
Choice of Information and Communication Technology Tools in Tomato Marketing Among Smallholder Farmers in Kirinyaga County, Kenya

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Abstract

This study examined the factors influencing the choice of information and communication technology (ICT) tools used in tomato marketing by smallholder farmers in Kirinyaga County, Kenya. Households were selected through a combination of purposive, two-stage stratified and probability proportionate to size sampling techniques. The study employed Semi-structured interview schedules to collect data from the sampled small-scale tomato farmers. Factors affecting the choice of ICT tools in tomato marketing were identified using multivariate model. The study revealed that age, income, level of education, farmers' experience, and farm size, tomato production, willingness to pay for ICT tools, tomato prices and knowledge on ICT are predictors of choice of ICT use. ICT should be given in such a way that all farmers can get information as per their need. Policy makers and agricultural extension agents should create awareness on the use and importance of ICT tools for farmers to accept and use available ICT tools.

Keywords: Information and communication technology for tomato marketing, small hoder tomato farmers

Introduction

Agriculture sector is the pillar of the economy, where it contributes about 15 percent to the national gross domestic product (GDP) and more importantly, a majority of the population dependent on agriculture for their livelihoods (Kenneth & Onyedikachi, 2021). Agricultural development is vital in the improvement of food and nutrition security, living standard and increase general growth (Tura & Hamo, 2018).

Tomatoes production serve as a source of employment either directly or indirectly by increasing job opportunities and income to small scale tomato farmers than other staple crops (Khatun & Rahman, 2020). Despite these contributions, the commodity is constrained by poor marketing arrangements. There is a very big margin between the price received by farmers and those paid by consumers, indicating inefficient

marketing system. Marketing plays a vital role in improving food security and living standards among smallholder farmers in developing countries where vegetable production is affected by inability of farmers to fully participate in the market (Montagnini & Metzler, 2017). Due to the perishable nature of tomatoes, farmers face marketing problems such as low tomato prices and market information being manipulated by few actors caused by disconnect between producers and consumers (Nyamba *et al.*, 2020). Use of ICT tools provide a solution to these problems (Shemfe, 2019)

The production and the marketing system of tomato consist of uncounted relationships and arrangements which are based on structure conduct-relationship image at every marketing level, that is, from the production to the consumption (Adams *et al.*, 2020). Marketing network is being moulded to give opportunities to the use of ICT, which is crucial for fresh fruit and vegetables that are perishable and thus requires a ready market (Owusu *et al.*, 2018). Information communication technologies (ICT) provide new ways of conversing and sharing knowledge and information among farmers (Aldosari *et al.*, 2018).

The use of ICT has increased the access to information and knowledge even in remote areas (Bahrini & Qaffas, 2019). Application of information and communication technologies (ICT) has a benefit of linking and providing market information to small scale tomato farmers (Binta *et al.*, 2019).

The effect of socioeconomic factors on mobile phone use is emphasised in local contexts; different studies focus on generic factors (Lubua, 2017). Social factors influencing the choice of ICT tool used, some are cultural, while others are learned and adopted over time (Alnosiaan, 2019). The purchasing power of users is one of the socioeconomic factors considered to affect the decision to use mobile phones among low-income societies since some users may fail to purchase a service due to their weak purchasing power (Lubua, 2019). Age, gender and income has been reported to have had influence on the use of ICT tools by smallholder fish farmers in the Southern Highlands of Tanzania (Benard, 2019).

Mobile use demands are expressed through a situation where the adoption of the facilitating technology is necessary to receive a certain service (Roztocki *et al.*, 2019). In agriculture, to use mobile money transactions and receive agricultural tips; subscription is mandatory (Batista & Vicente, 2020)

Methodology

The study was conducted in Kirinyaga County which is located between latitudes 001' and 00 40' South and longitudes 370 and 380 East. The county borders Murang'a County to the West, Embu County to the East and South and Nyeri County to the North West and also borders a small part of Machakos County. It covers an area of 1,478.1 square kilometers. Its five sub counties considered were; Kirinyaga Central, Kirinyaga West, Mwea West, Mwea East and Kirinyaga East. The sub-counties were purposively selected because of tomato production. The County has a tropical climate and an equatorial rainfall pattern. It experiences the long rain

season (March to May) and short rain season (October to November). The County is also known for high production of rice. Other major crops grown in the County include; maize, beans, French beans and other horticultural crops (Momanyi *et al.*, 2019).

The study targeted small-scale tomato farmers across the five sub-counties in the County. The sample size was determined following the method used by Sarstedt *et al.* (2018), which is applicable for heterogeneous population. The households were selected using a combination of purposive, two-stage stratified, and probability proportionate to size sampling techniques. In the first stage, five sub-counties were considered based on tomato production. Once the sub-counties have been considered, a two-stage stratified sampling technique was applied to select one ward and subsequently one village from each ward in every sub-county. Finally, households were randomly selected from each of the selected villages to form a sample size of 384. The population of the village determined the number of households selected from each village.

