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ICT Education and Determinants of Acceptance Amongst Smallholder Farmers in Mbombela, South Africa

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ABSTRACT

The study was carried out in Mbombela District, Mpumalanga, South Africa. The study aimed to assess selected farmers' acceptance of information and communication technology (ICTs). The study used a quantitative approach. Probability sampling was used as a quantitative approach. Random sampling was used, and 285 samples were sampled from a sampling frame of 380 farmers in the study area. Structured and semi-structured questionnaires were used to elicit necessary information from respondents, while focus group discussions were employed to validate in-depth responses. The binary logistics regression was used to determine significant variables that influence the acceptance of ICT. The results showed that the most accessible ICT tools to farmers were radio, mobile phones, and television. However, contemporary ICT tools such as the internet and flash drives were rarely accessible to the respondents. The study also found that demographic variables such as age ($P<0.000$), level of education ($P< 0.020$), household size ($P< 0.053$), ICT support ($P< 0.014$) and extension services ($P<0.019$) were the explanatory variables that affect the acceptance of ICT. Logistics regression results reveal that some variables were significant and positively related to the acceptance of ICT. The paper concludes that the effective application of ICT provides farmers with greater access to information and knowledge, which helps improve their production process.

Keywords: ICT Education, Acceptance, Farmers, Behaviour, Accessibility, Media

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1. INTRODUCTION

The need to disseminate relevant farming information to smallholder farmers timeously is a requirement for improved ways to ensure that farmers receive relevant information about them and their agricultural activities. With the increasing technological advancement and the current digital age, information and communication technologies (ICTs) are important factors that can promote agricultural development in rural areas while at the same time improving the technology transfer process between researchers, extension agents and farmers. Qiang, Pitt, and Ayers (2013) defined ICTs as technologies that collect, process, store, retrieve and distribute information using microelectronics, telecommunication, and computers. According to Rice and Leonardi (2014), ICTs facilitate communication, transfer, and process of information to benefit the user. ICTs used by agricultural extension organisations include radio, television, World Wide Web, search engines, cameras, video, email, web publications and so forth (Muñoz, Mera, Artiega, & Vega, 2017). The role of ICTs in rural development is gradually being recognised as they help enhance food security and improve rural livelihoods (Qiang, Pitt, & Ayers, 2013). Although ICTs are still relatively new, there is growing evidence that ICT contributes to development and poverty alleviation, especially in the agricultural sector. Munyua (2014) noted that ICTs are vital in ensuring that smallholder farming businesses are productive, efficient, and sustainable. The agricultural sector generally relies on the flow of information locally, nationally, and internationally with sufficient market knowledge (Taylor & Bhasme, 2018). Developing countries are expected to utilise ICTs to their full potential to bring development, especially to smallholder farmers in rural areas.

1.1. Statement of the Problem

Information has become crucial to development, and the need for accurate and relevant information is continuously increasing. With the continuous population growth in this digital age, the accumulation and utilisation of ICT knowledge are important in stimulating development and creating opportunities for economic growth and poverty alleviation. Tibesigwa and Visser (2015) indicated that agriculture is a major contributor to economic growth, especially in developing countries. The success of farms usually depends on the farmer's ability to make smart and timely decisions throughout the production season (Taylor & Bhasme, 2018). Therefore, smallholders need access to relevant data or information that will improve their decision-making.

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Mbatha (2020) identified inadequate and unreliable information as one of the causes of poor agricultural productivity in South Africa. To make practical and smart farming decisions, smallholder farmers require relevant and timely information on production practices, post-harvest handling, marketing of produce and access to support services. Smallholder farmers currently rely on various sources for agricultural information. These include local organisations, extension agents, NGOs, and other farmers. According to Phiri, Chipeta and Chawinga (2019), few smallholder farmers use information technology to acquire information despite continuous technological advancements. The application of ICT in smallholder farming in South Africa is still rare. The reliability of farming information is widely influenced by the information source and method of dissemination. Therefore, information from extension agents and agricultural agencies is more reliable than information from other obsolete sources (Phiri *et al*., 2019).

Given the impact of ICTs in disseminating agricultural information to smallholder farmers, it remains important for agricultural extension agents and agricultural agencies to identify the ICTs accessible to smallholder farmers and how they can be best utilised for the farmer's information needs. Some factors may affect the utilisation of ICTs by smallholder farmers, such as the skills of the farmers in using ICTs, and their willingness to change from traditional information sources to new technologies (Syiem & Raj, 2015). Socioeconomic and demographic characteristics of smallholder farmers also influence their use of ICTs as they may struggle with infrastructure availability and poor network coverage (Phiri *et al*., 2019). With the apparent potential of ICTs in improving smallholder farmers' productivity, agricultural stakeholders need to know which ICTs are most accessible to farmers and the challenges they face in using these ICTs. However, there is limited literature on ICT utilisation among small-scale farmers in South Africa.

