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Impact of Training on Adoption of Information and Communication Technology Tools in Agricultural Extension among Smallholder Cassava Farmers in Rangwe Sub-County, Kenya

John Caleb Dimo [a*], Maina Stephen Wambugu [a] and Alice Chesambu Ndiema [b]

[a] Department of Agricultural Education and Extension, Egerton University, Kenya.
[b] Department of Agribusiness and Extension Management, Masinde Muliro University of Science and Technology, Kakamega, Kenya.

Authors' contributions

Author JCD conducted the literature review, designed the study, gathered data, analyzed the data, and prepared the first draft of the manuscript. Authors MSW and ACN helped with data analysis, edited the manuscript, and supervised the study process. The authors consented and approved the manuscript.

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ABSTRACT

The use of Information and Communication Technology (ICT) tools in Agricultural extension in Kenya is key to providing farm families with appropriate technical information and helping them develop skills for improved resource use in their agricultural activities to improve the efficiency of their value chains. The latent perk of ICT tools in the dissemination of agricultural information is not well exploited. Studies to assess the determinants of ICT tools adoption among smallholder cassava farmers in Kenya are limited. The aim of this study was to describe the level of access to training on ICT tools, the level of ICT tools' adoption, and to determine the correlation between access to training and the use of ICT tools among the Small Holder Farmers (SHFs). A correlation research design was employed in this study at Rangwe Sub-County. The study used pretested structured questionnaire to collect data from 106 SHFs who grow cassava in the Sub-County. Data were analyzed using Statistical Package for Social Science Version 25 to run Spearman's correlation and descriptive statistics. From the results 36% of the respondents had used ICT tools in agricultural

**Corresponding author: E-mail: dimocaleb@gmail.com;*

extension; only 37% had access to ICT training and a majority had received training once from a private extension system. Spearman's correlation analysis showed that a correlation between access to training and the use of ICT tools among the SHFs was statistically significant at a 1% level of significance ($R = +.776^{**}$, $P = .000$, $R^2 = 0.602$). Training on ICT tools explained about 60% of the use of the tools among the SHFs. An increase in access to the training enhances the use of ICT tools in agricultural extension. The availability of training centers was recommended to increase the use of ICT tools.

Keywords: Access to training; agricultural extension; information and communication technology tools; agriculture.

1. INTRODUCTION

Agricultural extension is defined as the entire set of organizations that support and facilitate people engaged in agricultural production to solve problems and obtain information, skills, and technologies to improve their livelihoods and well-being. Agricultural extension is essentially a process of communication of ideas and skills between and among people. The ability to communicate determines to a very large degree the success or failure of an extension worker. The communication dimension of extension focus on getting useful information or technology to enable people to acquire the necessary knowledge, skills, and attitudes to improve their quality of life.

Across the world, the dissemination of quality agricultural extension services promotes the use of new agricultural technologies which in turn improve the production of security crops such as Cassava. However, the efforts of agricultural extension officers have been thwarted and limited by the challenges such as a vast number of farmers distributed over a wide geographical area [1]. The constraints were exacerbated by the spread of coronavirus; where the movements and physical interactions between agricultural extension staff and smallholder farmers were restricted. The restrictions interfered with the sharing of agricultural extension services and technology adoption among the smallholder farmers [2].

In Africa, one of the suggested solutions for the challenges that agricultural extension experience in their duties to disseminate agricultural information is the use of ICT tools in the sharing of agricultural extension information. The ICT tool is an electronic tool used to enter data, store, process, and share information. Common ICT tools among smallholder farmers include mobile phones, televisions, computers, and radios. The tools enable the farmers to reach many farmers at their various locations and at a convenient time [3]. Numerous ICT-based development initiatives around the world have beneficial impacts, starting from the Information Technology application in Europe, the IKisan portal in India, mobile phone-based animated videos in Burkina Faso, and the Agriculture portal in Bangladesh [1,4].

In Kenya, the ICT tools have shown the potential to improve the diffusion of agrarian technologies and connect rural smallholder farmers with agricultural extension officers easily. Farmers who use the tools in agriculture have been able to timely access agricultural extension services through radios, mobile phones, televisions, and computers. Farm digitalization and promoting data-based agrarian tools have been essential in fostering farming innovation. Giua et al. [5] noted that digitalized farm innovations are modern farm inputs to solve agricultural extension problems. This could mean that achieving full use of the tools among the smallholder farmers would translate to a great increase in agricultural production and rural development.

