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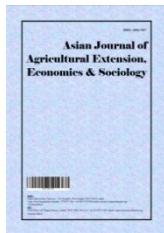
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Assessment of Information and Communication Technology Tools' Usage in Agricultural Extension among Cassava Peasants in Rangwe Sub-County, Kenya

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Authors' contributions

This work was carried out in collaboration among all authors. Author JCD designed the study, reviewed literature, collected data, analyzed the data and drafted the first manuscript. Authors MSW and ACN supervised the whole study process and edited the first draft. All authors scrutinized and consent to the manuscript.

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ABSTRACT

Aims: This study sought to determine selected demographic characteristics, the extent of Information and Communication Technology (ICT) tools' usage, opportunities in ICT, challenges in the use, strategies to improve the use, and the correlation between the selected demographic factors and ICT tools' usage among peasants who produce cassava in Rangwe Sub-County, Kenya.

Study Design: A correlation research design was used in this study conducted at Rangwe Sub-County, Kenya from 8th December 2021 to 14th January 2022.

Methodology: The study gathered data with the aid of pretested structured questionnaire from 106 Cassava Peasants (CPs) who used or not used ICT tools in agricultural extension.

Results: The response rate achieved was 100%. The majority of the CPs were female (62%), middle-aged (36-50 years), attained primary education (52%), and earned the lowest average annual income ($X \leq$ KES160, 000). The majority of ICT tools users in extension were males, elite, higher-income earners, and youths. The largest percentage of ICT tools users mentioned, ICT tools

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availability as one of the opportunities in ICT, expensiveness as the main challenge in the use, ICT services subsidies as one of the improvement strategies. Spearman's correlation analysis showed that a correlation between the selected demographic factors and ICT tools' usage was statistically significant at a 1% level of significance ($P=.000$).

Conclusion: Adoption of ICT tools in agricultural extension services is directly proportional to income, gender equality, and education, while it is inversely proportional to age. The provision of supporting policies for the selected demographic factors, availability of training centers, and subsidized credit interest rate would increase ICT tools usage in extension.

Keywords: *Information and communication technology tools; peasant farmers; demographic factors; agricultural information; agricultural extension.*

1. INTRODUCTION

Globally, agricultural extension service delivery, especially the traditional method experience notable constraints in satisfying the needs of farmers who have a larger number and widely distributed locations. On the same note, the novel agrarian technologies require triumphant marketing through timely provision of essential information to the targeted farmers [1]. According to Sa'adu et al. [2], efficacious conveyance of agrarian information and productive inter-linkage among agricultural stakeholders are greatly required to achieve the extension goals. Wan-Mohd et al. [3] noted that agricultural extension should embrace modern technology and Information and Communication Technology (ICT), which can facilitate the knowledge management process to achieve sustainable development.

In Africa, smallholder farmers need pieces of agricultural information that include adequate cassava inputs, management practice, and marketing, among other extension services [4]. In addition, there are infestations of crop pests and diseases like cassava bacterial blight and spiders [5]. Diseases affect the plants' growth and production of tubers depending on the infection level of the plant. Cassava that is severely affected by the illnesses shows poor growth with no tubers, while cassava moderately affected produces few tubers with intermediate development compared to a healthy plant. The pests cause chlorosis, shriveled leaves, and yellow speckles [6]. Kabir et al. [7] noted that the use of ICT tools in sharing agricultural extension services has a greater potential to solve farm problems.

In Kenya, the Government and other organizations introduced some clean cassava seeds. The seeds were believed to be early maturing and disease resistant. The varieties

include mijera, shibe, karembu, karibuni, nzalauka, tajirika, Siri, TMS30572, MH95/0183, TM/14, and MH93/OVA [8]. Agricultural extension officers from Green Shamba, One Acre Fund, and the public extension offices have been teaching peasants about the cultivation of the new varieties and the benefits. However, the extension staff was limited by large and widely distributed regions to cover. In addition, the use of ICT tools in agricultural extension services delivery has become more necessary following the lockdown directives communicated by the government of Kenya due to the emergence of coronavirus, which causes COVID-19 illness [9].