Moreover, most studies on ICT in South Africa focused on one ICT tool or service, which shows the need for further studies on the different ICTs used by smallholder farmers. The accessibility of ICT and its acceptance differs according to each farmer's situation and is influenced by many factors. This study emphasised socioeconomic factors, accessibility of ICTs and determinants of ICT acceptance by smallholder farmers. The primary focus was on selected ICTs: mobile phones, radio, television, print media, computers, internet, flash drives, audio CDs and DVDs, which are used to share agricultural information. There is also a need

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for further studies on ICT usage in rural areas where the participants have common characteristics, challenges, and views.

1.2. Research Objectives

The study aims to assess information and communication technology (ICT) used by smallholder farmers in the study area. Further studies on the use of ICTs by smallholder farmers will provide useful and in-depth information on the most used ICTs and the factors affecting the acceptance of ICTs by smallholder farmers. Against this backdrop, this study was designed to address the following objectives:

1. Examine the socioeconomic characteristics of smallholder farmers.
2. Assess the most available ICT tools smallholder farmers use in the study area.
3. Determine the factors influencing the acceptance of ICTs amongst smallholder farmers in the study area.

2. METHODOLOGY

The study focused on selected smallholder farmers in Mbombela, Mpumalanga Province. Three selected villages used for the study were Ka-Bokweni, Kayamazane and Luphisi. Ka-Bokweni is geographically located at 25º 20’ 0” South, 31º 8’ 0” East, Kayamazane at 25º 28’ 19” South, 31º 11’ 9” East and Luphisi at 25º 24’ 0” South, 31º 17’ 0” East of Mpumalanga Province.

2.1. Sampling and Data Collection

A random technique was used for sampling. This method eliminated bias during sampling. Smallholder farmers from the three selected villages were considered a unit of analysis, and a sample size of 285 smallholder farmers was obtained and considered adequate for this study. Primary data were collected using a structured and semi-structured questionnaire. The questionnaire instrument consisted of questions with pre-formulated responses from which the respondents selected their answers. Section A of the questionnaire focused on the respondents' socio-demographic information, such as gender, age, level of education, household size, and employment status. Section B focused on the respondents' accessibility of different ICT tools, and section C focused on smallholder farmers' acceptance of ICT tools. Furthermore, focus group discussions were used to elaborate on the responses recorded from the questionnaire. Before data analysis, the collected data sets were checked for errors and appropriately coded

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and captured into the Statistical Package for Social Sciences (SPSS) Version 27 software for analysis.

2.2. The Model

For the determinants of acceptance of ICT, analysis was performed using the binary logistic model as indicated below. The logistic regression model was used because it allows for estimating the probability of events about a set of independent variables which are hypothesised to affect an outcome. Logistic regression is applied to classify respondents into one or two groups in cases where only one set of independent variables is known. Nonetheless, no assumptions were made regarding the dispersal of the independent variables represented by X, which have been hypothesised. This means that the X variable can take a discreet or continuous format. Therefore, R_i represents the dichotomous variable equal to 1 if smallholder farmers have adopted ICTs and 0 if they do not.

To ascertain if there a significant relationship between the independent variables (farmer's socio-demographics) and the acceptance of ICTs, the logistic regression model was used as indicated:

$$Y = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots\ldots\ldots\ldots + \beta_{10} X_{10} + \mu \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$

Where:

Y = ICT adoption (smallholder farmers adopt ICTs = 1, O = Do not adopt)

X_1 - X_{10} = independent variables as illustrated below:

X_1 = Gender (Male = 1, Female = 2)

X_2 = Age (years)

X_3 = Marital status (Single = 1, Married = 2, Divorced = 3, Separated = 4, Widow = 5, Widower = 6)

X_4 = Level of education (No school =1, Primary school = 2, Secondary school = 3, ABET =4, Tertiary = 5)

X_5 = Household size (numeric)

X_6 = Employment status (Unemployed = 1, Employed = 2, Self-employed = 3)

X_7 = Farming experience (in years)

X_8 = Farm Size (numeric)

X_9= Farm income (numeric)

X_{10} = Type of farming (Livestock = 1, Crops = 2, Livestock and crops = 3)

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X_{11} = Lack of ICT skills (Not a challenge = 1, Minor challenge = 2, Moderate challenge = 3, Serious challenge = 4, Very serious challenge = 5)

