ROLE OF INFORMATION AND COMMUNICATION TECHNOLOGY AND SOCIO-ECONOMIC FACTORS ON MARKETING OF TOMATOES AMONG SMALLHOLDER FARMERS IN KIRINYAGA COUNTY, KENYA

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A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN AGRICULTURAL ECONOMICS OF THE UNIVERSITY OF EMBU

SEPTEMBER, 2021

DEDICATION

This work is dedicated to my dad Melchizedek Mauti, my mum Jemimah Mauti, my siblings Tison, Philip, Caroline and my lovely wife Esther and my son and daughter; Valentine and Gravine. Your encouragement, support and persistent nudging willed me on.

ACKNOWLEDGEMENT

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LIST OF ACRONYMS AND ABBREVIATIONS

AFRRI   African Farm Radio Research Initiative

ANOVA   Analysis of Variance

APT   Arbitrage Pricing Theory

FAO   Food and Agriculture Organization

FAOSTAT   Food and Agriculture Organization Statistical Database

HCD   Horticultural Crops Directorate

ICT   Information Communication Technology

MIS   Management Information System

MNL   Multinomial Logit Model

MOA   Ministry of Agriculture

MOALF   Ministry of Agriculture, Livestock and Fisheries

RUM   Random Utility Model

SDG   Sustainable Development Goal

SSA   Sub Saharan Africa

TAM   Technology Acceptance Model

TRA   Theory of Reasoned Action

DEFINITION OF TERMS

ICT   Technologies that provide access to information through Telecommunications.

ICT tools   Tools used to convey messages from one farmer to another or from agricultural organizations to farmers. They include radios, television, mobile phones, newspapers, and internet.

Marketing   Activities undertaken by farmers to promote the buying or selling of agricultural produce. Marketing include advertising, selling, and delivering agricultural products to consumers.

Market access   The ability of farmers in terms of the extent to which they can reach out in order to sell their tomatoes in different markets categories.

Smallholder tomato farmers   Households with a farm size smaller than or equal to four hectares

ABSTRACT

Tomato is produced and consumed worldwide. In Kenya, tomato is used to generate income among rural people. Despite this, the sub-sector faces numerous challenges such as fluctuating market prices, postharvest losses and inadequate marketing information. In spite of Information and Communication Technology (ICT) use in marketing of tomatoes among smallholder farmers in Kenya, there is scanty information on the information and communication technology usage in marketing of tomatoes among smallholder farmers in Kirinyaga County. The study was carried out in Kirinyaga County considering its five sub-counties. Data collection was done from a sample size of 384 households which were selected using a combination of purposive sampling, two-stage stratified and probability proportionate to size techniques. Primary data were collected using a semi-structured interview schedule. Descriptive statistics was used to analyze the extent of use of selected ICT tools in the marketing of tomatoes, the effect of use of selected ICT tools on the choice of tomato marketing channels was analyzed using multinomial regression model. The effect of use of selected information and communication technology tools on market access of tomatoes was analyzed using analysis of variance and the effect of selected socio-economic factors on the choice of ICT tools used in marketing of tomatoes was analyzed using multinomial probit model. Based on the effect of use of ICT on choice of the marketing channels and market access in marketing of tomatoes among smallholder farmers, tomato farmers in Kirinyaga County access market information through mobile phone, radio and television respectively. The most market accessed through the use of ICT is municipal market, followed by local market and lastly city market. The most marketing channel used is Farmer-Middlemen-Consumer followed by Farmer-Broker-Consumer and last is Farmer-Direct market-Consumer. Some socioeconomic factors such as age, educational level, market distance, knowledge on ICT, willingness to pay, tomato prices, farmers' income, tomato production affect the choice of ICT tools used in marketing of tomatoes. This study provides relevant organizational bodies and policy makers with required information that will aid in improving the tomato marketing sector through promotion of information and communication technology use in marketing of tomatoes.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Tomato, which is among the most valued vegetable crops in the world originated from South America from where it spread to Europe in the sixteenth century and later to East Africa (Etebu *et al*., 2013). There is a tendency by the farmers to embrace new cultivars of tomatoes such as Prostar F1, Rio-Grande, Kilele F1 that are high yielding and disease resistant (Mwangi *et al.,* 2015). Tomato is a source of vitamin C, calories, phosphorous and calcium. Globally, tomato has been ranked as number two after potato as the most important vegetable in most regions of the world (FAOSTAT, 2016).

A review on tomato production worldwide shows that average production of 177 million tons per year was recorded in 2007 (FAO, 2019). In Africa, tomato is mainly grown in Egypt, Morocco, and Algeria. In Sub-Saharan Africa (SSA), farmers produce more tomatoes than other vegetable crops because of its multiple harvests which results to higher profits per unit area of harvest (Affognon *et al*., 2015). There is tremendous increment of tomato production and marketing in Sudan. However, handling of the crop has been dominated by the traditional ways except in small portions where modern farms and supermarkets exists (AbdElrazig *et al.,* 2018). In Kenya, tomato is ranked among the horticultural crops grown under the rain fed conditions and under irrigation by small-scale farmesr (Meena *et al*., 2016). Kirinyaga, Meru, Isiolo, Nyeri, and Taita Taveta are the main tomato producing counties with a total production of 3,476,028 tons per year (Kithinji, 2016).

The relationship and arrangements of tomato production and marketing system are based on structure conduct-relationship paradigms at each marketing level, that is, from production to consumption (Wongnaa *et al*., 2014). Most of the farmers in growing countries are more connected to consumers in local markets. Consequently, the local farmers are confronting a high market competition both in local and international markets (Lambin & Meyfroidt, 2011). Smallholder farmers benefit from tomato fruit production given that, it generates income and acts as source of food security for the people, thereby contributing towards the overall strategy of alleviating poverty (Kahane *et al*., 2013).

Postharvest losses have reduced small-scale farmers' income (Ahmed, 2015). Postharvest losses (PHL) refer to the losses that occur along the food supply chain, from the farm gate through till it gets on the table of the final consumer (Fognon *et al*., 2013). Losses occur along the marketing channel thereby lowering the quality and market value of agricultural produce (Emana *et al*., 2017).

Smallholder vegetable fruit farmers are affected by the inability to reach markets and actively participate in the market (Schreinemacher *et al*., 2018). Access to high value markets (local, municipal and city markets) can increase living standards and eradicate poverty in rural areas (Ogutu *et al.,* 2014). Challenges such as market information asymmetries, poor market research and poor market access capacity hinder smallholder farmers from accessing markets hence huge difference between supply and demand (Kiveu & Ofafa, 2013). Smallholder farmers are also hindered from accessing markets by information imbalance therefore, reducing modern technology adoption among them (Ogutu *et al.,* 2014) Commercialization of the vegetable sub-sector is affected by poor information regarding market prices and choice of market channels among other factors. Marketing of horticultural crops is therefore affected by poor pricing system and excessive presence of intermediaries (Tura & Hamo, 2019).

Performance of a marketing system is measured using price spread or marketing margin which indicates how the consumers' expenditure is shared among market participants (Pingping & Cheung, 2016). The gap between prices received by the farmers and those paid by urban consumers is large, reflecting inefficient marketing arrangements. Unfortunately, these markets are controlled by a few traders and operate on a highly nontransparent basis resulting to a lower realization of income by the farmers (Dastagiri, 2013). Marketing have changed, and it includes an assessment and the involvement of various stakeholders in the decision making. Therefore, organizations should come up with effective marketing strategies which will target relevant marketing concept (Chendake & Chauhan, 2015). This involves the organic tasks of selecting a target market (customers/clients) in which to operate and developing an efficient and effective marketing ingredient combination (Morgan *et al.,* 2019).

Information and Communication Technology (ICT) tools such as radio, television and mobile phones are important to the producers as they support the agricultural sector during the changing process (Bunse *et al*., 2011). ICT is very crucial in determining the success of firms in agricultural management (Schimmenti *et al*., 2013). The competitive power of firms operating market without using ICT become reduced, thus high risk of marginalization (Schimmenti *et al*., 2016).

ICT provides communication channels to majority of the farmers as long as the farmers are e-literate (Palaiah *et al*., 2016). Research institutes and universities are channeling more synergies towards developing multimedia DVDs, expert systems and even Agric- portals (Kumar & Veeranjaneyulu, 2019). These will help in dissemination of tomato production and marketing related information to farmers. Small scale farmers with low level of income, requires ICT channels with low cost of operating and phone based features such as voice calls and short messages (Tadesse & Bahiigwa, 2015). The ICT services have positively affected tomato production and farmers' income (Zhang *et al*., 2017). The use of mobile phones has reduced the cost of searching market information and has improved access of necessary information related to agricultural production (Aker & Ksoll, 2016).

Bargaining power of farmers has increased due to the use of mobile phones (Maertens *et al*., 2012). ICT information cover the entire value chain (Rao, 2007). However, there are still major gaps on the extent of adoption of ICT in the marketing of tomatoes and their influence on farm prices and the choice of the marketing channels. Thus, it is on this basis that the study aimed to evaluate the use of ICTs and the choice of the marketing channels on market performance among smallholder tomato farmers in Kirinyaga County.

1.2 Problem Statement

Tomato is a crucial vegetable fruit crop as it is produced and consumed worldwide. It also generates income to actors along the marketing channel. Tomato marketing aids in alleviating poverty, creating employment, and thus reducing food insecurity in Kenya. Despite these contributions, market access remains a severe constraint among smallholder tomato farmers. Market access is a challenge to many smallholder farmers due to market imperfections that may be caused by inadequate market information, lack of connection between the actors and high transaction cost. There has been promotion of ICT use in

tomato marketing in Kirinyaga. However, there is scanty information on whether farmers in the area use ICT for market access, its effect on tomato marketing channel used and prices ultimately. Hence, this study aimed to fill the existing gap by using data randomly collected from smallholder tomato farmers in Kirinyaga County to establish the extent of ICT usage and its effect on choice of tomato marketing channels and market access. This study aimed at providing policy makers with required information that will aid in improving the tomato marketing sector through promotion of ICT use in marketing.

1.3   Objectives

1.3.1 General Objective

To evaluate the effect of use of information and communication technology (ICT) on choice of the marketing channels and market access in marketing of tomatoes among smallholder farmers in Kirinyaga County.

1.3.2 Specific Objectives

i.   To analyze the extent of use of selected ICT tools in marketing of tomatoes among smallholder farmers in Kirinyaga County.

ii.   To assess the effect of use of selected ICT tools on the choice of tomato marketing channels among smallholder farmers in Kirinyaga County.

iii.   To evaluate the effect of use of selected ICT tools on market access of tomatoes among smallholder farmers in Kirinyaga County.

iv.   To evaluate the effect of selected socio-economic factors on the choice of ICT tools used in marketing of tomatoes among smallholder farmers in Kirinyaga County.

1.4   Research Questions

i.   What is the extent of ICT usage in the marketing of tomatoes among smallholder farmers in Kirinyaga County?

ii.   How does the use of ICT tools in marketing of tomatoes affect the choice of marketing channels among smallholder farmers in Kirinyaga County?

iii.   How does the use of ICT tools in marketing affect market access of tomatoes among smallholder farmers in Kirinyaga County?

iv.   What are the effects of selected socioeconomic factors on the choice of ICT tools used in marketing of tomatoes among smallholder farmers in Kirinyaga County?