In Rangwe Sub-County, the condition necessitated the need to use the ICT tools in agricultural extension to ensure the smallholder farmers timely receive cassava information instead of the traditional method, where agricultural extension officers had to travel and physically serve many smallholder farmers demanding the information [10]. A few peasants who used the ICT tools and platforms in agricultural extension received agrarian information faster and easier, which translates to a significant cassava yield [11]. However, the ICT tools' adoption by the peasants is low.

This study chose to assess the use of ICT tools among the Cassava Peasants (CPs) in Rangwe Sub-County, Kenya because there is no clearly documented information explaining the extent of ICT tools usage, opportunities in the use, challenges, strategies to improve the use and correlation between the use and selected demographic factors which include age, gender, income, and education.

2. METHODOLOGY

2.1 Study Area and Target Population

The permission for the study was granted by the National Commission for Science Technology

and Innovation (NACOSTI) under license No. NACOSTI/P/21/14779. It was conducted in Rangwe Sub-County, Kenya (Fig. 1), located at a latitude $0^{\circ} 34' 30''$ S and longitude $34^{\circ} 9' 20''$ E. Its area is approximately 273.2 km^2 and has four administrative wards that include Kochia, Kagan, Gem west, and Gem east [12]. The Sub-County has an average bimodal rainfall of about 1150 mm. It has a population of 3808 peasant cassava farmers. Out of the total peasant population, the accessible population was 3025 CPs in a farming group [13]. The residents in Rangwe Sub-County derive their livelihoods from agriculture, formal or informal wage labor, and commerce. Agriculture is the main source of employment to about 60% of the residents. The farmers cultivate about 86% of their lands for subsistence farming practices. The farmers grow cassava, maize, beans, sorghum, sweet potatoes, kales, millet, and rice for consumption. They also grow pineapple and sugar cane as a cash crop [8].

The Sub-County government promotes cassava production among the Ps because the crop can tolerate drought and provide food security in times of insufficient rainfall [10]. Agricultural extension officers encourage the use of radios, computers and mobile phones as a tool for effective extension service delivery. However, the use of ICT tools among CPs was low.

2.2 Sampling Procedure and Sample Size

The study purposively chose the Sub-County due to its low adoption of ICT tools among the CPs [14]. Naissuma, [15] formula was used to

calculate the appropriate sample size out of the accessible population as shown:

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

Where: **N** = the population within the study area, **C** = Coefficient of Variation, **n** = the required sample size, **e** = Standard error.

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

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

The proportionate sampling method established appropriate sampling percentages of peasant 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, the study used a simple random sampling method to choose 106 respondents. The simple random sampling method ensured that every population unit had an equal chance of selection.

2.3 Ethical Considerations

Ethical considerations are the set standards and values for conducting research. In this study, the ethical issues were observed through presenting research permit to Rangwe Sub-County Agricultural Offers to seek data collection

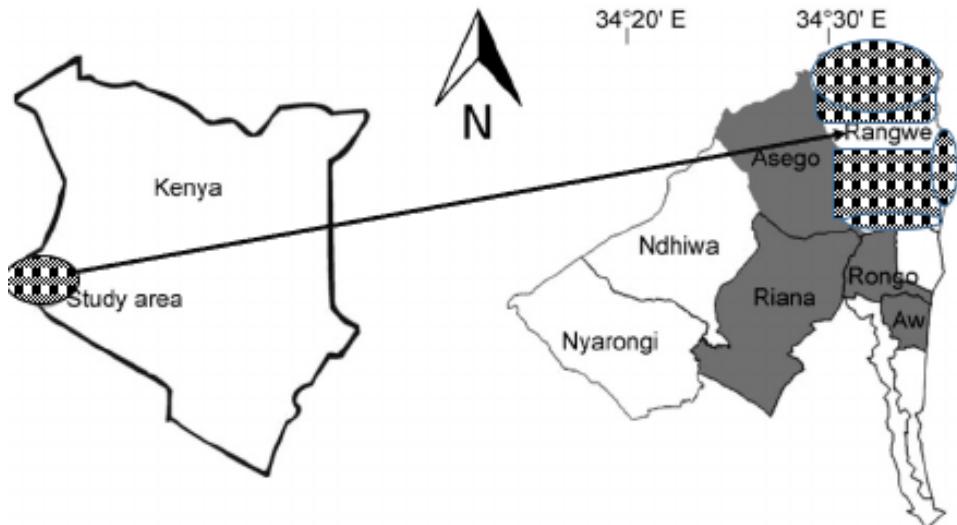


Fig. 1. Rangwe Sub-County's map (CIDP, 2021) [12]

permission, respecting the dignity and cultural values of the respondents, protecting them from any harm, their anonymity, confidentiality, privacy, and full consent sought from them. Self-introduction, explanation 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.