Empirical model

The purpose of this study was to evaluate the effect of selected farm socioeconomic factors on the choice of three ICT tools: mobile phone, radio, and television. Multivariate model was used to evaluate the factors affecting the choice of ICT tools used in marketing of tomatoes in the study area. In this case, the dependent variables were ICT tools, and the independent variables were the selected socioeconomic factors such as age, education level, size of family, farming experience, basic ICT skills, and farm size of the farmers. Unlike the use of binary probit regression to evaluate the effects of selected factors on the choice of each individual ICT tool, Multivariate model simultaneously regresses a combination of the three correlated binary equations against a single vector of explanatory variables. Multivariate therefore allows for the correlation of error terms in the binary equations, leading to reduced statistical bias and inefficiency in the estimates (Okello *et al.*, 2020). Empirically the Multivariate model can be expressed as:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n + \varepsilon_i \text{-----}2$$

Where: Y_i is the i^{th} dependent variable ($i=1,2,3$ for radio, television, and mobile phone respectively); $X_1, X_2 \dots X_n$ are the independent variables (selected socioeconomic factors); $\beta_1 \beta_2 \dots \beta_n$ are regression coefficients; and ε_i is error term.

Multicollinearity test

Multicollinearity is a condition in which two or more explanatory variables in a multiple regression model are related with each other, and likewise related with the response variable (Obite *et al.*, 2020). It can be determined through the variance inflation factor (VIF) (Lavery *et al.*, 2019). When no factors are correlated, the VIFs will all be 1. A VIF between 5 and 10 shows high correlation that may be problematic. When the VIF is above 10, it can be assumed that the regression coefficients are wrongly estimated due to multicollinearity which should be handled

accordingly. For this study, the VIF ranges from 1.12 to 3.81 showing weak multicollinearity which allows subsequent model procedures.

Results and Discussion

Social Characteristics

Farming is the main source of livelihood where 10.2% of respondents engage in non-farming activities. This indicates that farming is the most available form of employment in the study area.

Table I: Social characteristics of farmers

Variable	Percentage
Major occupation	
Farming	89.8
Non-farming	10.2
Knowledge on ICT	
Yes	99.2
ICT improves tomato prices	
Yes	73.7
Willingness to pay for mobile phone	
Yes	75.8
Willingness to pay for television	
Yes	62
Willingness to pay for radio	
Yes	69.3

Enterprise Characteristics of Respondents

Table 2 gives the results of the analysis of the respondents' enterprise characteristics. Most respondents (81.5%) are fully farmers while 18.5% are involved in both farming and off – farm activities. This is because farm produce can be sold to earn income and be used as food by family members. It is only 18.5% of the responded who are involved in the off- farm employment where 91.5% earn less than Kes. 10,000, and few (1.8%) earn Kes. 30,000 and above. This necessitates the call for tomato farming that will fetch more.

The majority (97.9%) of farmers sell their output to earn income while it is only few (2.1%) who produce for family consumption. The majority of farmers (99.2%) do not access credit facilities.

The 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 land between 2 and

4 acres. Very few farmers (2.1%) carry out their tomato farming in lands that are more than 6 acres.

A great number of farmers (56.5%) carry out tomato farming on land with a title deed, 26% without title deed and 17.4% operate on a rented land. The majority of the farmers (47.7%) earn Ksh.10000-20000 per month from their farming followed by 24.5% who earn Ksh.21, 000-30,000 per month while 25.5% of farmers earn less than Ksh.10, 000 per month.

Most (63.8%) farmers sell their tomatoes in a market which take between 51 and 100 minutes' walk while 26% sell to market of 50 minutes' walk. Only 10.2% of farmers who sell to a market of 100 and above minutes' walk.

Table 2: Enterprise characteristics of respondents

Variable	Percentage
Off-farm employment	
No	81.5
Farm Income	
Less than 10,000	25.5
10,001-20,000	47.7
21,000-30,000	24.5
Above 31,000	2.3
Tomato production (crates)	
Less than 200	46.9
200-400	35.7
More than 400	17.4
Land ownership	
Rented	17.4
No title deed	26
Title deed	56.5
Farm size (acres)	
<2	54
2- <4	40.5
4-<6	3.2
Above 6	2.1
Market distance (Walking minutes)	
Less than 50	26.0
51-100	63.8
More than 100	10.2

ICT Tools Used in Marketing Tomatoes

In analysing the extent of using ICT tools in marketing of the tomatoes, descriptive statistics were used which include frequencies and percentages. The majority of tomato farmers, (82.6%) in the study area use mobile phones to access market information, followed by 78.4% of farmers who use radios, while 70.1% of respondents in the study area use television. Television is the least ICT tool being used as compared to mobile phone and radio. This indicates that mobile phone is the most preferred ICT tool in tomato marketing among the farmers sampled. Mobile phone increase the way in which farmers get and exchange agricultural information

(Khan et al., 2019). Table III gives the results of the descriptive statistics for the selected ICT tools.