1.5 Justification of the Study

Kirinyaga County is among the leading producers of tomatoes in Kenya. Smallholder farmers in the County faces many challenges after harvest of the tomato for it is a perishable fruit and therefore requires ready market. This challenges can be mitigated through the use of various ICT tools and choice of the appropriate marketing channels that will enable the farmers reach the market faster, hence fetching high prices that results in high income among the farmers. This will reduce poverty levels among smallholder farmers. The farmers will also be able to access basic needs, hence increasing the living standard among rural people. This will contribute to achievement of Sustainable Development Goal (SDG) number 1 and 2, which are to reduce poverty and hunger at all levels by 2030. With advanced marketing channels and use of ICT, the entire horticultural sector will grow and this will contribute to the attainment of Vision 2030 growth target of increased annual economic growth by 10%. In Addition, improved income as a result of appropriate choice of the marketing channel will lead to enhanced access to quality food among the rural people, which will contribute to food and nutrition security, which is among the Big Four Agenda of the Government of Kenya.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Tomato is one of the most widely grown vegetable food crops not only in Kenya but also in East Africa and the whole world at large, second only to potato. It is one of the most highly consumed vegetable crops in Kenya and very large quantities are processed and preserved in a variety of forms such as juices, sauces and soups (FAO, 2015). Tomato marketing is encountered by a number of problems ranging from limited storage facilities, inadequate market information, limited value addition coupled with high production cost making its export less competitive (Sibomana *et al*.,2016). Tomato marketing has the capacity to increase incomes to farmers and traders in the rural areas, thus alleviating rural poverty. However, despite these advantages in the tomato sector, farmers receive low prices as compared to what consumers pay for the tomatoes (Ruttoh *et al*., 2018) .

2.2 ICT Usage in Agricultural Marketing Among Small-holder Farmers

A study to evaluate the effectiveness of the role of ICT tools among horticultural farmers in accessing market information in Mwea Sub County, Kirinyaga indicated that mobile phone, radio and television are used by farmers to access market information. It was also found that computers and newspapers were used in a less extent due to low literacy levels and the high cost involved (Mugwimi, 2015). This study did not consider other ICT tools that are used in marketing of agricultural produce by smallholder farmers such as wireless networks in conjunction with the tools used in the study.

A study to examine the use of ICT in production information and marketing of rice among smallholder farmers in Mwea Irrigation Scheme found that the major barriers facing rice marketing include lack of ICT skills, the cost of acquiring the tools and accessing agricultural market information (Nzonzo & Mogambi, 2016). This study did not consider the usage of other ICT tools in agricultural marketing such as internet, newspapers, computers which might significantly influence the marketing of agricultural produce.

Radio, television, mobile phones, computers, tablets and networking, satellite systems were found to facilitate farming activities (Munyua & Adera 2009; Pande & Deshmukh

2015). In the same way, (Yimer, 2015; Munyua & Adera 2009) reports that farmers use radio to get new farming technique, farming practices and market information.

Marketing of commodities and agricultural knowledge are also disseminated through internets. The study conducted by Ramli *et al*. (2015) showed evidence that ICT offer solutions to problems that militate against the development of agricultural sector, such as poor market connections and poor information management. Singh *et al.* (2015) noted that the importance of ICT is sharing agricultural information among smallholder tomato farmers.

2.3   Effect of Use of ICT Tools on the Choice of Tomato Marketing Channels

Radio has a positive significance on choice of agricultural marketing channel as it is the most widely used medium in dissemination of choice of agricultural marketing information. This is because farmers share information among themselves through cooperatives and associations. Radio sets are cheap and can be used in rural areas where there are no supply of electricity. Local radio enable farmers acquire practical information and share knowledge and experiences (Wangu, 2014). Use of mobile phones throughout the country has changed people's way of communication where farmers can easily receive, send messages and money from different parts of the world. Mobile phone in combination with radio stations, help listeners in calling the radio stations to request information or advice (Wangu, 2014).

Safaricom Mobile text messaging and mobile network services have introduced a mobile texting service called agricultural produce uploaded on its network. Farmers are able to access agricultural produce information such as market prices of maize, beans, potatoes, tomatoes, cabbages, and beans. The service also offers buying and selling prices according to market prices. A request is made through the mobile free of charge and the answer is given promptly (Baumüller *et al.,* 2016).

Another method of disseminating agricultural information to farmers is via wireless networks. An example of wireless network is in Ghana where a community started a project spanning 20 KM radius which offers connectivity to schools, businesses and community activity centers. Each node has an antenna, a router and various cables (Chelemek, 2012).

A study to examine how ICT has been used to enhance decision making in the agricultural industry by the smallholder farmers in Kenya found that, ICTs has significant effect on the marketing decision among small-scale farmers (Langat *et al*., 2016). A study by Nyamba (2017) indicated that distance to the market affect the use of mobile phones in sharing agricultural information in Tanzania.

2.4 Effect of ICT Usage on Market Access.

A major challenge to growth and competitiveness of small and medium enterprises (SME) in Kenya is limited access to markets owing to a reduction in domestic market due to globalization (Kiveu & Ofafa, 2013). Market access in developing countries is a major constraint to small businesses due to market imperfections which is caused by inadequate market information, poor connections among actors along marketing channel and increased transaction cost (Chete, & Fasoyiro, 2014). Smallholder farmers have increased the use of ICT tools such as mobile phone which is owned by majority of the rural people to improve markets access (Okello *et al*., 2012). In sub Saharan Africa and Southeast Asia, use of mobile phone has lowered communication costs, thereby lowering search costs. Existing evidence indicate that information technology has lowered price dispersion across markets for highly perishable commodities (Aker & Fafchamps, 2010).

A study carried out by Mittal & Mehar (2012) in India indicate that digital ICT such as mobile phones and internet, in particular, increases farm prices and efficiency in the fruit and vegetable marketing system by reducing communication and search costs (Radhakrishnan *et al*., 2009). Additionally, they improve access to market information, correct information externalities and promote greater price transparency. Mobile phone penetration, internet usage and fixed telephone usage was found to positively and significantly affect farm prices using gravity model (Thiemann *et al*., 2012).

2.5 Effect of Selected Factors on Choice of ICT Tools Used in Marketing of Tomatoes

A study to assess on the drivers of adoption of mobile phone technology in agricultural marketing among smallholder farmers in Malawi found that literacy, distance to market, land size and access to electricity affect the use of mobile phone. Additionally, the intensity of use of mobile phones was positively affected by gender, participation, ownership of

mobile phones and region variation (Katengeza *et al*., 2011). Mobile phones use by Zimbabweans smallholder farmers among 58 households found low level of household mobile phone usage (Musungwini, 2018).

A study assessing the strength of ICT in contributing to agriculture and rural development among small scale farmers in Tanzania show that age, sex, level of education and marital status of the respondent greatly affect ICT use (Levi *et al*., 2015).

The prominent constraints towards the choice of ICT tools among smallholder vegetables farmers in South Africa were found to be lack of access to credit, storage facilities, finance and lack of infrastructure (Matsane & Oyekale, 2014). This study did not look at other factors such as market access, off-farm income, education level, that might significantly influence the choice of ICT tools among the producers. The age of respondent, distance to the market and land size were found to be the factors that significantly and positively influenced the use of ICT tools along the agricultural marketing value chains (Katunyo *et al*., 2018).

2.6   Theoretical Framework

The current study is anchored on four models: Technology Acceptance Model (TAM), participation decision and household welfare model, random utility theory and arbitrage pricing theory. The four models are described in the subsequent sub-sections.

2.6.1 Technology Acceptance Model

This model explains factors that lead to individuals accept ICT, explains user behavior across a broad range of end-user computing technologies and user populations. It is derived from the theory of reasoned action (TRA) and it explains how users come to accept and embrace technology (Rao & Troshani, 2007). The degree to which a person believes that using a particular system would enhance his or her performance is perceived by ease of use. Thus, one will believe that using a particular system would be free from effort (Davis *et al*., 1989). This study was therefore anchored to this model by looking at different ICT tools used in tomato marketing and also on various tools such as radio, television, internet, computers and even newspapers and their extent of usage on marketing of tomatoes among small-scale tomato farmers. It also looked at the effect of this selected ICT tools on the choice of marketing channel and farm prices of tomato.

2.6.2 Participation Decision and Household Welfare Model

Following Ali & Abdulai (2010), it can be assumed that the decision to participate in an ICT-based Management Information System (MIS) project is dichotomous, where participation only occurs when the expected utility with participation (Uip) is greater than without participation (U_iN). The difference between the utility with and without participation may be denoted as a latent variable R_i^*, such that $R_i^* = (U_{ip}) - (U_iN) > 0$, indicating that the utility with participation exceeds that without participation.

The decision by a farmer to participate or not to participate in the new ICT-based MIS project is dependent on the farm, as well as farmer characteristics; hence, it relies on each farmer's self-selection rather than random assignment. Assuming a risk neutral farmer who bases his or her production decisions on the criterion of maximizing the expected return of his or her monetary income, the index function to assess participation in an ICT based MIS project can be expressed as:

$R_i^* = X_i I \gamma + \varepsilon$ (1) … …..… … … … … … ………………………… … ..… … … … ..2.1

Where R_i^* is a latent variable signifying the difference between the utility derived from participation in an ICT-based MIS project and the utility from failure to participate in an ICT-based MIS project. The term $X_i \gamma$ represents an estimate of the difference in utility derived from participating in an ICT-based MIS project by employing the household and farm-level characteristics (X_i) as explanatory variables, whereas i ε is an error term.

Theoretically, participation in the ICT-based MIS project is expected to reduce information asymmetry and transaction costs among members by linking them to credit providers, agro input dealers and buyers. To link the participation decision with these potential outcomes of participation in the ICT-based MIS project, it is considered that a risk neutral farmer maximizes profits subject to a competitive output and input market and a single output technology that is quasi-concave in the vector of variable inputs (Rawstorne *et al.*, 2000). It is however noteworthy that this is a strong assumption which might not hold in imperfect markets which are prominent in Kenya, but is only used to show linkage between the decision to participate in the ICT-based MIS project and its potential effects. This study therefore considered this model, to describe the importance of farmer's participation on the

ICT based techniques which can be used to improve the farm prices as well as choice of the marketing channels.

2.6.3 Random Utility Theory

This study is based on the random utility model (RUM) which assumes that the decision maker has perfect discrimination capability. A farmer decides on the marketing channel to be used based on the option which maximizes their utility, subject to internal and external factors. If the costs that are associated with using a particular channel are greater than the benefits, households will be discouraged from using it, shifting to another option that maximizes their utility. The decision maker has incomplete information and therefore uncertainty has to be taken into account. Farmers are more likely to choose two or more market channel simultaneously assuming the selection of different marketing channel as well as their simultaneous use depends on farmers' willingness to maximize their profit and conditonal to socioeconomic, institutional, production and market related factors (Tura & Hamo, 2019).

The utility that individual i obtains in associating with alternative j is expressed as;

$$U_j^i = Z_j^i + \varepsilon_j^i \ \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.2.2$$

Z_j^i = deterministic part while ε_j^i is the stochastic part to represent uncertainty. If the decision maker selects alternative j, then it is assumed that U_j^i is the maximum among utilities.

2.6.4 Arbitrage Pricing Theory (APT)

This is a general theory of produce pricing that holds that return from agricultural produce can be modeled as a linear function of various factors or theoretical market indices (Arthur *et al*., 1988). The model derived rate of return will then be used to price the tomato produce correctly. The asset pricing implications of the APT can be summarized as;

$$E(R_i) = R_F + \lambda_i b_{i1} + \lambda_2 b_{i2} + \dots + \lambda_j b_{ij} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots.2.3$$

where λ_i is the premium associated with the systematic role of factor j, and, b_{ij} is the reaction coefficient which describes the sensitivity of the returns of asset i to risk factor j.