3. RESULTS AND DISCUSSION

The study was set to determine demographic characteristics, the extent of ICT tools' usage, opportunities, challenges, improvement strategies, and the correlation between selected demographic factors and ICT tools usage among CPs in Rangwe Sub-County, Kenya. The results were analyzed and discussed.

3.1 Demographic Characteristics

The selected demographic factors included education level, age, average annual income level, and gender. Studying the selected characteristics was important because they could help one understand the nature of cassava farming among peasant farmers. Descriptive characteristics of the demographic factors were established as shown in Table 1.

Based on education level, it revealed that CPs who attained primary education level were the largest percentage (49%) in the study area but none of them used ICT tools in extension services. This was followed by 30% who attained secondary, 15% attained post-secondary and 6% did not attain formal education. Out of 106 sampled CPs, only 38 CPs used ICT tools in extension and the majority (24 CPs) of them attained secondary education level (Table 1). This may suggest the low use of ICT tools in cassava production due to inadequate formal skills and knowledge applied in the use of the tools. The results could suggest high demand for adult education among the farmers. The findings concurred with Naqvi et al. [16] that the largest percentage of the smallholder farmers in their study were illiterate. However, it contrasted with Kacharo [17] who found that a higher percentage of farmers had attained secondary level.

Based on age, it revealed that the majority (43%) of the CPs were in the age range of 36-50 years. A significant percentage of middle-age showed that the farmers were still in their active stage of agricultural production. This was followed by 26% within 51-65 years and 23% within 18-35

years. Lastly, 7% of them were above 65 years. Out of the total 38 CPs who adopted ICT tools in agricultural extension, the majority (24CPs) were youths (Table 1). This could mean that young farmers are the quickest category in risk-taking and trying new technology. The young people also learn about the existence and operation of new technology faster. The results supported Uzochukwu et al. [18] that the majority of farmers are in their middle age. On the other hand, it opposes Khan et al. [19] that most farm producers are youths.

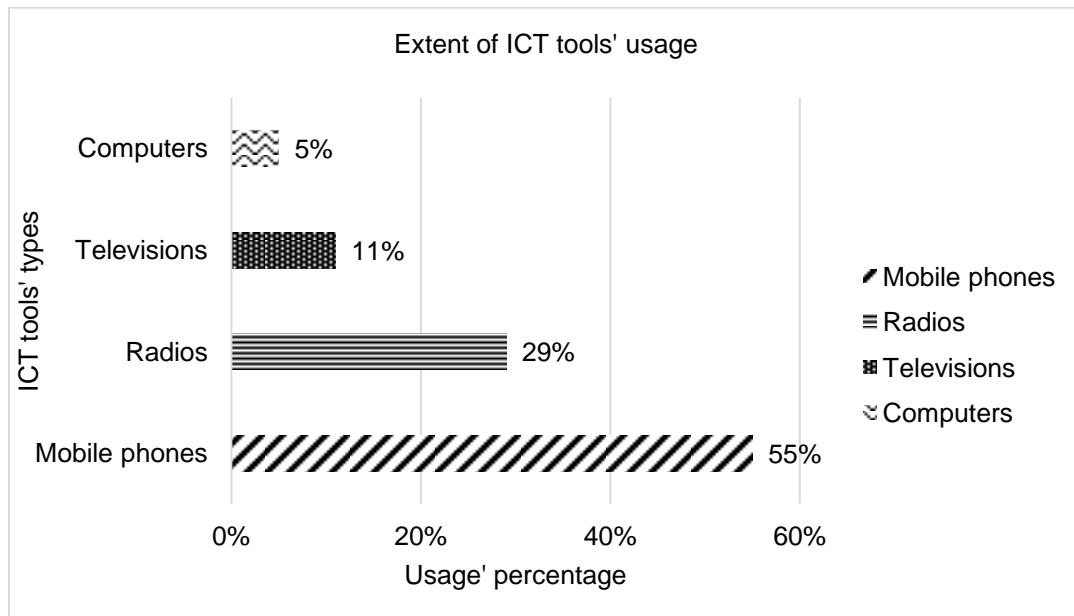
Based on income level, it revealed that the majority (59%) of the CPs recorded a lower average annual income level of KES 160,000 and below. This was followed by 23%, who recorded an average annual income level of between KES 161,000 to 270,000, and lastly, 18% recorded KES 271,000 to 38,00. The majority (20 CPs) of those who used ICT tools (38 CPs) were within the category of KES 161-270 (Table 1). This may suggest the low use of ICT tools in cassava production due to inadequate capital required to purchase and maintain the ICT tool. An increase in income level among the farmers is necessary for the adoption of most agricultural technologies. The results supported the findings of Wichean and Sungsanit [20] that a larger number of farmers in their study had lower income levels. However, the results opposed the findings of Spielman et al. [21], who found that most farmers had a middle-income level.