In Rangwe Sub-County, it was detected through observation and informal interviews that the use of ICT tools among smallholder farmers who grow cassava was low. This was attributed to the decreasing production and yield of cassava in the Sub-County. A number of institutional factors could contribute to the low use of agricultural technology among the farmers. Some of the major institutional factors that influence the adoption of technology in agriculture are access to training, access to credit, and marketing [6]. The training was majorly chosen for this study because it creates awareness of the technology and improves the skills, knowledge, and attitude of the clients. In Rangwe Sub-County, there is limited information on whether the smallholder cassava farmers have received ICT training and whether the training has an impact on their use of the ICT tools in the Sub-County. This indicates the gap that this study sought to fill.

2. LITERATURE REVIEW

2.1 Agricultural Extension

Globally, the dissemination of quality agricultural extension services promotes the use of new agricultural technologies which in turn improve farm productivity. Agricultural extension officers always introduce new farming technologies to the farmers. However, their impact is limited by the challenges such as a vast number of farmers distributed over a wide geographical area [1]. The constraints exercabated after the spread of coronavirus altered the normal ways of farming interaction. The movements and physical interactions between agricultural extension staff and smallholder farmers were restricted. The changes interfered with the sharing of agricultural extension services and farm technology adoption among the smallholder farmers [2].

In Africa, one of the major solutions for the agricultural extension challenges is the use of ICT tools in the sharing of agricultural extension services. The ICT tool is an electronic tool used to enter data, store, process, and share information. Common ICT tools among smallholder farmers include mobile phones, televisions, computers, and radios [3]. These tools have the potential to improve the diffusion of agrarian technologies and connect rural smallholder farmers with agricultural extension officers easily. Farm digitalization and promoting data-based agrarian tools are essential in fostering farming innovation. Steinke *et al.* (2020) noted that digitalized farm innovations are modern farm inputs to solve agricultural production problems.

In Kenya, especially in Rangwe Sub-County, the use of ICT tools among cassava farmers was low. The farmers were not making optimum use of the tools for the benefit of accessing the information on agricultural extension. Studies revealed that the effective use of ICT tools in agricultural extension depends greatly on institutional and socio-economic factors among smallholder farmers. The ability of the smallholder farmers to use various ICT tools depends on continued training and funding from organizations. It is also based on their age, income, education, and gender (Maria *et al.,* 2021). Steinke *et al.* (2020) noted that promoting farm technologies instead of addressing communication constraints of smallholder farmers is one of the reasons for agricultural extension failures in the adoption of ICT tools. There is a gap in knowledge on whether the farmers received training and the effect of the training on the adoption of the tools.

2.2 Access to Training Relationship on the Use of the Tools

Globally, training smallholder farmers on how to access agricultural information such as input supply, management practices, and reliable marketing services through ICT tools play a crucial role in the decision making to adopt or reject such tools. The same training may become more useful when agricultural extension officers are also included [7]. According to Ulhaq *et al.* [8], numerous and repeated training for smallholder farmers increases the extent of agricultural technology adoption. Lack of knowledge, skills, and awareness are some of the most suggested barriers that block smallholder farmers from adopting some of the agricultural technologies [9].

In Africa, it is reported that the effectiveness of smallholder farmers' training on the use of new agricultural technologies depends more on the number of times an individual receives the training. The training programs that are well-strategized and focused might increase the use of ICT tools in cassava production [4]. According to Parvand and Rasiah [10], training on the use of ICT tools is a very important and effective factor in the adoption of ICT tools in agriculture among smallholder farmers. It is well noted that a well-trained and skilled workforce is crucial in work progress and project performance.

In Kenya, Bolt et al. (2019) reported that farmers' training on the benefits and costs of the technology enables them to receive the details of what is required and improve the rate of its adoption. Training smallholder farmers on the knowledge and skills of the use of technologies as well as why they should be used through training play a role as an incentive for their adoption [7]. Similarly, access to training on ICT tools might enable smallholder farmers to familiarize themselves with the use of ICT tools in agriculture. This might translate into the adoption; nevertheless, there is no information on the number of times smallholder farmers should be trained to improve their skills effectively. In addition, [11] reported that smallholder farmers were able to use mobile phones and radios in sharing agricultural information without attending any training. This revealed inconsistency on whether there is a

relationship between access to training and the use of ICT tools that this study sought to determine among smallholder cassava farmers in Rangwe Sub-County, Kenya is limited.

