4-5 acres)			
Medium (6-9 acres)			
Large (10-15 acres)			

Very large (16 acres and above)			
---------------------------------	--	--	--

**B: NUMBER OF TREES IN THE FARM**

The statements below relate to the number of mangoes trees in the farm. The respondents will have five options corresponding to these statements, tick appropriately:

KEY: very few (VF)=5, few(F)= 4, medium(M)= 3, many(M)= 2, very many (VM)=1

STATEMENT	Tick	Yes	No
Very few (15- 50 plants)			
Few (51-80 plants)			
Medium (81-100 plants)			
Many (101- 150 plants)			
Very many (151 and above)			

**B: ESTIMATED PERCENTAGE MANGOES SOLD PER SEASON FROM THE FARM**

The statements below relate to the number of mangoes trees in the farm. The respondents will have five options corresponding to these statements, tick appropriately:

STATEMENT	Tick	Yes	No
Very few (0-25%)			
Few (26% -45% )			
Medium (46%-60% )			
Many (61%- 80%)			
Very many (80% and above)			

**SECTION 5: REASONS USE OF ICTs ENHANCING PROFIT LEVELS IN THE MANGO VALUE CHAIN IN MAKUENI COUNTY**

The statements below relate to the view of stakeholders in the mango value chain relating to enhancement of performance of the mango value chain. The respondents will have five options corresponding to these statements, tick appropriately,

STATEMENT	Tick	Yes	No
Has use of ICTs improved access to important information to you?			
Has the ICTs you are using reduced time period of your operations?			
Has the use of ICTs reduced your costs of operations?			
Has the application of ICTs enhanced your operational efficiency?			
Has your productivity levels improved due to use of ICTs?			
Has the use of ICTs enhanced your profitability levels?			

**SECTION 6: INTERVENING FACTORS IN THE USE OF ICTs ENHANCING PROFIT LEVELS IN THE MANGO VALUE CHAIN IN MAKUENI COUNTY**

The statements below relate to the view of stakeholders in the mango value chain relating to enhancement of performance of the mango value chain. The respondents will have five options corresponding to these statements, tick appropriately.

STATEMENT	Tick	Yes	No
Has your choice of ICTs been influenced by county government preference?			
Does the county government support your role in the value chain?			
Does the government support in use of ICT in the value chain enhance profitability?			

Are you aware of the existence of the ICT policy?			
Has the enforcement of the ICT policy enhanced profitability levels in the value chain?			

## SECTION 7: AGRICULTURAL EXTENSION OFFICERS

### H: BIODATA

1. Gender: Male  Female
2. Age:  
 19-25 Years  25 – 35 Years  36 -45Years  Over 45 Years

3. Name of sub-county

Sub- county name	Tick appropriately
Makueni	
Mbooni East	
Mbooni West	
Kibwezi West	
Kibwezi East	
Makindu	
Mukaa	
Nzau	
Kilungu	

### 4. What is the level of willingness of using ICTs

The statements below relate to the willingness of stakeholders to use ICTs1

. The respondents will have five options corresponding to these statements, tick appropriately:

STATEMENT	TICK
Very low	
Low	
Undecided	
High	
Very high	

5. Is there noticeable improvement in access to information? Yes [ ] No [ ]

6. Have stakeholders reported enhanced profitability due to use of ICTs in the value chain? Yes [ ] No [ ]

Thank you for your participation.



### **APPENDIX III: INTRODUCTORY LETTER**



## DIRECTORATE OF GRADUATE STUDIES

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MAME/2020/66347

6<sup>th</sup> September, 2024

National Commission for Science Technology & Innovation (NACOSTI)  
Off Waiyaki Way, Upper Kabete,  
P.O Box 30623- 00100  
NAIROBI, KENYA

Dear Sir/Madam,


**RE: MUTUNE JUDITH MBETE – REGISTRATION NO. MAME/2020/66347**

The purpose of this letter is to introduce the above named student who is pursuing **Master of Arts in Monitoring and Evaluation** in the Department of **Social and Development Studies** in the School of **Social Sciences**.

The title of the research is "**Assessment of Factors Affecting Use of ICT on Enhancing Performance of Mango Value Chain in Makeni County, Kenya.**" It has been cleared by the University's Ethics Review Committee (Certificate attached) and now has to proceed to the field to collect data between **September, 2024 and November, 2024**.

Any assistance accorded to the student will be highly appreciated.

Thank you.

  
**Dr. Samuel M. Karenga, PhD**  
**Director, Graduate Studies**  
Enc.

---

Main Campus, General Kego Road, P.O. Box 342-01000 Thika.

Cell: +254 709 153 000 / +254 709 153 200

Email: info@mku.ac.ke, Web: www.mku.ac.ke

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**APPENDIX IV: NACOSTI LICENCE**





REPUBLIC OF KENYA



NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Ref No: 304165

Date of Issue: 20/September/2024

RESEARCH LICENSE



This is to Certify that Ms. JUDITH MBETE MUTUNE of Mount Kenya University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Makuani on the topic: ASSESSMENT OF FACTORS AFFECTING USE OF ICT ON ENHANCING PERFORMANCE OF MANGO VALUE CHAIN IN MAKUENI COUNTY KENYA for the period ending : 20/September/2025.

License No: NACOSTI/P/24/40109

304165

Applicant Identification Number

Director General NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION

Verification QR Code



NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

## APPENDIX VII: INFORMED CONSENT ON PROPOSAL

Mutune Judith Mbete,

P.o Box 15365, 00100

Nairobi.

The Agricultural officer,

Ministry of Agriculture Makueni County-Kenya

P.O Box .....

24/09/2024 Dear

Sir/Madam,

Re: Research Study:

I am a student at the Mount Kenya University Nairobi Campus, pursuing a Master's degree in Development studies, specializing in Monitoring and Evaluation. Currently, I am undertaking research on "monitoring and evaluation on the extent of use of ICT in the mango value chain in Makueni county; Kenya.

I therefore request for your participation and free response to the questions in this questionnaire. The questionnaire consists of two sessions and it is self administered. The information provided will only be used for academic purposes and will not be diverged to anyone whatsoever. The questionnaire will be used to carry out research in various subcounties of Makueni county.

I accept to responsible and professional during the research and will follow all the stipulated protocol.

Thank you in advance,

Yours Faithfully,



Mutune Judith Mbete

**MAME, Student Mount Kenya University**