Based on gender, it (Table 1) established that the majority (62%) of the CPs were female, while 38% were male. This revealed a relatively wide range in the number of male and female smallholder farmers producing cassava in the study area. The cause of the wide gender gap could be researched on and male farmers equally encouraged and supported to produce cassava. Out of the 38 CPs who used ICT tools in extension, 28 CPs were male while 10 CPs were female. This revealed that more males than females used the tools. The finding could suggest that female farmer had more domestic responsibilities that keep them busy during the use of the tools. Also, most of the production resources are owned by males and this encourages them to adopt technologies. The results supported the findings of Nyarko and Kozari [22], who reported that most smallholder farmers are female. Nevertheless, it opposes the results from the study by Rowntree [23] which reported a few percentages of females engaged in farming activities.

Table 1. Descriptive statistics for the selected demographic factors

Demographic factors			Use ICT tools	No use ICT tools
	Frequency	Percentage	Frequency	Frequency
Education Level				
None	6	6	0	6
Primary	52	49	0	52
Secondary	32	30	24	8
Post-secondary	16	15	16	0
Total (N)	106	100	38	68
Age Range				
18-35 (Youths)	25	23	24	1
36-50 (Middle-age)	45	43	10	35
51-65 (Seniors)	28	26	3	25
Above 65 (old-age)	8	7	1	7
Total (N)	106	100	38	68
Income Level in KES[□] 1000				
160 & below 160	62	59	0	62
161-270	25	23	20	5
271-380	19	18	18	1
Total (N)	106	100	38	68
Gender				
Male	40	38	28	12
Female	66	62	10	56
Total (N)	106	100	38	68

[□]Kenyan Shillings (1 USD to KES= 114.15 as of 9th March 2022)

**Fig. 2. Extent of ICT tools' usage**

3.2 Extent of Information and Communication Technology Tools' Usage

The study determined the extent of ICT tools' usage and discussed the results as shown (Fig.

2). The majority (55%) of the ICT tools' users in agricultural extension adopted mobile phones. This was followed by 29% who used radios, 11% used televisions and lastly, 5% used computers. The results could mean that mobile phones were the most important ICT tools among the farmers

since; the majority preferred to use it. Perhaps, mobile phones are more available and easy to use than the rest. The other ICT tools required more subsidies among the farmers to affect their adoption. The results supported Nyarko and Kozári [22] that mobile phones were greatly employed in agricultural extension services among smallholder farmers. However, Hoang [24] noted that many farmers adopted radios to access extension services.

3.3 Opportunities in Information and Communication Technology Usage

The peasants were asked to suggest some of the set circumstances that make it possible to use the ICT tools in cassava production and the results are shown (Table 2). It established that the majority (43.4%) of the CPs mentioned the availability of ICT tools. This was followed by 23.6%, who suggested the efficient delivery of ICT services, 19.8% suggested the convergence of ICT tools. Lastly, 13.2% held the view that subsidies in ICT services are one of the opportunities in the use. The suggestions could mean that the CPs were aware of the beneficial conditions available in the use of ICT in agricultural extension. The identified opportunities could be made more available among the CPs to enhance the use of ICT tools. The results were in agreement with the United Nations [25], who reported that the availability of the ICT tools makes it easier for smallholder

farmers to use them in agriculture. However, other opportunities proposed by the CPs were missing in the existing information. The use of ICT tools in agricultural extension among farmers has great potentiality that would be utilized for the benefit of agrarian development.