Table 3: Extent of use of selected ICT tools

ICT tool	Percentages
Radio	78.4
Television	70.1
Mobile phone	82.6

Effect of selected socioeconomic factors on choice of ICT tools

Socioeconomic factors affecting the choice of ICT tools used in marketing of tomatoes among smallholder farmers were analysed using multivariate model. The factors include 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 multivariate 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 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 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. A study by Palloni *et al.* (2018) indicated that more farmers are willing to pay for Vodafone Farmers' Club service at low prices and less at high prices.

The effect of education level on the likelihood of using television and mobile phone was positive and significant 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 with better education are more likely to use mobile phone and television to acquire relevant information that could promote agricultural activities. 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 adoption and absorption of technology. However, education level negatively predicted use of radio. Udimal *et al.* (2017) found that small-scale farmers who have gone through formal education are likely to accept and use new technologies for agricultural development. 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.

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. A study by Krause (2020) indicated that radio use was well incorporated among older adult participants' daily lives.

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. This is contrary to findings by Emeana *et al.* (2020) who found that farming experience impart to farmer some negotiation skills thus, farmers make more calls when carrying out farming business. This study however, considered only mobile phone leaving out other forms of ICT tools. Yeh (2020) also reported that consumers who have used a certain technology for a long period will develop a cognitive lock.

Farm size was a significant predictor in the use of both radio and mobile phone tools. The variable was however positively significant for mobile but negatively significant for radio. A study by Boon & Edler (2018) indicated that the more the land planted in a season, the more the inputs used and the more the expected output, thus making farmers to adopt and intensify the use of ICT tools for guaranteeing input and output markets. 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. However, Kalema (2017) reported that farmers with large farm size do need ICT tools since they have already their target market compared to farmers with small farms. Further, market distance was a significant and positive determinant in the use of mobile phone at 5% level of significance. This meant that a unit increase in distance correlates with increased likelihood of using phone to acquire tomato market information. Similarly, knowledge on ICT has a significant positive relationship with the use mobile phone in obtaining market information at 5% level of significance. This implies that those who have the knowledge on ICT tools are more likely to use mobile phones in gathering market information. These findings are like the result of Verhoeven *et al.* (2020) who found that more use and exposure to ICT tools should be considered as a factor for someone to think positively towards ICT. A study by Hanemann & Scarpino (2016) also considered focused on the importance of attending ICT courses and seminars that can increase ICT interests and skills among people. Use of mobile phones could improve the economic opportunities among farmers and traders by allowing them to access consumers (Minkoua Nzie *et al.*, 2018). 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. Similar finding was reported by Quandt *et al.* (2020) that mobile phone use has increased farmers' income, price and productivity since farmers must communicate directly with brokers and consumers.

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. These results agree with those by Eskia (2019); Li *et al.* (2020) that increased farm income impacted on farmer's decision to use ICT tools. 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 of 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 decreased likelihood of using radio and television in marketing of tomatoes. The results are as shown in Table IV.

Table 4: Choice of ICT tools used in marketing of tomatoes

Variables	Radio β(S.E)	Tv β(S.E)	Phone β(S.E)	VIF
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
Willing to pay radio	0.582(0.032)***	-0.223(0.033)***	-0.236((0.023)**	2.01
Willing to pay Tv	-	0.801(0.027)***	-0.150(0.019)***	1.53
Willing to pay phone	0.109(0.027)***	-	0.634(0.026)***	2.02
ICT improve tomato prices	0.118(0.035)***	-0.248(0.036)***	0.634(0.026)***	2.02
Farm income (log)	0.261(0.039)***	0.232(0.040)***	0.411(0.028)***	2.64
Tomato production (log)	0.072(0.028)**	0.054(0.028)*	-0.011(0.020)	2.69
R squared	-0.045(0.015)**	-0.044(0.015)**	0.004(0.011)	1.95
F	0.76	0.80	0.85	
P	56.73	71.11	102.78	
P	0.000	0.000	0.000	

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

Conclusions and Recommendations

Age, farmers' experience, farm size, willingness to pay for ICT tools, farm income and tomato production has significant influence on the choice of ICT tools used. Age, level of education, farm size, income and farmers' experience are significantly related to farmer's choice of different ICT tools. Using ICT tools in agricultural development greatly relies on the accessibility of ICT tools and farmers' preference for a particular ICT tool. Mobile phone was found to be the most ICT tool used in the marketing of tomatoes in Kirinyaga. Farmers were willing to pay for other ICT tools. ICT tools improves tomato prices

Farmers in Kirinyaga should be trained on how to use ICT tools in marketing of tomatoes. Government should lower the cost of acquiring market information of tomatoes through ICT tools. In addition, institutional factors that support use of mobile phone and other ICT tools such as electricity should be provided. Awareness should be created through extensions over ICT tools.

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