3. MATERIALS AND METHODS

3.1 Study Location

The study was carried out in Rangwe Sub-County, Kenya (Fig. 1). The Sub-County is sitting on an approximate area of 273.2 km^2 and is located at a latitude of 0° 34' 30" S and a longitude of 34° 9' 20" E. The Sub-County comprises four administrative wards including Kagan, Kochia, Gem East, and Gem West [12]. It receives an average bimodal rainfall of about 1150 mm and has a population of 3808 smallholder cassava farmers [13]. Agriculture is the major economic activity; where about 60% of the residents cultivate approximately 86% of the land and grow cassava, maize beans, sweet potato, kales, millet, pineapple, sugar cane, and rice [14]. The study selected Rangwe Sub-County because the government promotes cassava production and the use of ICT tools in agricultural extension service delivery. However, there was low adoption of ICT tools in the Sub-County.

3.2 Sampling Procedure and Sample Size

The study chose the Sub-County purposively based on its low use of ICT tools among the smallholder cassava farmers. The appropriate number of respondents was arrived at with the aid of the Naissuma [15] formula as illustrated.

$$n = \frac{\boldsymbol{NC^2}}{\boldsymbol{C^2 + (N-1)e^2}}$$

Where: e = Standard error, *n* = appropriate sample size, N **=** accessed population in the area, C**=** Coefficient of Variation.

$$n = \frac{3025x(0.21)^2}{(0.21)^2 + (3025-1)x(0.02)^2} = 106$$

The study expected 95% confidence (5% sampling error) to obtain an appropriate sample size of SHFs from Rangwe Sub-County.

The proportionate sampling method established appropriate sampling percentages of smallholder cassava farmers in Kochia, Kagan, Gem West, and Gem East administrative wards. The sampling method was preferred because it enhances equity in the selection percentage. Out of the obtained proportion from the four wards, a simple random sampling method was used to select 106 SHFs from the four wards of Rangwe Sub-County. The simple random sampling method ensured that every population unit had an equal chance of selection. Table 1 provides Accessible population and sample size distribution.

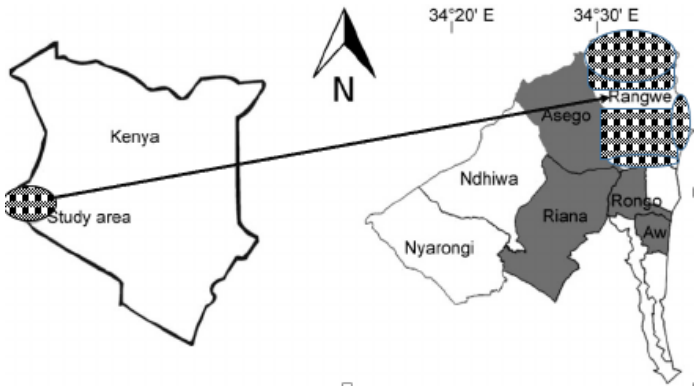

Fig. 1. Rangwe Sub-County, Kenya (CIDP, 2021)

Table 1. Accessible population and sample size distribution

Population unit	Accessible population	Proportion (%)	Sample size
Kochia ward	760	25	27
Kagan ward	867	29	31
Gem Westward	740	24	25
Gem Eastward	658	22	23
Total	3025	100	106

Source: MoALFI, (2021)

3.3 Instrumentation

A structured questionnaire was prepared based on the study objectives and gathered primary data from the SHFs who grow cassava in Rangwe Sub-County. The structured questionnaire was appropriate for this study because it allowed the practical gathering of data that was easy to analyze. Section A of the questionnaire gathered data on selected socioeconomic status. Section B gathered data on the use of ICT tools in cassava production, while section C gathered on access to ICT tools training and credit.

3.3.1 Validity

Validity is the extent to which an instrument measures what it is supposed to measure (Mugenda & Mugenda, 2008). Before data collection, the questionnaire was prepared and submitted to the experts in the Department of Agricultural Education and Extension of Egerton University and the Department of Agribusiness and Extension Management of Masinde Muliro University of Science and Technology help in the validation. The comments and recommendations from the experts were used to improve the questionnaire.