2.7   Conceptual Framework

Figure1 shows the study's conceptual framework. It gives a relationship between the dependent and the independent variables. Level of ICT usage, age, gender, education and

farming experience are independent variables of this study. It also includes the economic factors such as farm size, labour, household income and off- farm income and institutional factors such as market access, market information, access to credit and extension services. The dependent variables of this study includes the marketing channels, farm prices and the ICT tools used. The expected output of this study will include food security, improved incomes and poverty alleviation.
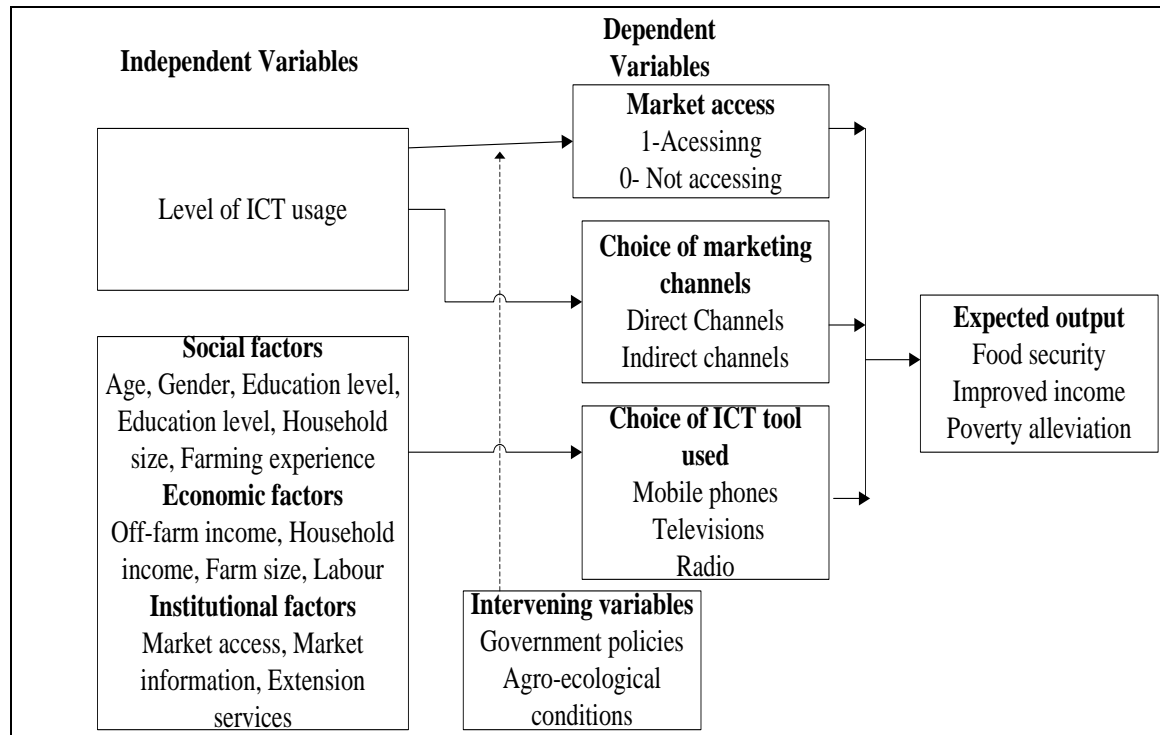
Figure 1. Conceptual Framework

2.8 Summary of Literature

Even though, the rate of ICT growth is high in Kenya, existing literature still show a major gap in accessing market information by farmers (Mugwimi, 2015). The use of ICT tools among smallholder farmers is impeded by lack of ICT skills, the cost of acquiring the tools and accessing agricultural market information (Nzonzo & Mogambi, 2016). Mobile phone communication is important in that it saves time and easy to use thus faster adoption (Wangu, 2014). Most farmers in rural area are still using traditional ICT tools to access market information which cannot be relied (Yimer, 2015). Rural people have increased their incomes with the use of ICT to access information (Tione, 2011).

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Description of the Study Area

The study was done in Kirinyaga County, considering its five sub-counties. The county borders Muranga County toward the West, Nyeri County toward the North West and Embu County toward the East and South. It covers an area of 1,478.1km2 with a complete populace of 610,411 as per 2019 census reports (KNBS, 2019). It receives long downpour season in the period of March to May and short downpour season in the period of October to November. The temperatures ranges from a mean of 8.1 ºC in the upper zone to 30.3 ºC in the lower zones during the most sweltering seasons. The County is most popular for high production of rice. Other major crops include; maize, beans, french beans and other green crops (RoK, 2018).

3.2 Research Design

The study used cross-sectional survey design. This plan is the best since it empowers the scientist to gather information at single point on schedule. Cross-sectional review configuration is normally simple, modest and speedy to perform utilizing surveys.

3.3 Target Population and Sample Size

The study targeted all the small-scale tomato farmers across the County. The sample size was calculated using the following formula by (Cochran, 1977); which is applicable for a population of more than 10,000 people.

$$n = \frac{Z^2 pq}{d^2}$$ …………………………………………….………………………..3.1

Where: n = wanted example size, Z = standard typical go amiss at 95% (1.96) certainty level, p = the assessed extent of the objective populace having the qualities being estimated (0.5), q=1-p and d = level of factual importance (0.05). Utilizing condition 2, the example size was determined as:

n = (1.96)^2 (0.5) (0.5) / (0.05)^2 = 384

3.4   Sampling Procedure

The study applied a mix of purposive, two-stage stratified and probability proportionate to size sampling techniques in choosing the households. In the main stage, five sub-counties were chosen based on tomato production. When the sub-counties have been chosen, a two-stage stratified sampling procedure was applied to choose one ward and subsequently one village from each ward in every sub-counties chose. Finally, households were randomly chosen from each of the chose village to shape an example size of 384 as shown in table 3.1. The number of households chose from every village depended on the population of that village. The household (farmers) interviewed were randomly chosen from a list which was provided by the area chief.

Table 3. 1: Total Population of Household

Sub-counties	Wards	Villages	No. of households
Kirinyaga Central	Kerugoya Central	Kaitheri	110
Kirinyaga East	Mukure	Mukure	83
Kirinyaga West	Kiine	Kiangai	47
Mwea West	Mutithi	Kibiriri	50
Mwea East	Nyangati	Kirimara	94
Total			**384**

3.5   Pre-testing of Research Instruments

Semi-structured interview schedules was used to collect data from the sampled small-scale tomato farmers. The schedules were administered by both the researcher and the assistants. It contained questions related to household socio-economic characteristics and farm characteristics and also information on ICT, marketing channels and farm prices. Structured interview schedules are easy to analyze, distribute and are saves time.

3.5.1 Reliability of Data Collection Instrument

A pilot test were done with 20 randomly sampled small scale farmers to determine the reliability of the interview schedule. Split-parts strategy was used to test for dependability. Relationship coefficient (r) between equal parts of the things was determined utilizing Pearson Product straight connection coefficient equation;

$$r = N\Sigma Y - [\Sigma(X)\ (\Sigma(Y)]/\sqrt{[N\Sigma X^2 - (\Sigma(X^2)][N\Sigma Y^2 - (\Sigma(Y^2)]}\dots \dots \dots \dots \dots \dots \dots \dots \dots \dots .3.2$$

Where: X = odd scores, Y = even scores, Σ(X) = amount of X scores, = Σ(Y) amount of Y scores, Σ(X^2) = amount of squared X scores, ΣY^2 = amount of squared Y scores, ΣXY = amount of the result of combined X and Y scores, N = number of matched scores and r = coefficient correlation between halves. Since r addresses one portion of the instrument, Spearman-Brown Prophesy is used to determine dependability of the full instrument.

$Re = \frac{2r}{1+r}$ = 2 × reliability for ½ tests / 1 + reliability for ½ tests; r lies between 0 and 1; reliability is stronger when *r* value approaches one.

3.5.2 Validity of Instrument

Validity refers to the accuracy of the data obtained. This was achieved through using all questions representing the variable to be measured and the appropriate indicators were used to capture the data required. The 20 sample interview schedules for pilot study helped in assessing the accuracy of data collection instrument. Items found ambiguous and inadequate were correctly worded and re-modified to avoid misinterpretation by the respondents.

3.6 Data Analysis

Data analysis was done using statistical package for Social Sciences (SPSS). The socio-economic characteristics of the smallholder farmers used in this study were analyzed using descriptive statistics (mainly means, frequencies and percentages), t-test, chi-square, multivariate regression and multiple regression.

3.6.1 ICT Tools Used in Marketing of Tomatoes

To establish the ICT tools used in marketing of the tomatoes and the extent of use of these tools, descriptive statistics was used which include means, frequencies and percentages and the data was presented in tables, pie charts and graphs and chi-square was used to determine the most efficient ICT tool

3.6.2 Effect of Use of ICT Tools on the Choice of Tomato Marketing Channels

Multinomial logit (MNL) model was used to determine the impacts of chosen ICT tools utilized in the marketing of the tomatoes among smallholder farmers. It was the most reasonable for this goal on the grounds that the decision of variable (dependent variable) has multiple unranked options while the independent factors comprise of provisions or the

characteristics of the respondent. Assume the utility of household i choosing channel j is given by U_{ij} is a linear stochastic function of exogenous household characteristics X and endogenous household choices Z:

$$U_{ij} = \alpha\,X + \beta\,Z + \varepsilon \ldots \ldots \ldots \ldots \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.3$$

The parameter estimates of the MNL model provides guidance of the impact of the predictor factors on the reliant variable; consequently the estimated address neither the real greatness of progress nor the probabilities. Marginal effects are used to measure the normal change in likelihood of a specific advertising alternative being picked concerning a unit change in the predictor variable from the mean (Greene and Hensher, 2003). The consequences of condition 4 is indicated as displayed beneath;

$$TM = \beta_0 + \beta_1\,X_1 + \beta_2\,X_2 + \ldots\beta_n X_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 3.4$$

Where: TM is the dependent variable (choice of the tomato marketing channels eg farm gate, direct sales , sale to brokers), $\beta_1, \beta_2 \ldots \beta_n$ are the coefficients of the explanatory variables while $X_1, X_2 \ldots X_n$ are the explanatory variables (ICT tools eg radio, television, mobile phones etc).

The ICT tools in the study were also ranked in terms of availability, reliability and usefulness using a scale of 1- 5 where 1 is least while 5 is most. The tool with the highest score was taken to be the most preferred.

3.6.3 Effect of Use of ICT Tools on Market Access of Tomatoes

This study used the farm prices and the type of tomato markets accessed to assess the farmers' level of market accessed. Farmers who are able to access buyers from the large city markets in Nairobi and Mombasa were considered to have the highest level of market access, followed by those who were able to access the municipal markets within Kirinyaga County and the neighboring Counties. Farmers who were only able to access the local markets within the vicinity of the farm were considered to have the least market access

To determine the effects of ICT tools on tomato prices, ANOVA was used. ANOVA is method of data analysis which is used to find out whether a survey or experimental results are significant. It was basically used to find out whether there is significant price

differences between users of different ICT tools. Multinomial logit (MNL) model was used to determine the effects of selected ICT tools on market access among smallholder tomato farmers

3.6.4 Factors Affecting the Choice of ICT Tools Used in Marketing

Multivariate probit model was utilized to recognize factors influencing the decision of ICT devices utilized in promoting marketing of tomatoes. For this situation, the reliant variables were ICT instruments and the free factors was chosen financial elements for example age, schooling level, size of family, cultivating experience, fundamental ICT expertise, and land size of the farmers.

$$Y= \beta\_0 + \beta\_1 X\_1 + \beta\_2 X\_2 + ….. \beta\_n X\_n + ei… … … … … … … … … ……..… \ 3.5$$

Where, Y are the ward factors (ICT apparatuses eg radio, TV, cell phone and so forth); $X\_1, X\_(2)….X\_n$ are free factors(chose financial variables eg age, schooling level, sex, family size, land size and so on) ; $\beta\_(1) \beta\_2… .B\_n$ are relapse coefficients; and ei is Error term.

3.7   Operationalizing the Study Variables

The study variables, descriptions, measurements and expected effect (sign) on the dependent variables are shown in table 3.1 (Appendix 2). The sign (+) shows a positive effect while (-) shows a negative effect.

CHAPTER FOUR
RESULTS AND INTERPRETATION

4.1 Overview

Results of the study in this chapter are given as per the specific objectives. Section one presents the results of descriptive analysis of socio-demographic characteristics of respondents. Such characteristics include age, marital status, sex, and level of education. Other socio-demographic variables analyzed include off-farm activities, income and farming experience. The chapter also presents the results of analyzes of farm economic and institutional characteristics such as farm sizes, scale of production and market access and their effect on ICT use in communicating agricultural information. The results of multinomial logit and multivariate probit regression models are also presented.