X_{12} = No access to ICT and infrastructure (Not a challenge = 1, Minor challenge = 2, Moderate challenge = 3, Serious challenge = 4, Very serious challenge = 5)

X_{13} = ICT support (Yes = 1, No = 2)

X_{14} = Contact with extension advisors (Weekly = 1, Fortnights = 2, Monthly = 3, Yearly = 4, other = 5)

X_{15} = Perceived benefits of ICT adoption (Easier communication = 1, Easier information access = 2, Improves job performance = 3, Reaching more customers = 4, Managing finances = 5)

β_0 = constant

B_1- β_{10} = standardised partial regression coefficients

μ = error term

3. RESULTS AND DISCUSSION

3.1. Socioeconomic Characteristics of Smallholder Farmers

Table 1 shows the socioeconomic characteristics of smallholder' farmers. The study result illustrates that 75% of the 285 respondents were females, while the remaining 25% were males, as indicated in Table 1. The largest proportion (30%) of respondents were between the ages of 51-60, while 27% were older than 60. Only 16% of the respondents were between 41 and 50, while 14% indicated their age to be between 30 and 40. Those younger than 30 years were 13%. This result suggests that older people were involved in farming compared to the youth. The marital status of smallholder farmers in the study area, shown in Table 1, indicated that most (49%) of the respondents were single, while 34% were married and 7% were widows. The other 4% were separated, and 3% were divorced. Only 2% of the respondents were widowers.

Regarding education level, 35% of the respondents have a secondary school education, while 27% have no formal education. Those with primary school education make up 26%, while those with tertiary education and ABET make up 9% and 3%, respectively. The result (Table 1) shows that 27% of the respondents have no formal education. Results of household size of the respondents indicate that 47% had a household size of 6-10 people, while 25% had a household size of more than 10 people. The other 19% had a household size of 3-5 people, whereas only 10.2% had a household size of less than three people. From the employment

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category, results show that 49% of the respondents were unemployed, while 26% were employed, and only 25% were self-employed. The majority (36%) of the respondents had 6-10 years of farming experience, while 27% had 11-15 years of farming experience. Furthermore, 17% have farming experience of less than five years, and only 14% have 16-20 years of farming experience. The lowest percentage was 6%, comprising respondents with more than 20 years of farming experience. As shown in Table 1, the majority (39.6%) of the farmers had a farm size between 1-5 acres, while 23.9% had a farm size between 6-10 acres. Furthermore, 23.5% of the respondents had a farm size less than 1 acre, and 10.2% had a farm size between 11-15 acres. Only 2.8% of the respondents had a farm size greater than 15 acres. The results show that most respondents had small farm sizes, affirming that they were subsistence farmers.

The annual farm income of the respondents was investigated, as shown in Table 1. The results indicated that 41% of the respondents had a farm income of R5000-R10000, while 38% had a farm income of less than R5000. Those with a farm income between R11000-R15000 made up 13%, whereas only 7% had a farm income between R16000-R20000. The remaining 1% had a farm income over R20000. The results show that most of the respondents have a low farm income. From our focus group discussion with respondents, it was clear that rural households usually realise a small amount of income from their farm activities due to different constraints on smallholder farming.

The demographic information of the study's respondents is shown in Table 1.

TABLE 1: Socioeconomic Characteristics of the Respondents

Variable	Frequency	%
Gender:		
Male	72	25.3
Female	213	74.7
Total	285	100.0
Age:		
< 30 years	37	13.0
30 – 40 years	40	14.0
41 – 50 years	46	16.1

51 – 60 years	85	29.8
> 60 years	77	27.0
Total	285	100.0
Marital status:		
Single	140	49.1
Married	98	34.4
Divorced	9	3.2
Separated	12	4.2
Widow	20	7.0
Widower	6	2.1
Total	285	100.0
Level of education:		
No school	77	27.0
Primary school	74	26.0
Secondary school	99	34.7
ABET	9	3.2
Tertiary	26	9.1
Total	285	100.0
Household size:		
< 3	29	10.2
3 - 5	53	18.6
6 - 10	133	46.7
> 10	70	24.6
Total	285	100.0
Farm experience:		
< 5 years	48	16.8
6 – 10 years	103	36.1
11 – 15 years	76	26.7
16 – 20 years	40	14.0
>20 years	18	6.3
Total	285	100.0
Farm size:		

<1 acre	157	55.1
1 – 5 acres	57	20.0
6 – 10 acres	34	11.9
11 – 15 acres	29	10.2
>15 acres	8	2.8
Total	285	100.0
Farm income (Rand):		
< 5000	109	38.2
5000 - 10000	116	40.7
11000 - 15000	37	13.0
16000 - 20000	19	6.7
>20000	4	1.4
Total	285	100.0