3.3.2 Reliability

Reliability is the consistency with which an instrument measures what it is supposed to measure (Mugenda & Mugenda, 2008). In this study, the reliability of the questionnaire was ensured using a pilot study with randomly selected 30 SHFs who grow cassava in Homa-bay Town Sub-County. The Sub-County was the most appropriate because it has similar characteristics to those in Rangwe Sub-County. The reliability coefficient was estimated using Cronbach Alpha Scale to be 0.756α (Appendix E). The questionnaire was considered reliable after attaining the alpha coefficient above the threshold (0.70α) for acceptable reliability (Cronbach, 1975).

3.3 Data Collection Procedure

Egerton University Board of Post-Graduate Studies issued an introduction letter to facilitate obtaining a research permit from the National Commission for Science, Technology, and Innovation (NACOSTI). The permit under license No. NACOSTI/P/21/14779 was obtained and used to seek data collection permission from Rangwe Sub-County Agricultural Office. One ward agricultural officer from each of the four wards guided the data collection process. They invited the smallholder cassava farmers from each ward for group meetings at one point. Primary data were collected from the respondents randomly in the order of their arrival at the venue following ethical considerations. Those who could not respond to the questions on their own were assisted.

3.4 Data Analysis

The raw data obtained were organized systematically through coding into Statistical Package for Social Sciences (SPSS) Version 25 to enhance analysis. Percentage and frequency were used to describe the data and study population meaningfully. Spearman's rank-order correlation coefficient was used to determine the relationship between the training and the use of ICT tools among smallholder cassava farmers to reject or fail to reject the null hypotheses at a 1% significance level. The Spearman rank-order correlation coefficient (Spearman's correlation) is a nonparametric measure of the direction and strength of correlation between two variables measured on at least an ordinal scale.

4 RESULTS AND DISCUSSION

The aim of this study was to describe access to ICT training, the level of ICT tools' usage, and determine the correlation between access to training and the use of ICT tools among smallholder farmers. The results obtained from this study were analyzed and discussed as follow.

4.1 Descriptive Statistics for Access to ICT Training among the Farmers

The sampled smallholder farmers were asked to describe how they respond to training on ICT. The results were recorded and discussed in this section.

4.1.1 Level of access to ICT training

Based on access to training, it revealed that 63% had no access to training on the use of ICT tools to access agricultural extension services, while 37% had access to the training (Fig. 2). The relatively low percentage of the farmers who had access to the training could mean that the farmers had some drawbacks keeping them away from the training. This may contribute to

the low use of the tools. This is because training exposes the smallholder farmers to institutions that support the use of ICT tools in agriculture and equip them with the skills and knowledge necessary to operate the tools. The training also creates awareness and adds value to the tools as farmers learn the benefits of using them. The results concurred with Ankit et al. [16], who noted that ICT training also equips them with the skills and knowledge they require to adopt ICT tools in agriculture effectively. However, it opposes Wang et al. [17], who found a higher percentage of farmers trained on the benefits and use of ICT tools.

4.1.2 Sources of ICT training accessed

The majority (54%) of those who had access to training, were trained by agents from the private sector, followed by 39% who received the training from the public sector, and lastly, 7% of them received it from the institutional sector (Fig. 3). The greater percentage of farmers receiving training from the private sector could mean that there are many privatized companies working to subsidize the low number of public extension agents in the field. The number of the farmers to be served by extension officers are greater and widely spread across the world. This called for the need to have more extension systems to subsidize extension service delivery. The below-average percent of farmers interacting with public extension staff could indicate that the public extension sector is understaffed. An increase in staffing is necessary to enable them to reach many farmers. The lower percentage of the farmers receiving training from the institutional sector could mean that the majority of the institutions like universities and colleges are not directly engaging themselves in the extension work. The results supported (Gikunda et al. [18] who noted that Kenya has many private extension systems engaging in the training of farmers.