4.2 Social Characteristics of Respondents.

Descriptive statistics were utilized to show the respondents' social qualities which incorporated sex, age, level of schooling, cultivating experience, family size, significant occupation, information on ICT and eagerness to pay for ICT devices, among others. The frequencies and rates for the qualities were processed as shown in Table 4.1.

Table 4. 1: Social Characteristic of Farmers

Variable	Frequency	Percentage
Gender		
Male	323	84.1
Female	61	15.9
Age (years)		
20-30	79	20.6
31-40	196	51.0
41-50	73	19.0
Above 50	36	9.4
Education level		
No formal	14	3.6
Primary	47	12.2
Secondary	290	75.5
College	33	8.6
Farming experience in years		
1 - 10	335	87.2
11 - 20	33	8.6
Above 21 years	16	4.2
Household size		
1 - 3	180	46.9
4 - 6	188	48.9
7 – 9	16	4.2
Major occupation		
Farming	345	89.8
Non-farming	39	10.2
Knowledge on ICT		
Yes	381	99.2
No	3	0.8
ICT improves tomato prices		
Yes	283	73.7
No	101	26.3
Willingness to pay for mobile phone		
Yes	291	75.8
No	93	24.2
Willingness to pay for television		
Yes	238	62
No	146	38
Willingness to pay for radio		
Yes	266	69.3
No	118	30.7

Results given in Table 4.1 indicate that majority of respondents were males with 84.1%
while 15.9% were females. The observed male predominance could be due to the fact that

tomato farming requires a lot of capital which is easily accessed by men. Majority of the farmers were young (31-40years). They were in their energetic and productive years, which shows that there may be a possibility of increasing tomato farming in the area. The results point out that the farmers in the area were educated with 8.6% having attained college level education, 75.5% having attained secondary level education, 12.2% primary education and only 3.6% having no formal education. Majority of respondents are therefore able to understand many tomato management practices and are also capable of using ICT tools to search for market information. Farmers in the area may therefore easily adopt modern technology in the farming as they can fully understand the benefits of such technologies.

Majority of the farmers (87.2%) had a farming experience of between 1-10 years, with very few (4.2%) having an experience of 21 years and above. Due to the changing trend of employment in urban areas, a large number of youths in rural areas are unemployed. This has forced them to engage in the tomato farming to earn their livelihood. The most prevalent (48.9%) household size in the sample was 4-6 people followed closely by 1-3 people with 46.9%.

Majority of the respondents (89.8%) carry out farming as their main activity of earning a livelihood while 10.2% engage in non-farming activities. This indicates that farming is the most available form of employment. The results also indicate that majority (99.2%) of respondents have knowledge on ICT while a small percentage (0.8%) have no knowledge on ICT. This shows that farmers can use ICT in search of market information and other market related activities.

Majority of respondents (73.7%) agreed that ICT improves tomato prices while 26.3% respondents showed that ICT have no effect on tomato prices. For those who agreed, they cited that with ICT, it is easy to connect with buyers thus reducing the transaction cost. Majority of respondents (75.8%) were willing to pay for mobile phone whereas 24.2% of respondents were not willing while 62% were willing to pay for television as 38% were not willing. Lastly, 69.3% were willing to pay for radio whereas 30.7% were not willing. This indicates that mobile phone is the most preferred ICT tool followed by radio and television in searching for market information.

4.3 Economic Characteristics of Respondents.

Descriptive statistics (frequencies and percentages) were used to analyze the respondents' economic characteristics which include off-farm employment, off-income, sale of output, farm income, tomato production, land ownership, farm size and tomato varieties,. The frequencies and percentages were computed as indicated in Table 4.2

Table 4. 2: Economic Characteristics of Farmers Along the Tomato Marketing Chain

Variable	Frequency	Percentage
Off-farm employment		
No	314	81.5
Yes	70	18.5
Off-farm Income/month (Ksh)		
Less than 10,000	352	91.4
10,000-20,000	21	5.7
20,001-30,000	4	1.1
Above 30,000	7	1.8
Sale of output/month (Ksh)		
No	8	2.1
Yes	376	97.9
Farm Income/month (Ksh)		
Less than 10,000	98	25.5
10,001-20,000	183	47.7
21,000-30,000	94	24.5
Above 31,000	9	2.3
Tomato prod/month (Ksh)		
Less than 200	180	46.9
200-400	137	35.7
More than 400	67	17.4
Land ownership		
Rented	67	17.4
No title deed	100	26
Title deed	217	56.5
Farm size (Acres)		
Below 2	207	54
2- 4	155	40.5
4- 6	16	3.2
Above 6	6	2.1
Tomato variety		
F1	139	36.2
Ranger	128	33.3
Money maker	16	4.2
Roma vf	6	1.6
Zawadi	4	1.0
F2	79	20.6
2s	12	3.1

Most respondents (81.5%) are fully farmers while 18.5% are involved in both farming and off–farm activities. This is due to the fact that farm produce can be sold to earn income and also be used as food by family members. It was also found that 91.5% of the respondents who are involved in the off- farm employment earn less than Ksh. 10,000 per month and few (1.8%) earn Ksh. 30,000 and above. This necessitates tomato farming that would fetch more income.

Majority of farmers (97.9%) sell their output to earn income while very few (2.1%) produce for family consumption. This is because most farmers produce tomatoes in more than ½ an acre which cannot be consumed fully by family members. Majority of farmers (99.2%) do not access credit facilities. This implies that farmers depend on their income for production process.

Most farmers (36.2%) grow F1 tomato variety because of being resistance to diseases and also being high yielding. The second most grown variety is Rangers (33.3%), followed by F2 (20.6%), Money maker (4.2%) and the least being Zawadi with only 1.0% of farmers producing it.

Majority of respondents (54%) carry out their tomato farming in a land less than 2 acres followed by 40.5% who carry out their tomato farming in a land between 2-4 acres. In Kenya more specifically Kirinyaga, land is subdivided as per the number of adult members in the extended family. This leads to most farmers having land less than 2 acres. Some farmers lack land thus they rent as per their ability. The other reason of farming in a land less than 2 acres is the inadequacy of labour. A number of people are required in the tomato farming sector starting from planting, spraying, staking, picking, loading and offloading both in the farm and in the market respectively. This reduces the number of acres a farmer can operate. Few farmers (2.1%) carry out their tomato farming in a land more than 6 acres.

Majority of farmers (64.3%) use both hired and family members as a source of labour. Majority of farmers (56.5%) carry out tomato farming in a land with a title deed, 26% without title deed and a few (17.4%) operate on a rented land. This implies that farmers carry out tomatoes farming on their own land which they have legal possession. Majority of the farmers (47.7%) earn 10000-20000 per month from their farming followed by 24.5% who earn 21,000-30,000 per month while 25.5% of farmers earn less than 10000 per month.

The income for farmers from tomato farming depends on management practices, farmers' knowledge on modern technology and market prices.

4.4   Institutional Characteristics of Respondents

Respondents' access to institutional factors such as credit, electricity, road types and market distance were analyzed using descriptive statistics (frequencies and percentages). The   frequencies and percentages were computed as shown in Table 4.3

Table 4. 3: Institutional Characteristics of Farmers

Variable	Frequency	Percentage
Availability of electricity		
No	6	1.6
Yes	378	98.4
Road type		
Tarmac	57	14.8
Murram	20	5.3
Tarmac and murram	307	79.9
Market distance (km)		
Less than 50	96	26.0
51-100	244	63.8
More than 100	39	10.2

Majority of the farmers (98.4%) access electricity while very few farmers (1.6%) have no access to electricity. Electricity is very important in obtaining tomato market information through radio, television and mobile phone. Majority of farmers (79.9%) have access to both tarmac and marram roads while very few farmers (5.3%) use only marram road to transport their tomato fruits to the market. Most farmers sell their tomatoes in markets to which they travel 50-100 km.

4.5   ICT Tools Used in Marketing of Tomatoes

In analyzing the extent of using ICT tools in marketing of the tomatoes, descriptive statistics were used which include frequencies and percentages. Table 4.4 gives the results of the descriptive statistics for the extent of use of selected ICT tools in tomato marketing.

Table 4. 4: Extent of Use of Selected ICT Tools in Tomato Marketing

ICT tool	Frequency	Percentages
Radio	301	78.4
Television	269	70.1
Mobile phone	317	82.6

Majority (82.6%) of tomato farmers in the study area use mobile phones to access tomato related market information, followed by 78.4% of farmers who use radios to access tomato related farming information with 70.1% of respondents in the study area using television to access information. Therefore, television is the least ICT tool being used in tomato marketing as compared to mobile phone and radio. This implies that farmers have the potential of exploring different market opportunities.

4.5.1 Farmer Perception on ICT Tools Used in Tomato Marketing

The study ranked the ICT tools in terms of the farmers' perception on the tools' availability, usefulness and reliability in accessing market information. The ranking scale used runs from 1 to 5, where 1 indicates the least and 5 the highest ranking in accessing market information. Table 4.3 shows the results of the ranking of the three ICT tools (Television, radio and mobile phone). The ranking was analyzed in terms of frequencies, percentages and means weighted against the proportion of respondents.

Table 4. 5: Results of Farmers' Ranking of ICT Tools in Accessing Market Information.

ICT	Ranking Frequencies (Percentages)					Weighted mean
	1	2	3	4	5	
Television						
Availability	279 (72.7)	104 (27)	-	1 (0.3)	-	1.279
Usefulness	136 (35.4)	142 (37)	103 (26.8)	2 (0.5)	1 (0.3)	1.918
Reliability	134 (34.9)	119 (31)	126 (32.8)	5 (1.3)	-	2.005
Radio						
Availability	84 (21.9)	172 (44.8)	122 (31.8)	6 (1.5)	-	2.129
Usefulness	91 (23.7)	150 (39)	135 (35.1)	7 (1.9)	1 (0.3)	2.161
Reliability	95 (24.7)	123 (32.1)	153 (39.8)	13 (3.4)	-	2.219
Mobile phones						
Availability	58 (15.1)	12 (3.1)	35 (9.2)	204 (53)	75 (19.6)	3.589
Usefulness	58 (15.4)	12 (3.2)	19 (4.9)	178 (46.4)	116 (30.1)	3.726
Reliability	59 (15.4)	10 (2.6)	30 (7.8)	123 (32)	162 (42.2)	3.820

Percentages in brackets

Majority of farmers (42.2%) ranked mobile phone as the most reliable ICT tool in accessing market information with only 15.4% ranking it as being the least reliable. It has a weighted mean of 3.820. The radio was ranked as the second most reliable ICT tool at 3.4% with 24.7% ranking it as the least reliable and a weighted mean of 2.219. Television was ranked as the least reliable with none of the respondents ranking it as most reliable and 34.9% of the respondents ranking it as least reliable and a weighted mean of 2.005.

The greatest percentage of respondents (30.1%) ranked mobile phone as the most useful ICT tool with 15.4% ranking it as the least useful ICT tool and a weighted mean of 3.726. Radio and television followed in ranking with less than 1% of the respondents ranking them as the most useful ICT tools and weighted means of 2.161 and 1.918 respectively.

Majority of farmers 19.6% ranked mobile phone as the most available ICT tool in accessing market information with 15.1% ranking it as the least available ICT tool and a weighted mean of 3.589. Radio and television were ranked as the least available ICT tools in accessing market information with 21.9% ranking radio as the least available and 72.7% ranking television as least ICT tool available. Their weighted means were 2.129 for radio and 1.279 for television.

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4.6 Effect of ICT Tools on Choice of Marketing Channel

The study identified four marketing channels that were used in the study area. The marketing channels are described as follows:

Farmer – Direct Market – Consumers (F – D – C): This marketing channel entails a flow of tomatoes from tomato farmers to the nearby markets and finally to consumers. Tomatoes are sold in the nearby centers that are accessible to farmers. In this marketing channel, the farmer serves as both a producer and a seller.