3.4 Challenges in the use of Information and Communication Technology Tools

The CPs stated challenges they faced in the use of ICT tools to obtain agricultural extension services (Table 3). The majority (45.3%) of peasants claimed that the use of ICT tools to obtain extension services is expensive. They said that the tools required money to buy and maintain them. This was followed by 26.4% who mentioned inadequate skills, 11.3% stated unawareness and 9.4% said inadequate motivation. Lastly, 7.5% said they were not interested. The results could mean that ICT comes with constraints that could be addressed to facilitate its use among the CPs. In order to increase the use of ICT tools in agricultural extension services, the county government could come in and support the peasants to overcome the said problems. The results were consistent with Chohan and Ghosh [26], who at least acknowledged that farmers have a problem in buying and maintaining the ICT tools in use due to inadequate funds.

Table 2. Opportunities in the use of ICT tools

Opportunities	ICT tools availability	Efficient ICT services	ICT tools convergence	Subsidies in ICT services	Total
Frequency	46	25	21	14	106
Percentage	43.4	23.6	19.8	13.2	100

Table 3. Challenges in the use of ICT tools

Challenges	ICT expensive	Inadequate skills	Unaware	Inadequate motivation	Not interested	Total
Frequency	48	28	12	10	8	106
Percentage	45.3	26.4	11.3	9.4	7.5	100

Table 4. Farmers' proposed strategies

Strategies to improve the use of ICT tools	Frequencies (F)	Percentages (%)
Subsidize ICT services	49	46.2
Provide online services in local languages	14	13.2
Establish more training centers	29	27.4
Improve motivation	14	13.2

3.5 Strategies to Improve Use of the Tools in Cassava Production

The CPs were asked to propose strategies, which can improve the use of ICT tools in cassava production and the responses recorded (Table 4). The majority (46.2%) of the peasants proposed that the ICT services should be subsidized through lower-interest loans and free online services. This was followed by 27.4% who proposed that more training centers should be established to allow more peasants to get access to the training places. Lastly, 13.2% proposed the provision of the online services in local languages to enable many of them adequately understand and benefit from the services and another 13.2% also proposed that more peasants should be motivated to use the ICT tools in extension. The proposed solutions could suggest that the CPs had identified solutions to the problems and formed a strong interest to use the tools whenever they would receive the services they proposed.

3.6 Correlation between Selected Demographic factors and ICT tools' Usage

The study employed Spearman's rank order to determine the correlation between the selected demographic factors and ICT tools' usage in agricultural extension among CPs.

3.6.1 Correlation between education level and ICT tools usage

The study employed Spearman's correlation to find out the correlation between peasants' education level and their use of ICT tools in cassava production (Table 5). It revealed a high, positive correlation, which is statistically significant at 1% level of significance ($R = +.815^{**}$, $P = .000$, $R^2 = 0.664$). Education level appears to provide a substantial guide to ICT

tools' adoption as it predicts at 66% of its usage in cassava production. The remainder (34%) of the unexplained variance may involve other factors. This shows that the use of ICT tools is directly proportional to the peasants' education level. It means that more investments in educating the peasants would increase the adoption of the tools in agricultural extension. The results refuted [27] who stated that the formal education level of farmers does not affect the use of agricultural technology. On the other hand it agreed with Naqvi et al. [16] that education encourage technology adoption.

3.6.2 Correlation between age and ICT tools usage

The study used Spearman's correlation to establish whether peasants' age and the use of ICT tools correlate (Table 6). It revealed a high, negative correlation, that is statistically significant at 1% significance level ($R = -.777^{**}$, $P = .000$, $R^2 = 0.604$). The age appears to explain 60% of ICT tools' adoption in cassava production. The remaining (40%) unexplained variance may involve other unknown factors among the peasants, for example, farming experience and land ownership. The use of ICT tools decreases with an increase in age. It could mean that old people are slow at trying out new technology in agriculture. The results opposed the report by Parvand and Rasiah [28] who noted that age does not directly determine the adoption of advanced technology. Nevertheless, it supported Nyarko and Kozari [22] in the sense that farmers' education provides formal skills that facilitate the adoption of technology.