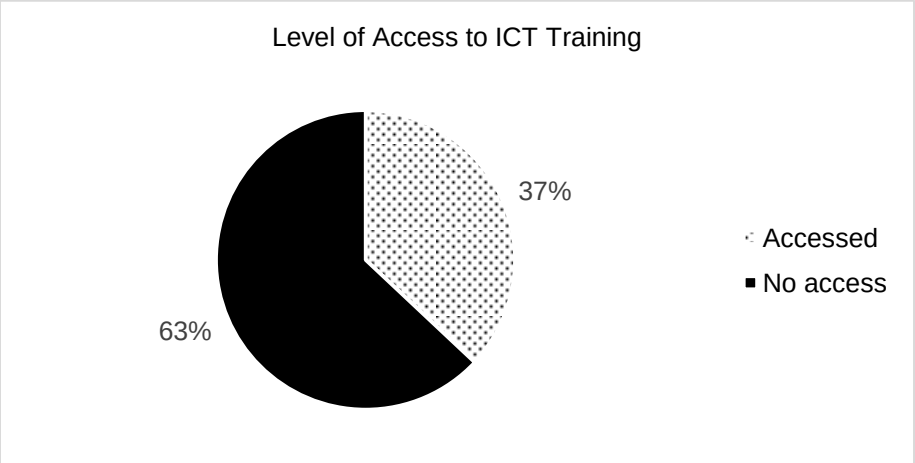

Fig. 2. Level of access to ICT training

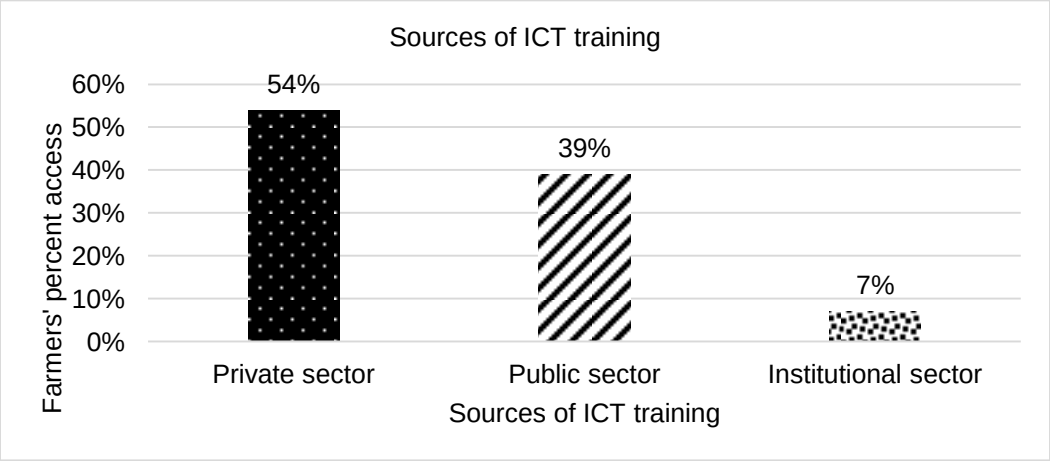

Fig. 3. Sources of ICT training accessed

4.1.3 Number of ICT training accessed per year

The majority (46%) of those who received ICT training had attended one training a year, while 39% had attended about 2 to 3 training. Lately, 15% had attended more than 4 training in a year (Fig. 4). The fact that the majority of the farmers had a lower number of training could mean that the number of training organized by the extension staff per year was inadequate. This resulted in inadequate skills and knowledge necessary to use ICT tools in agricultural extension. In addition, it could contribute to the low use of ICT tools in agricultural extension service delivery. Training the farmers regularly would equip them with skills, and knowledge and change their negative attitude toward the ICT. This would increase the number of farmers using the tools in agriculture. The results opposed Ravikishore et al. [19] that repeated training did not change farmers' perception of new technology due to some factors such as inadequate incentives. On the other hand, it agreed with Addison [20] that exposing farmers to several extension training programs improves the adoption of technology.

4.1.4 Types of ICT training accessed

The majority (49%) of those who had access received training services such as the importance of ICT, operation skills, opportunities, and programs available. This was followed by 36% who received training on the importance of using ICT tools in agriculture and how to operate the tools. Lastly, 15% received the training on the available ICT programs and opportunities that exist in the use of ICT (Fig. 5). The fact that the majority received knowledge on the importance, operation skills, opportunities, and available programs means that the training was so beneficial and equipped them with the necessary information to use the tools in agricultural extension. This could be the reason some of the farmers adopted the use of ICT tools. The lower percentage who received training only on the available ICT programs and opportunities developed an awareness that would enable them to identify the potential of ICT in agriculture and use it in agricultural extension. The results were in line with Rengaraj and Shibu [21] who reported that farmers need ICT training on how they can operate the devices and how the knowledge to access the information.