Farmer – Broker – Consumers (F – B – C): Brokers are actors who arrange sales without taking possession of the commodity, they benefit by getting a commissions. Brokering is important in that it connect buyers and sellers more effectively than if buyers were to search for sellers independently.

Famer – Middlemen – Consumer (F – M –C): Middlemen are actors who intermediate between the farmers and the consumers. They take possession of the produce by buying it from farmers at a lower price and selling it to consumers at a higher price, thus benefitting from the profit earned. The main function of middlemen is to take up the risks that would otherwise   be taken by the farmers.

Farmer – Cooperative – Consumer (F – C – C): A cooperative is a group of farmers with a common interest who willingly cooperate to pool their tomato produce for sale. The produced tomatoes are marketed and distributed through the cooperative which is under the farmers' control.

The study established the average prices for each marketing channel used. The frequency of farmers who were found to use each of the marketing channels and the average prices are given in Table 4.6.

Table 4. 6: Frequency of Farmers Using Different Marketing Channels and the Average Prices

| Market channels | Frequency | Percentage | Average price | ANOVA Test | |
				F-value	Sig.
F-C-C	7	1.8	46	8.433	0.000
F-M-C	220	57.3	40		
F-D-C	56	14.6	43		
F-B-C	101	26.3	44		

Table 4.6 shows that Farmer-Middlemen-Consumer was the most preferred (57.3%) followed by Farmer-Broker-Consumer (26.3%), Farmer-Direct market–Consumer (14.6%) and Farmer-Farmers' cooperative-Consumer (1.8%) respectively. Majority of farmers (57.3%) sell their tomatoes through middlemen at an average price of Ksh. 40 followed by 26.3% of farmers who sell through brokers at an average price of Ksh. 44. The study found that 14.6% of farmers sell directly to consumers at an average price of Ksh. 43, while 1.8% of farmers sell their tomatoes through farmer cooperatives at an average price of Ksh. 46. Marketing through farmers' cooperative used as a reference category in the analysis of the effect of ICT tools on the choice of marketing channels because is the one which gives the highest average price.

One way-ANOVA test (Table 4.6) was done to establish whether the observed differences in average prices across the marketing channels were statistically significant. The results of the ANOVA test show that there is a significant difference in average tomato prices across the four marketing channels at 1% level.

4.7 Effect of ICT Tools and Selected Socioeconomic Factors on Choice of Marketing Channel

The study analyzed the effect of ICT tools and selected socioeconomic factors on the choice of marketing channels. The results of Multinomial regression are given in Table 4.7.

Table 4. 7: Results of Multinomial Regression Analysis for the Effect of ICT Tools and Selected Socioeconomic Factors on Choice of Marketing Channel

	F-M-C			F-D-C			F-B-C		
	B	Wald	Exp (B)	B	Wald	Exp(B)	B	Wald	Exp(B)
Intercept	5.248	3.130	-	5.516	3.574	-	8.191	7.832	-
Phone	2.485	4.676	11.999**	0.601	1.108	1.824	0.930	0.703	2.533
Television	1.676	2.290	5.345	0.658	1.107	1.931	0.616	0.319	1.852
Radio	2.945	6.948	19.012**	1.939	3.127	6.954*	1.654	2.268	5.230
Tomato production	0	0.705	1.00	0	0.001	1.000	0	0.124	1.000
Farm size	-.334	4.666	0.263**	-.689	1.411	0.502	-1.094	3.289	0.335*
Market distance	-.092	4.405	0.123**	-.695	2.923	0.184*	-1.640	2.733	0.194*
Experience	-.101	1.760	0.332	-.687	0.797	0.503	-.341	2.736	0.262*
Household size	1.079	1.522	2.941	0.506	0.864	1.658	-.046	0.003	0.955

Reference Category-F-C-C, Exp- Exponential Beta, (B) - Coefficient

R-square 0.507, -2log likelihood = 507.441, Chi-square = 223.079, df = 36, Sig = 0.000

The R-square was 0.507 indicating that the variables considered explain up-to 51% of variability while the log-likelihood and Chi-square were significant showing the model suitability. Use of phone in accessing market information was significantly and positively related to use of F-M-C channel. Its coefficient was 2.485 and its exponential beta was 11.999, implying that use of mobile phone to access the tomato market increases the odds of selling through middle men by 11.999 times the odds of selling through Famer-Cooperatives. Use of radio was also positively significant in explaining F-M-C channel .The logit coefficient was 2.945 while its exponential beta was 19.012. This meant that use of radio increases the odds of selling through middlemen by 19.012 times the odds of selling to farmer cooperatives.

Farm size was critical and contrarily identified with F-M-C channel. The logit coefficient was -1.334 and its remarkable was 0.263. This suggests that with an increment in ranch size by one unit, the chances of selling tomatoes through agents' abatement to 0.263 occasions the chances of selling through rancher cooperatives. In this way the chances of selling through go between would diminish by 133.4 % with an expansion in ranch size, for selling through cooperatives.

Ultimately, distance to showcase was critical and contrarily identified with F-M-C channel. Its logit coefficient was -2.092 and its remarkable beta was 0.123 suggesting that increment in distance to the market by one unit, diminishes the chances of offering tomatoes through agents to 0.123 occasions the chances of offering to through rancher cooperatives. In this manner, the chances of selling through the mediators diminishes by 209.2% with an increment in market distance by one unit for selling through cooperatives.

4.8   Farmers' Access to Tomato Markets

4.8.1 Relationship between Prices and Type of Market Accessed

Farmers were found to access three types of markets: city markets in Nairobi and Mombasa, municipal markets in major municipality markets in Kirinyaga and other neighboring Counties, and local markets in close proximity to the farm. The City markets have a combination of wholesale and a retail components. Wholesale component usually operates very early in the morning (4:00 am - 8:00 am), while the retail component operates throughout the day. These markets are usually unlicensed. Municipal markets are those markets authorized and/or maintained by a municipality, or County governments. Local markets include selling tomatoes along the roadsides, usually next to formal markets, and in open sections of residential areas. These local markets serve those who cannot get time to go to distant formal municipal or city markets. Table 4.8 gives the number of farmers, frequency and the average prices for the markets accessed.

Table 4. 8: Number, Frequency and Average Prices for the Markets Accessed by Farmers

Market accessed	Frequency	Percentages	Average price	ANOVA Test F-value	Sig.
City markets (Nairobi, Mombasa)	56	14.6	35	30.207	0.000
Municipal (Embu, Kerugoya, Murang'a)	176	45.8	27		
Local markets	152	39.6	18		

Majority of farmers (45.8%) sell their tomatoes to the municipal markets followed by 39.6% of farmers who sell to the local market, and lastly 14.6% of tomato farmers sell to the city market. City markets comprise of middlemen and brokers who are better equipped with financial capital than any other group of suppliers. They avoid losses due to rotting

by buying and selling in large a mounts within a day or two. The middlemen and brokers buy from farmers enabling farmers to save on transportation cost and market charges. The middlemen will go to the farms and even harvest the tomatoes for themselves. This reduce the number of farmers accessing city markets. At other times, the farmers take their tomatoes to the nearest markets, from where middlemen and brokers buy them. Middlemen are geared toward profit maximization and choose the option that that will earn them the highest profits.

Municipal markets comprise middlemen and brokers but are not equipped with high financial capital as those in city markets. These markets are often governed by the county governments. Municipal markets are fed by farmers from nearby farms where most farmers sell directly to consumers thus avoiding middlemen and brokers. The number of farmers accessing the municipal markets is higher than those accessing City markets. The reason for this is that the transportation cost for agricultural produce increases with increase in distance and tomato being perishable, they need to be transported and sold within a short time to avoid losses through rotting. This prevents low income farmers from accessing City markets. The study found that famers selling to the city markets earned higher tomato prices than those selling to local and municipal markets

ANOVA test (Table 4.8) was done to find out whether price differences across the market types are a statistically significant. The findings show that there are significant differences in average tomato prices between the Local markets, Municipal markets and City market as shown in Table 4.8.

4.9   Effect of ICT Tools and Socioeconomic Factors on Type of Market Accessed

The study established the effect of ICT tools and selected farmer and farm socioeconomic characteristics on the type of market accessed by farmers using multinomial regression analysis. The results of multinomial regression analysis are given in Table 4.9.

Table 4. 9: Multinomial Regression Analysis Results on Type of Market Accessed

Variable	Market access					
	Local market			**Municipal market**		
	B(S.E)	Wald	Exp(B)	B(S.E)	Wald	Exp(B)
Intercept	15.331(2.524)	36.905	-	2.162(1.735)	1.554	-
Phone	-2.521(1.173)	4.619	0.080^{**}	-0.273(0.825)	0.109	0.761
Television	-2.655(0.918)	8.356	0.070^{**}	0.4450.622)	0.511	1.560
Radio	1.890(0.901)	4.396	6.619^{**}	0.934(0.665)	1.971	2.544
Tomato production	-0.024(0.004)	43.853	0.977^{***}	-0.003(0.001)	14.392	0.997^{***}
Family labor	-1.359(0.367)	13.717	0.257^{***}	-0.488(0.240)	4.134	0.614^{**}
Age	0.733(0.531)	1.903	2.080	1.142(0.450)	6.431	3.133^{**}
Farm size	-0.072(0.836)	0.007	0.931	-0.463(0.371)	1.556	0.629

Reference- City market

*** 1 % significance, ** 5% significance * 10% significance

Fittness-2log likelihood- 328.561, Chi-square -436.960, df- 20, Sig.- 0.000

R-square - 0.786

Results given in Table 4.9 had an R- square of 0.786 showing that the independent variables explain up-to 79% variability. Additionally, log-likelihood and chi-square were significant showing model fitness. It goes ahead and shows that use of phone was significant and negatively related to farmer's access to local market at 5% level of significance. The associated coefficient was -2.521 implying that with mobile phone use, the odds of accessing local markets reduces by 252.1% in favour of selling through the city markets. The exponential beta was 0.080, implying that for farmers using mobile phones to access market information, the odds of accessing local market were 0.080 times the odds of accessing city market.

Similarly, use of television was significant and negatively related to local market access at 5% level of significance. The coefficient was -2.655 while the exponential beta was 0.070. This implies that with the use of television to access market information, the odds of selling to local market reduces by 265.5% in favour of selling through the city markets.. Also the odds of selling to a local market was 0.070 times the odds of selling to city market

for farmers using television to access market information. In contrast, use of radio to access market information significantly and positively predicted access to local market at 5% level of significance. The coefficient was 1.890, while the exponential beta was 6.619. Thus, access of market information through radio increases the odds of selling through the local market by 189%. This meant that for radio users, the odds of selling to local market was 6.619 times the odds of selling to city market.

Further, the amount of tomato produced significantly and negatively predicted access to local market at 1% level of significance. Its coefficient was -0.024 while its exponential beta was 0.977. This implies that with an increase in tomato production by one unit, the odds of selling through local market would be 0.977 times the odds of selling through city markets. The odds of selling through the local markets decrease by 2.4% in favour of selling through city markets, with an increase in tomato production by one unit. Similarly, tomato production was significant and negatively related to municipal market. Its coefficient was -0.003 while its exponential beta was 0.997. This means that the odds of selling through the municipal markets were 0.997 times the odds of selling through city markets. Therefore the odds of selling through municipal market would decrease by 0.3% in favour of selling through the city markets with a unit increase in tomato production.

Family labor was also significant for both local and municipal market at 1% level of significance. For local market access, its coefficient was -1.359 while its exponential beta was 0.257. This showed that the odds of selling through local markets were 0.257 times the odds of selling through city markets. Therefore the odds of selling to local market decrease by 135.9% in favour selling through city markets with an increase in family labor by one unit. For municipal market, the coefficient was -0.048 while the exponential beta was 0.614 implying that the odds of selling through municipal markets was 0.614 times the odds of selling through the city markets. Therefore, the odds of selling to municipal market would decrease by 4.8% in favour of sale through city markets with a unit increase in family labor.