3.6.3 Correlation between average annual income and ICT tools usage

The study applied Spearman's correlation to ascertain whether the peasants' average annual income level and ICT tools adoption correlates (Table 7). There was a high, positive correlation,

Table 5. Spearman's correlation for education level and ICT tools' usage

Number of the respondents	Coefficient of Correlation (R)	P-value	R ²
106	+0.815 ^{**}	0.000	0.664

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

Table 6. Spearman's correlation for age rang and ICT tools' usage

Number of the respondents	Coefficient of correlation (R)	P-value	R ²
106	-0.777 ^{**}	0.000	0.604

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

Table 7. Spearman's correlation of annual income level and the use of ICT tools

Number of the respondents	Coefficient of correlation (R)	P-value	R ²
106	+0.882 ^{**}	0.000	0.778

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

Table 8. Spearman's correlation between gender and ICT tools' usage

Number of the respondents	Coefficient of Correlation (R)	P-value	R ²
106	-0.554 ^{**}	0.000	0.307

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

which is statistically significant at 1% significance level ($R = .882^{**}$, $P = .000$, $R^2 = 0.778$). The average annual income level appears to provide a substantial guide on ICT tools adoption as it predicts 78% of the adoption in cassava production. The remaining (22%) unexplained variance may include other undetermined factors such as inheritance patterns that enable others own properties from kins. This could mean that an increase in the income level of the peasants facilitates the use of ICT tools in extension. Availability of money enabled the peasants to buy the tools and subscribed to the ICT services. The finding contradicted Akintelu et al. [29], who noted that farmers' income levels did not affect the adoption of modern technology.

3.6.4 Correlation between gender and ICT tools' usage

The study recruited Spearman's correlation to discover if gender and ICT tools usage correlate (Table 8). The results revealed a moderate, negative correlation, which is statistically significant at 1% significance level ($R = -.554^{**}$, $P = .000$, $R^2 = 0.307$). Gender explained 31% of ICT tools' adoption in agricultural extension. The remaining 69% constitutes other undetermined factors. The study revealed that gender has a less significant impact on the use of ICT tools in agricultural extension. However, there is a need to improve campaigns on gender equality to ensure that both female and male peasants get equal access to agricultural resources. The results opposed Cetin et al. [30] women empowerment has reduced the impact of gender on technology adoption. On the other hand, it was on the same note as McGuire et al. [31] that the existing gender gap hinders the adoption of new technology.

In general, the results of Spearman's correlation among income, age, education, and ICT tools' adoption revealed that there is a statistically significant strong correlation. However, gender contributes a lesser percentage to the adoption.

Income, education and gender had a positive correlation with the use of ICT tools. Meaning that an increase in their level increase adoption of the tools in extension. Nevertheless, age had a negative correlation with the use of ICT tools, revealing that an increase in age results to a decrease in adoption of ICT tools among the peasants.

4. CONCLUSION

The majority of the CPs were females, middle-aged, lower-income earners, and category of primary education level. The availability of ICT tools was mentioned by many as the best opportunity in ICT. The use of ICT tools among the CPs was confirmed to be low. The mobile phone was the most used ICT tool among the CPs who adopted the tools in extension. The expensiveness of ICT was stated as the main challenge in ICT. The results indicated a statistically significant correlation between the selected demographic factors and ICT tools' usage. The analysis confirmed that ICT tools were used more among youths, males, higher-income earners, and highly educated peasants. This could mean that males tend to own most of the production resources, such as land. Youths are more proactive in trying new technology. Higher education level provides necessary skills required to operate the ICT tools, and lastly, higher income levels increase financial muscles to buy and subscribe the ICT services. Policymakers should prioritize policies that would support demographic factors, especially education, income, gender, and age.

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DATA AVAILABILITY

Authors will avail the data whenever there is a need.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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