4.2 Level of ICT tools' Adoption

The study analyzed the degree to which smallholder farmers in the Sub-County had used the ICT tools in agricultural extension services (Fig. 6). It showed that a greater percentage (64%) had not used ICT tools while only 36% had used them. The revealed low use of ICT tools in agricultural extension was evidence that the potential of ICT tools in agricultural extension is underutilized. This could be caused by a greater number of unknown factors. Determining these undefined factors would act as a starting point for solving and improving the condition of low use of ICT tools in accessing agrarian information. The percentage of the farmers using the ICT tools in agricultural extension indicates that it is possible for other farmers to benefit from the tools when they receive the necessary attention. The results supported Spielman et al. [22] that the use of ICTs in agriculture has not been optimized among farmers. However, it opposes Kabir et al. [2] that the majority of smallholder farmers utilized mobile phones in farming.

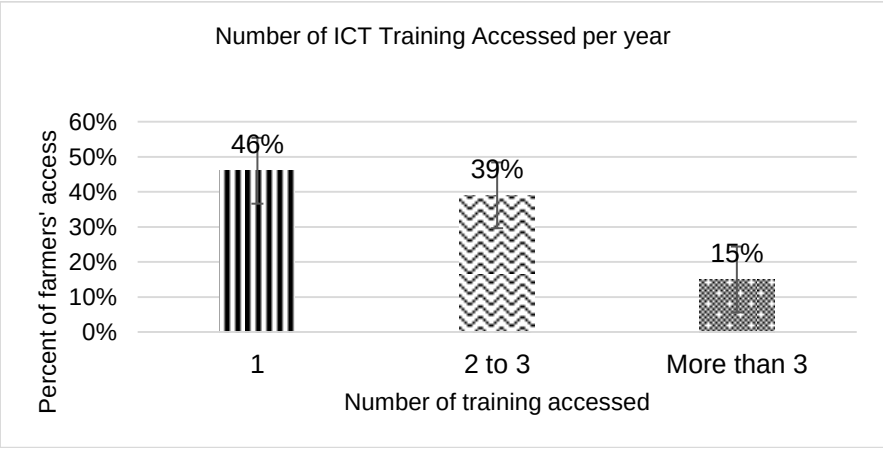

Fig. 4. Number of ICT training accessed per year

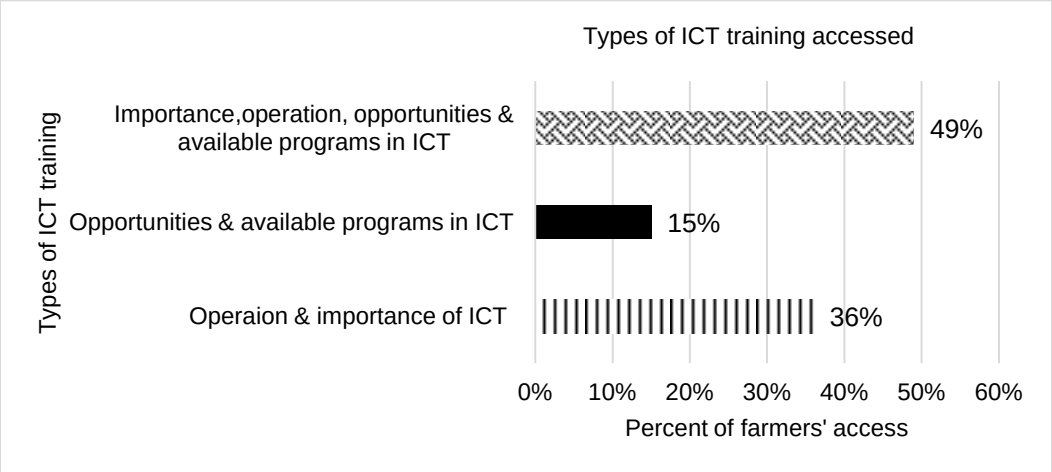

Fig. 5. Types of training accessed

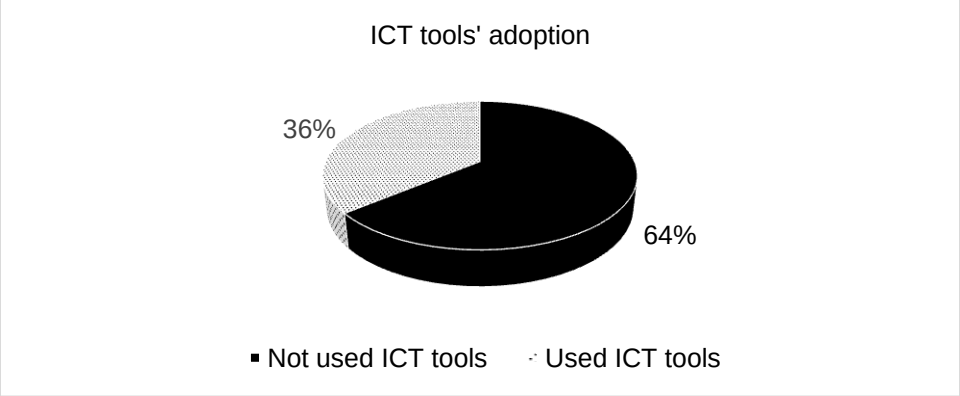

Fig. 6. ICT tools' adoption

Table 2. Access to training and use of ICT tools

		Access to ICT training		
		No Access	**Access**	**Total**
Use of ICT tools	No Use	62	6	68
	Use	5	33	38
Total		67	39	106

Table 3. Spearman's correlation between access to training and ICT tools' usage

Number of respondents	Correlation coefficient (R)	*P*-value	R^2
106	+0.776**	.000	0.602

*Note: ** indicates correlation is significant at the 0.01 level (2-tailed)*

4.3 Access to Training and Use of ICT Tools

Access to training on ICT was cross-tabulated with the use of ICT tools in agricultural extension and frequency results were recorded (Table 2). The results showed that out of the total number of those who received the training (39), the majority (33) used ICT tools in agricultural extension. The fact that the majority of those who received the training dominate the use of ICT tools in agricultural extension means that the training is crucial in the adoption of the ICT tools. An increase in access to training appears to increase the use of ICT tools in agricultural extension among the smallholder farmers. The

results were in line with Bansal et al. [23] who noted that training of farmers facilitates them in the adoption of agricultural technologies.

4.4 Correlation between Access to Training and Use of ICT Tools