Finally, age significantly predicted access to municipal market at 5% level of significance. Its coefficient was 1.142 while its exponential beta was 3.133. This meant that with increasing age of the farmer, the odds of selling through municipal markets were 3.133

times the odds of sale through city markets. Thus, the odds of selling to municipal market increase by 114.2% with a unit increase in age.

4.10 Effect of Selected Socio-economic Factors on Choice of ICT Used in Marketing

Socioeconomic factors affecting the choice of ICT tools used in marketing of tomatoes among smallholder farmers were analyzed using multivariate probit (MVP) model. The factors included age, level of education, experience, household size, off farm employment, farm size, knowledge on ICT tools, willingness to pay for ICT tools, farm income and tomato production. The results are as shown in table 4.10.

Table 4. 10: Multivariate Probit Results for Choice of ICT Used in Marketing Tomatoes

Variables	Radio	Tv	Phone	VIF
	B(S.E)	B(S.E)	B(S.E)	
Constant	-0.044(0.257)	-0.380(0.262)	-0.010(0.187)	
Gender	-0.002(0.032)	-0.001(0.033)	0.024(0.024)	1.25
Age	0.005(0.002)**	0.002(0.003)	-0.003(0.002)	3.81
Education level	-0.038(0.021)*	0.068(0.022)**	0.040(0.016)**	1.46
Experience	0.007(0.003)**	-8.17e-06(0.004)	-0.003(0.002)	2.98
Household size	0.009(0.012)	-0.003(0.112)	0.005(0.009)	2.89
Farming major occupation	-0.026(0.049)	0.087(0.050)*	0.018(0.035)	1.98
Off farm employment	-0.032(0.041)	0.005(0.042)	-0.050(0.040)*	2.27
Farming credit	0.102(0.127)	-0.039(0.130)	-0.099(0.093)	1.12
Farm size	-0.033(0.013)**	0.007(0.013)	0.026(0.009)**	2.15
Land ownership	-0.11(0.017)	-0.006(0.017)	-0.002(0.013)	1.55
Labor	-0.002(0.14)	-0.026(0.015)*	-0.018(0.011)*	1.42
Market distance	0.0001(0.0004)	0.0001(0.0004)	0.0008(0.0003)**	1.33
Knowledge on ICT	-0.129(0.132)	0.201(0.135)	0.307(0.097)**	1.22
Willingness to pay for radio	0.582(0.032)***	-0.223(0.033)***	-0.236((0.023)**	2.01
Willingness to pay for Tv	-0.109(0.027)***	0.801(0.027)***	-0.150(0.019)***	1.53
Willingness to for pay phone	-0.118(0.035)***	-0.248(0.036)***	0.634(0.026)***	2.02
ICT improve tomato prices	0.261(0.039)***	0.232(0.040)***	0.411(0.028)***	2.64
Farm income (log)	0.072(0.028)**	0.054(0.028)*	-0.011(0.020)	2.69
Tomato production (log)	-0.045(0.015)**	-0.044(0.015)**	0.004(0.011)	1.95
R-squared	0.76	0.80	0.85	
F-statistic	56.73	71.11	102.78	
P-value	0.000	0.000	0.000	

*** 1 % significance, ** 5% significance * 10% significance

The MVP regression results show that willingness to pay for a particular ICT tool was the most dominant in affecting the choice of that ICT tool. Willingness to pay for radio was significant for all the ICT tools at 1% level of significance. It however had a positive

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relationship with radio only and negative relationship for both Television and phone. This meant that those who were willing to pay for radio were more likely to use radio and less likely to use both television and phone. Similarly, willingness to pay for television was positively significant for television while negatively significant for both radio and mobile phones at 1% level of significance. This meant that those who are willing to pay for television are more likely to use television and less likely to use both radio and mobile phones. In addition willingness to pay for mobile phone was significant for all the ICT tools at 1% level of significance. However it was only positively determining use of mobile phone while negatively determining the likelihood of using both radio and television. This simply means that those farmers willing to pay for phone are more likely to use phone only ignoring both television and radio. These results mean that farmers are only willing to pay for one ICT tool at a time.

Age was also a significant determinant in the use of radio at 5% level of significance. The results show that an increase in age increases use of radio in accessing tomato market information. Precisely, a unit increase in age corresponds to 0.5% increase in the likelihood of radio use.

Education level was a positive predictor on the use of television and mobile phone at 5% level of significance. This shows that a unit increase in education level correlates with 6.8% increase in the likelihood of television use and 4% increase in likelihood of mobile use. This implies that respondents who are educated are likely to use mobile phone and television to search for agricultural information. However, education level negatively predicted use of radio. This meant that less educated farmers are more likely to use radio to access market information. Specifically, a unit reduction in education level leads to 3.8% increase in the likelihood of radio use. Some radio programs are aired in local languages which are easily understood by non-educated farmers.

Experience positively predicted use of radio tool at 5% level of significance. This implies that increase in experiences increases use of radio ICT tool. A unit increase in age relates to 0.7% unit increase in use of radio.

Farm size was a significant predictor in the use of both radio and phone tools. The variable was however positively significant for mobile but negatively significant for radio. This

meant that increase in farm size leads to increased likelihood of using phones while a decrease in farm size corresponds to increased likelihood of using radio.

Further, market distance was a critical positive determinant in the utilization of cell phone at 5% degree of importance. This implied that a unit expansion in distance relates with improved probability of utilizing cell phone to get to tomato market data. Essentially, information on ICT has a huge positive relationship with the utilization of cell phone in admittance to showcase data at 5% degree of importance. This infers that the individuals who have the information on ICT use are bound to utilize cell phones in getting to showcase data.

Interestingly, the perception that ICT improved tomato prices was positively significant across all ICT tools at 1% level of significance. This showed that those who believe ICT tools improve tomato prices are more likely to use all the ICT tools. Additionally, farm income significantly explained the use of radio at 5% level of significance. Its coefficient was positive implying that an increase in income increase the probability of using radio.

Additionally, farm income significantly explained the use of radio and television at 5% level of significance. The coefficient was positive implying that a unit increase in income corresponds with 7.2% increase in the probability of using a radio. The farmers with higher levels of income can afford to own the ICT tools and be able to cover all cost of operations in accessing market information than those with low income levels.

Lastly, tomato production was a significant predictor for both radio and television use at 5% level of significance. The variable was however negatively predicting use of both radio and television. This meant that a unit decrease in tomato production corresponds to increased likelihood of using radio and television in marketing of tomatoes.

CHAPTER FIVE

DISCUSSIONS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussions

This section entails discussions of the study results related to the objectives and compares with the findings of other studies.

5.1.1 Extent of Use of ICT Tools in Tomato Marketing

Radios, TV and cell phone were observed to be the fundamental ICT instruments utilized in marketing of tomatoes among smallholder tomato farmers in Kirinyaga County. Comparative discoveries were accounted for by Tonny *et al*. (2019) who reported that cell phone is the significant source of data followed by radio and the least being TV. Farmers in the study region announced that they used cell phone in getting market related data through voice calling and short messages.

Majority of respondents agreed that ICT tools are reliable source of getting market information. ICT tools helped them to find different groups of buyers from which they choose potential buyers of their products. ICT tools enables farmers to get better quality information regarding buyers and market prices of their products thus helping them to decide on all aspects of agricultural marketing (O'Donnell, 2013). Farmers reported that mobile phone is commonly used because it can be handled even by illiterates. These findings are similar to the result of Prasad & Pradhan, (2019) who reported that mobile phone is commonly used because it is mobile friendly in nature and user friendly even an illiterate can also handle it.

The farmers reported that radio has bought a significant changes in broadcasting new agricultural technologies both in agriculture and other allied disciplines.

5.1.2 Effect of ICT Tools on Choice of Tomato Marketing Channel

The multinomial results indicated that use of mobile phone in accessing market information was significantly and positively related to Farmer-Middleman-Consumer (F-M-C) channel. Using mobile phone enable tomato farmers to contact middlemen at any time and make arrangement on the harvesting. This helps farmers to get time to undertake other activities and minimize transaction costs and any other transportation related risks. Similar

findings were reported by Ase *et al*. (2017) that lack of facilities for transportation, storage and quick need of money made farmers to sell their produce to informal traders. These results are inconsistent with findings of Donkor *et al.,* (2018) that mobile phone benefits enable farmers to sell their produce in the direct marketing channels thereby avoiding middlemen. Use of radio was also positively significant in explaining F-M-C channel.

Farm size negatively affected choice of Farmer-Middlemen- Consumer (F-M-C) in favor of Farmers' Cooperative-Consumer (F-C-C). This implies that with an increase in farm size by one unit, the odds of selling tomatoes to F-M-C decrease by 0.263 times the odds of selling to F-C-C. Similar findings were reported by Mehdi *et al*. (2019) that increase in farm size increases the probability of selling to processors. These results are also inconsistent with findings of Dessie *et al.* (2018); Kumar *et al,* (2018), that farm size positively influenced choice of informal traders.

Distance to market was significant and negatively related to F-M-C channel. A study by Zhang *et al*. (2017) indicated that the longer the distance to the nearest market, the farmer would choose cooperative more than farmers' market. Mehdi *et al*. (2019) in addition noted that distance from the market in the nearest city is positive and highly significant in all marketing channel, which implies a higher probability to engage in these marketing channel as more than processor's category. These results are also inconsistent with findings of Donkor *et al.* (2018) and Umberger *et al*. (2015) that an increase in distance to the market increase farmers' sale to middlemen.

5.1.3 Effect of ICT on Market Access

Multinomial logit model showed that radio, television and mobile phone were found to be the main ICT tool used by farmers to access different markets (Local market, Municipal market and City market). Radio was significant and positively predicted access to local market. These results collaborate with those found by Chete & Fasoyiro (2014) that use of mobile phone by women farmers have increased their access to markets. This study however, did not specify the kind of market accessed by women through the use of mobile phone. A study by Chikaire *et al*., (2017) also indicate that use of mobile phone platforms enable small scale farmer access high-value markets. Similar findings were also reported by Ifeoma & Mthitwa, (2015,) that markets that were inaccessible before are being

increasingly accessible as they currently receive real time information on markets and interested buyers as well as the prevailing prices.

Family labor was also significant for both local and municipal market. This is in line with Mirie & Zemedu, (2018) who found that farmers with more family labour are likely to produce more quantity of teff which in turn increases chances of farmers to participate in teff marketing. These results are inconsistent with findings of Megerssa *et al.* (2020) who found that a larger household is likely to consume more output, leaving smaller and decreasing proportions for sale.

Finally, age significantly predicted access to municipal market. This implies that as a farmer becomes older, the chances of accessing city markets reduces compared to younger farmers. This concurs with the findings of Mushi (2018) who found that young farmers have many opportunities of accessing marketing information using social networks that enable them to make better production and marketing decision that reduce marketing cost. An examination by Mirie & Zemedu (2018) also indicated that age of household head had negative and significance influence on farmers' marketable supply in teff marketing.

5.1.4. Effect of Selected Socio-economic Factors on Choice of ICT Used in Marketing

Education level and willingness to pay were found to have positive effect on use of radio, television and mobile phone. The effect of education level was positively significant in the use of television and phone. This indicates that educated farmers are likely to use television and mobile phones to acquire market related information. These findings are consistent with those of Kafura *et al.* (2016); Yu *et al*. (2017) and Kumar *et al.* (2017) who indicated that education is a major factor in the adoption and absorption of technology. However, education level negatively predicted use of radio. According to Udimal *et al.* (2017), small-scale farmers with formal education are likely to adopt and use new technologies for agricultural practices. This meant that less educated farmers are more likely to use radio in access to information.

Age was also a significant determinant in the use of radio. This indicates that an increase in age increases the use of radio in searching market related information. A study by Okwu *et al*., (2007) indicated that young farmers are more responsive to new ideas and practices

while older ones are conservative and less responsive to adoption of new ideas and practices.

Experience positively predicted use of radio as ICT tool. This concur with findings of Emeana *et al.* (2020) who found that farming experience increase farmers' skills in farming management thus farmers increased the use of mobile phone when transacting. This study, considered only mobile phone leaving out other forms of ICT tools. Yeh, (2020) also reported that consumers with more experience of using a particular technology will develop a cognitive lock.

Farm size was a significant predictor in the use of both radio and phone tools. The variable was however positively significant for mobile but negatively significant for radio. This meant that increase in farm size leads to increased likelihood of using phones while a decrease in farm size corresponds to increased likelihood of using radio. A study by Mittal, & Mehar, (2016) indicated that farmers with large farms are more likely to receive information from different sources, such as face-to-face interactions, traditional media and modern ICT. Kalema (2017), also reported that farm size had a negative significance on ICT adoption as farmers with large farms were perceived to have their target market already and hence do not need ICT to connect them with buyers as compared to farmers with small farm sizes. This shows that an increase in farm sizes will probably lead to an increase in the use of mobile phone and a decrease in the use of radio. Also, farmers with larger farms are more likely to adopt new technologies because they can spread costs over a wide range of outputs than it is possible with small-scale farmers.

 Further, market distance was a significant positive determinant in the use of mobile phone. Similarly, knowledge on ICT has a significant positive relationship with the use mobile phone in access to market information. This implies that those who have the knowledge on ICT use are more likely to use mobile phones in accessing market information. These findings are similar to the result of Verhoeven *et al*., (2020) found that frequent usage and exposure to ICT should be considered for someone to form a positive attitude towards ICT. A study by Hanemann & Scarpino, (2016) also focused on the importance to attend persistent ICT courses and seminars that can enhance people's ICT interests, skills and compatibility. Seminar & Sarwoprasodjo, (2019) also reported that connectivity costs and

inadequate ICT skills limit the use of ICTs by small-scale farmers. Use of mobile phones could improve the economic opportunities among farmers and traders by allowing them to access consumers who were not previously accessible (Minkoua Nzie *et al.,* 2018).

Willingness to pay for radio was significant for all the ICT tools. It however had a positive relationship with radio only and negative relationship for both Television and phone. This meant that those who were willing to pay for radio were more likely to use radio and less likely to use both television and phone. Similar findings were reported by Faisal & Alhassan, (2018) that older women, educated above the primary school level, with high expenditure levels, and are members of a community organization are more willing to pay for information delivered via a community radio. Similarly, willingness to pay for television was positively significant for television while negatively significant for both radio and mobile. This meant that those who are willing to pay for television are more likely to use television and less likely to use both radio and mobile phones. In addition willingness to pay for mobile phone was significant for all the ICT tools. However it was only positively determining use of mobile phone while negatively determining the likelihood of using both radio and television. This simply means that those farmers willing to pay for phone are more likely to use phone only ignoring both television and radio. These results mean that farmers are only willing to pay for one ICT tool at a time.

Interestingly, the perception that ICT improved tomato prices was positively significant across all ICT tools. This showed that those who believe ICT tools improve tomato prices are more likely to use all the ICT tools. Similar finding were reported by Quandt *et al.* (2020) that the use of mobile phones among farmers has led to increased income and production since, before travel farmers will share with buyers and sell their produce in good price. Kabbiri *et al.* (2018) also noted that mobile phones directly links the farmers and buyers thus receiving good price from brokers and customers. In addition, they do not go to the market but directly communicate and ask the price of their production.

Additionally, farm income significantly explained the use of radio. These results agree with those by Eskia (2019) that income of farmers has an impacts on farmer's decision to use ICTs that is farmers with higher level of income can afford to own the ICTs tools and be able to cover all cost of operations in accessing market information than those with low

income levels. These results concur with those found by Li *et al*. (2020) that both education and income are top factors influencing access and usage of different kinds of technologies.

Lastly, tomato production was a significant predictor for both radio and television use. The variable was however negatively predicting use of both radio and television. This meant that a unit decrease in tomato production corresponds to increased likelihood of using radio and television in marketing of tomatoes. A study by Das *et al.* (2016) indicated that the use of ICT in accessing agricultural information increased production of rice. Ali *et al*., (2016) showed that use of ICT in agriculture has a positive impact on productivity.

5.2   Conclusions

The study sought to evaluate the effect of use of information and communication technology (ICT) on choice of the marketing channels and market access in marketing of tomatoes among smallholder farmers in Kirinyaga County. The conclusions drawn from the study findings are given in the subsections that follow.

5.2.1 Extent of Use of Selected ICT Tools in Tomato Marketing

The advantages of ICT tools based services for the betterment of agriculture sector in Kirinyaga County includes advices in local language, searching for better prices in different markets, improved networking and communication. The current study has identified radio, television and mobile phone as the most effective tools for sharing marketing information among tomato farmers. After ranking, it was found that mobile phone is the most commonly ICT tool used in the marketing of tomatoes followed by radio and last television. Ranking was done considering availability, reliability and usefulness of the ICT tools.

5.2.2 Effect of Use of Selected ICT Tools on the Choice of Tomato Marketing Channels

Mobile phone use increases chances of selling through farmer – middlemen – consumer channel and reduce the likelihood of selling tomato through farmer – cooperative - consumer channel. Radio use also increases chances of selling tomatoes through farmer – middlemen – consumer channel than selling to farmer – cooperative – consumer channel. Television use was found to have no effect on the choice of marketing channel used in the marketing of tomatoes in the study area. Other factors which were found to have effect on

the choice of marketing channel used include; farm size which was found to be significant and negatively related to farmer – middlemen – consumer channel. This shows that an increase in farm size reduces the chances of selling through middlemen while the same increase in farm size increases the likelihood of selling through farmer – cooperative – consumer channel and distance to the market decreases chances of selling through farmers – middlemen – consumer channel but increases chances of selling to farmer – farmers' cooperative – consumer channel.

Selling through farmers – middlemen – consumer channel had the largest number of farmers hence dominant over other marketing channels in terms of market shares. Selling tomatoes through cooperatives gives the highest average prices compared to other tomato marketing channels thus high profit margin.

5.2.3 Effect of Use of ICT Tools on Access to Tomato Markets
Multinomial results showed that phone, television and radio are the ICT tools used in accessing different tomato markets. It also identified local market, municipal market and city markets as the markets accessed through the use of ICT tools. The results further indicates that the use of mobile phone and television increases chances of accessing city markets while use of radio increases chances of accessing local markets. Average price, increase in family labor and increase in tomato production also increases chances of accessing city markets while low prices increases chances of accessing local markets. Age significantly predicted access to municipal markets. This indicates that an increase in age reduces chances of selling to city markets.

5.2.4 Effect of Socio-economic Factors on the Choice of ICT Tools Used in Tomato Marketing
The results of multivariate probit regression showed that level of education, willingness to pay for ICT tools, age, experience, farm size, market distance, knowledge on ICT tools, perception that ICT improves tomato prices and tomato production affect the choice of ICT tools among smallholder tomato farmers in Kirinyaga County.
Education level was positively significant in the use of both mobile phone and television. This showed that an increase in level of education by tomato farmers, increases the probability of using mobile phone and television. Both age and experience, positively

predicted the use of radio. Experience increases with an increase in age thus older tomato farmers have more experience than younger farmers and they prefer use of radio in accessing tomato market information.

Farm size was a significant negative predictor in the use of radio and positive predictor in the use of mobile phone. This indicates that farmers with large farm size prefer using mobile phone while those with small farm size use radio in accessing tomato market information. Market distance and knowledge on ICT was a significant positive determinant in the use of mobile phone in accessing tomato market information. Increase in distance and ICT knowledge among farmers, increased the likelihood of using mobile phone.

Willingness to pay for radio was significant for all ICT tools but only positive predictor for radio and negative predictor for both mobile phone and television. Willingness to pay for television was positive determinant for television but negative determinant for both radio and mobile phone. Similarly, willingness to pay for mobile phone was positive predictor for mobile phone use but negative predictor for both radio and television. This means that farmers are only willing to pay for one ICT tool at a time.

The perception that ICT improved tomato prices was positively significant across all ICT tools. This indicates that those who believe that ICT tools improves tomato prices are more likely to use all ICT tools. Tomato production was also a significant negative predictor for both radio and television use. This showed little tomato production, increases the likelihood of using radio and television in accessing tomato market information. Similarly, income positively predicted the use of radio. An increase in income, increases the likelihood of using radio.

5.3   Recommendations

The findings of the study indicates that tomato farmers choose to use a particular ICT tools depending on its availability, reliability and usefulness. Therefore, the government and other related organizational bodies should make ICT tools available, reliable and useful through reducing the cost of acquiring such tools and providing relevant marketing information through the same tools.

Multinomial regression analysis results indicated that mobile phone, radio, farm size and market distance have an influence on the choice of marketing channel. Therefore, farmers should increase their effort of accessing and using ICT tools since they determine the marketing channel used by tomato farmers. Additionally the portion of land size allocated for tomato farming should be increased. It was also found that farmer – cooperative – consumer channel gives the highest average market price with high profit margin compared to farmer – middlemen – consumer channel and farmer – broker – consumer channel.

Therefore, both the national and county government should support and strengthen agricultural marketing organizations since they yield high market prices for tomato farmers. Providing appropriate market information is another essential component for tomato farmer households to select best channel for the delivery of tomatoes to the market. Therefore, putting in place and strengthening ICT tools for conveying timely and adequate market information for tomato farmers is very crucial so that the farmers carry out their activities timely and earn more from the marketing of tomatoes.

It was also found that farmers in the study area access local, municipal and city markets. City markets give the highest average tomato prices compared to local and municipal markets thus high profit margin per kilogram of tomatoes. Thus, farmers should reduce cost of transportation and other related challenges through forming farmers' organization. It will also connect farmers to high value markets. Multinomial result also indicate that mobile phone, radio, amount of tomato produced, family labour and age have an influence on the type of market accessed. Thus, non-literate tomato farmers should benefit by being provided with ICT content in local language.

Multivariate results indicate that age, level of education, experience, farm size, market distance, knowledge of ICT, willingness to pay for ICT tools, farm income, and amount of tomato produced influences the choice of ICT tools used in marketing of tomatoes. Thus, awareness should be created through extension agents on the use of ICT tools among tomato farmers, by pointing out young farmers who have higher chances of using ICT tools and providing them with agricultural related knowledge and reliable source of electricity which will facilitate use of ICT tools.