The study used Spearman's correlation to determine the correlation between smallholder farmers' access to training and the use of ICT tools in agricultural extension (Table 3). It revealed a high, positive correlation between access to training and the use of ICT tools, which was statistically significant at a 1% level of significance ($R = +.776^{**}$, $P = .000$, $R^2 = 0.602$). Access to training appears to provide a substantial guide to the use of the ICT tools as it predicts 60% of the use of ICT tools among smallholder cassava farmers. The remainder (40%) of the unexplained variance may involve other variables. The use of ICT tools increases with an increase in access to the training. This concurred with Malik et al. (2021) that there is a relationship between access to training and the use of technologies. Nevertheless, it opposed Coggins et al. [24] who noted that the farmers with no training could still use mobile phones in agriculture.

5. CONCLUSION

The results proved that there was a statistically significant correlation between access to training on ICT tools and the use of the tools in agricultural extension among smallholder cassava farmers in Rangwe Sub-County, Kenya [25]. The analysis confirmed that ICT tools were used more among those who had the access to the training on ICT tools. This could mean that the training equipped the farmers with the necessary skills, and knowledge required to successfully use the tools. Repeated training also increases the use of ICT tools among the farmers. Policymakers should prioritize policies that support the establishment of local ICT training centers to increase the level of the farmers' access to the training.

ETHICAL APPROVAL AND CONSENT

Ethical considerations are the set standards and values for conducting research. In this study, the ethical issues were observed through presenting research permits to Rangwe Sub-County Agricultural Offers to seek data collection permission, respecting the dignity and cultural values of the respondents, protecting them from any harm, their anonymity, and confidentiality, privacy, and full consent sought from them. Self-introduction explanations of the purpose of the research were done, and deception was avoided. Lastly, the findings were shared with the relevant authorities and the participants after data analysis and presentation.

RECOMMENDATION

The research study recommended the following issues:

i) The County Government should organize regular training programs on the use of ICT tools in agricultural extension.
ii) Institutions like agricultural universities should put more effort into agricultural extension services to help in community development.
iii) The smallholder farmers should attend several training on the use of ICT tools to enable them to gain the necessary skills, knowledge, and the right attitude.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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