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APPENDICES

APPENDIX 1: MAP OF THE STUDY AREA
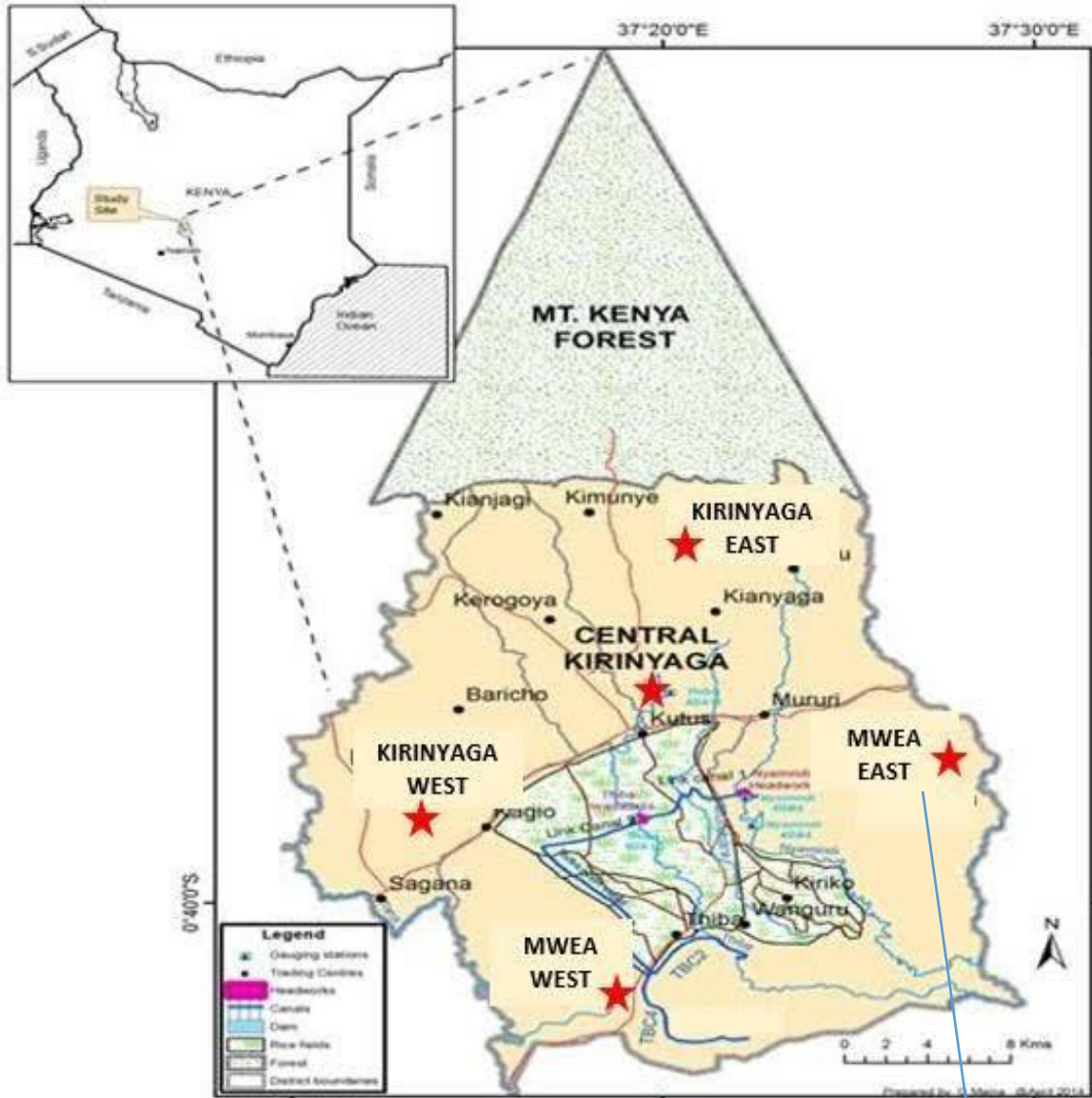
Study area

Source: Kirinyaga County development plan

APPENDIX 2: OPERATIONALIZING THE STUDY VARIABLES

Table 3. 2 Variable descriptions, measurements and expected effect

Variable	Description	Measure	Expected effect
Choice of ICT tools	Mobile phones, televisions, newspapers, radio and internet	Non-use=0 Use=1	
Marketing channels	Farmers-brokers-consumers Farmers- middlemen-market-consumers Farmers –direct market Farmers-farmers' cooperative-consumer	non-use=0 Use=1	
Market access	Ability to reach and use the market	0= No access to market 1=Access to local markets 2=Access to municipal markets 3=Access to city markets	
Age	Number of years	Number of years	+
Gender	Gender of the respondents	1 = Male 0 = Female	+
Education	Level of education of the respondent	Number of years spent in school	+
Household size	Family members, household head included	Number of household members	+
Household income	Respondent's monthly income	Income in Kenya Shillings	+
Farmer's experience	Respondent's farming experience	Years in farming	+
Farm size	Respondent's farm acreage	Farm acreage (acres)	+
Credit access	Access to credit/inputs by the respondent	Amount of credit in cash or kind (1 = Access 0 = No access)	+
Extension contact	Contacts between the respondent and extension agent	Number of extension contacts	+

Information access	Access to market information	Information source (1 = Access 0 = No access)	+
Farmer associations/ groups	Respondent's membership in farm associations	1= Member, 0=Non-member	+
Labor	Type and source of farm labour	Man-days per hectare	+
Off-farm income	Monthly income from off-farm sources	Amount in Kenya Shillings	+
Farm income	All the farm incomes	Amount in Kenya Shillings	+
Tomato production	Produce from farm	Number of crates	+

INFORMATION AND COMMUNICATION TECHNOLOGY IN MARKETING OF TOMATOES AMONG SMALLHOLDER FARMERS IN KIRINYAGA COUNTY

Introduction

This questionnaire aims to collect data on information and communication technology in marketing of tomato among smallholder farmers in Kirinyaga County. The information provided herein will be treated with the utmost confidentiality.

QUESTIONNAIRE **NO:**

GENERAL INFORMATION

Enumerator:	Sub-County
Location	Ward
Sub-location	Village

SECTION A: SOCIO-ECONOMIC INFORMATION

This section will record information on socio-demographic information of smallholder tomato farmers in Kirinyaga County.

1) Household head gender	1=male 2=female
2) Marital status of the household head	1= married 2=window 3= single 4= widower
3) Household head age in years	
4. i) Household head Education level	1= primary 2=secondary 3=college 4= university
ii) Household years spent in school	
5) Household head occupation	1= farming 2= business 3=employment 4) others specify
6) Household income per year in KES	
7) The off-farm income per year in Ksh	
8) Sources of off-farm income	1= self-employment 2= salaried jobs 3= pension 4=wages 5 others specify…
9)No. of years spent in tomato farming	

SECTION B: TOMATO PRODUCTION

10 Do you grow tomatoes in your farm (1=YES 2= NO)

11 If YES, what is the total farm size under tomato production?................. acres

12Total production per season…………………………….

13 Which varieties of tomatoes do you grow………………

14. Identify the type of land ownership (1 = Owned with title 2 = Owned without title 3 = Rented)

15. What is the source of labor for your farm?   (1 = Family labour   2 = Hired labour 3 = both family and hired labour)

16. If family labor, how many members of your household are involved in active farm labor?..........

SECTION C: The extent of use of ICT tools in marketing of tomatoes.

17. Do you receive agricultural related information from the ICT tools? (1= Yes   2= No)

If yes from which ICT tool do you mostly access the information? (1= Radio 2= Television3= mobile phones 3= others specify……………………………………….

18. How frequent do you access the information? (1= once in a month, 2= twice in a month 3= thrice a month 4= always 5=others (specify)

Access to ICT tool information used in tomato marketing

	Radio	Tv	Mobile phones	**Others (specify)**
19 Do you own the ICT tools / facility?				
20) Give two types of agricultural information that you access through these ICT tools in order of priority				
21) Are you able to access marketing information				

through these tools?			
22) Are you aware that you can receive marketing on tomato through these ICT facilities?			
23) Do you use the facility in accessing marketing information on tomatoes?			
24) If yes, how often?			
25) For how long have you been able to access the marketing information using the ICT tools?			
26) Do you have control over the ICT tool in terms of using it at your convenient time?			
27) Can you use this ICT tool to access information on tomato marketing?			
28) Have you had any training on how to use the ICT tool to access information on marketing?			

29. If yes, who provided the information?				
30) Is there any cost associated with accessing this information?				
31) If yes indicate the cost associated with each ICT tool in Kenyan shillings				
32) Would you be willing to pay for this service?				
33) How much would you be willing to pay for this service in a week?.............				

34) What type of agricultural information would you like to access through ICT ……

35) What kind of information is not provided by the ICT and you would wish to have it………

36) Based on scope of coverage which ICT tool comes first? Please rank in a scale 1-5 (1-being least and 5-being most) in terms of availability, reliability and usefulness. (Tick all that applies)

Ranking					
ICT	1	2	3	4	5
Television					
Availability					
Usefulness					
Reliability					
Radio					
Availability					
Usefulness					
Reliability					
Mobile phones					
Availability					

Usefulness					
Reliability					

37) What factors leads to this high coverage? (Tick all that applies)

 a) It provides right information at the right time ( )

b) It makes getting to new information quicker than the rest ( )

c) It is cheap

d) Others specify………………………………….

38) In terms of timeliness in conveying agricultural information which of the ICT tool is leading? Please rank

 i) Radio ( )

ii) Television ( )

 iii) Mobile phone ( )

39) Regarding relevancy of information, which ICT tool will you first choose? Please rank

i) Radio ( )

 ii) Television ( )

iii) Mobile phone ( )

40) Indicators that leads to relevance of the ICT you have first chosen (tick all that applies)

 i) Change in the methods of production ( )

 ii) Increase in the volume of tomato produce ( )

iii) Improvement in the quality of tomato produce ( )

4) Others (specify) …………………………………………………………………

D) Farmer's choice of tomato marketing channels

41. Which channel do you prefer when marketing your tomatoes? Tick where appropriate

a) Farmer-broker-consumer

b) Farmer-middlemen – consumer

c) Farmers – direct market

d) Farmers- farmers' cooperative – consumer

f) Others (specify)……………………

42. Indicate the amount of tomatoes (in kilograms) sold through each channel

Farmer – broker………… (kgs)

Farmer – middlemen –market – consumer………. (kgs)

Farmer – direct market……..(kgs)

Farmer – farmers' cooperative – consumers…… (kgs)

43. Give reasons why you prefer a given marketing channel

E) Use of selected ICT tools on farm prices

44) What do you want to achieve with the help of ICT tools?..

45) What do you think the long term impacts of ICT use in marketing will be?

a. High farm prices

 b. Improve crop quality?

c. Increase diversity of crops – if so, what are they?

d. Increase availability of inputs – fertilizers, quality seeds, pesticides, etc.?

e. Better income?

f. Social issues/ mobility?

g. Better and efficient market access?

46) If high Farm prices, to what extent does one kilogram of tomato rise due to the use of ICT tool?

Tool	Farm prices

Radio	
TV	
Mobile phones	
Others specify	

47) How much did you sell tomatoes in the last season?...............................

a) Highest price received………………….. b) Lowest price received………………..

F) Access to selected socio-economic and institutional services

Extension services

48. Do you receive agricultural extension service or information? (1= YES   0 = NO)

49. If YES, from where do you get the extension information? (1 = County extension officer   2 = Farmer Groups   3 = Non-Governmental Organization   4 = Television   5 = Radio   6 = Newspapers/ magazine   7 = Others (specify)…………………

50. How often did you receive extension support? (1 = once a year   2 = Twice a year   3 = Thrice a year   4 = Others (specify)……………

Information on access to credit

51. Do you have access to any farm credit?   (1 = YES   2 = NO)

52. If YES, provide the information required in the table below;

B1. Sources of credit	1=Banks 2= SACCO 3= Government 4= Merry go round 5=Others specify…………………..
B2.Amount of credit borrowed in KES	
B3. Purpose of credit	1= Tomato farming 2=school fees 3= medical 4=others specify…………..

B4. Constraints in obtaining credit	1= fear of risk 2= high-interest rate 3=lack of collateral 4= others specify…………

Information on market access

53. a) Do you have access to market? (yes/no)

b) if yes, what kind of market?

0= no access to market, 1= access to local market, 2= access to municipal market, 3= access to city market, 4= others, specify……………………..

c) What kind of roads do you use reach the market? Tick where appropriate

i) Tarmac

ii) Marram road

d) Are roads well maintained? (Yes/No)

e) How far from the farm to the market?

i) Tarmac road ……… (Km)

ii) Marram road……… (Km)

f. Are they passable during the rainy season? (Yes/No)

g. If no, how do you access the market during the rainy season?

Information on electricity

54. Is there electricity in your area? (Yes/No)

If yes, how do you utilized it? Tick where appropriate

a) Charging phones ( )

b) Connecting Television ( )

c) Connecting computers ( )

d) Connecting radios ( )

55. Do you use internet in marketing of tomatoes? (Yes/No)

If yes, how? Tick where appropriate

a) In getting market price ( )

b) In getting buyers ( )

c) In getting the easiest and cheapest route to use to the market ( )

THANK YOU