3.2. Accessibility of ICT Tools Among the Respondents in the Study Area

Access to ICT tools among the respondents was investigated (Table 2). The results show that the most accessible ICT tools were radio, mobile phone, and television. The majority (99%) of respondents had access to a radio. Many (91%) respondents also had access to a mobile phone and a television (72%). This finding is supported by Mwombe, Mugivane, Adolwa and Nderitu (2014), who showed that most participants had radio access in their study on ICT utilisation by smallholder banana farmers. The radio is an affordable ICT tool compared to several ICT tools, and most radio devices are small and portable, allowing users the convenience of taking them along. According to Akintonde et al. (2021), radio is useful in transferring information to farmers as it is relatively affordable and has different slots and programmes that appeal to the farmers. However, the language used in radio programmes is also important as radio stations using vernacular languages are preferred, especially by farmers with low literacy levels (Ologundudu & Eniola, 2021).

Gillwald and Stork (2018) found that 85% of South Africans own a mobile phone, which supports the findings showing that most respondents in the study had access to a mobile phone. Ogunniyi and Ojebuyi (2016) indicated that mobile phones have become important for agribusinesses, especially for communication and marketing. According to Shobiye, Naidoo and Rugbeer (2018), television has become a common ICT tool in most households, with at

least 75% of South African households having access to television. Furthermore, 47% of the respondents had access to print media, while only 22% had access to the internet. The flash drive was only accessible to 16% of the respondents. This result shows numerous constraints to accessing internet services and print media. This finding is corroborated by the study of Kumwenda (2020), who found that people in rural areas may find it difficult to access the internet and print media because of long distances to shopping centres. Furthermore, Thurman (2014) posited that print media, such as newspapers and magazines, are less popular due to the use of digital platforms. However, some people still prefer print media because they have little trust in online and digital sources of information. A survey by Research ICT Africa (2018) found that only 47% of mobile phone owners in South Africa have smartphones. Those who do not have smartphones may struggle to access the internet, making it one of the ICT tools with lower levels of accessibility.

South Africa was also ranked among the countries with high data prices, contributing to inadequate access to internet services. The least accessible ICT tools were audio CDs, DVDs and computers, as shown in Table 2. Only 14% of the respondents had audio CDs, while 14% had access to DVD. The ICT tool with the lowest level of accessibility was the computer (10%). According to Mwangi and Kariuki (2015) most farmers do not have adequate skills and physical access to computer-based services. Furthermore, some extension organisations still rely on printed information sources such as posters and pamphlets to distribute agricultural information, implying that ICT tools such as computers and DVDs are still unpopular among smallholder farmers (Orikpe & Orikpe, 2013). According to Saidu et al. (2017), rural areas usually do not have adequate ICT centres where people may access computer services that are unavailable in their households.

TABLE 2: Accessibility of ICT Tools Among the Respondents

	Accessible		Not accessible	
ICT tools	Frequency	Percent (%)	Frequency	Percent (%)
Mobile phone	260	91.2%	25	8.8%
Radio	282	98.9%	3	1.1%
Television	206	72.3%	79	27.7%

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Print media	135	47.4%	150	52.6%
Computer	27	9.5%	258	90.5%
Internet	62	21.8%	223	78.2%
Flash drive	46	16.1%	239	83.9%
Audio CD	40	14.0%	245	86.0%
DVD	39	13.7%	246	86.3%

3.3. Logistic Regression Results for ICT Education and Determinants of Acceptance Amongst Smallholder Farmers

Table 3 shows the logistic regression result portraying the relationship between the selected predictor variables and acceptance of ICT. In the regression analysis, Cox and Snell (0.234), McFadden (0.194), and Nagelkerke R^2 of 0.314 results obtained indicated that the variables were explained in the model and consequently, the model was suitable for this study (Sekabira, Bonabana-Wabbi & Narathius, 2012). The variables selected and discussed in Table 3 were measured for their relevance in ICT acceptance by respondents.

As shown in Table 3, the variable age was significant with a $p<0.000$ and positively associated with the acceptance of ICT with a coefficient of $\beta= 1.071$. These findings suggest that for every unit increase in age, there is 1.071 times increase in the *log* odds of accepting ICT. This result contradicts previous findings by Irungu, Mbugua and Muia (2015), who found that young people are more likely to accept ICT than older people. Similarly, Anoop, Ajjan and Ashok (2015) found that young people were regular users of mobile phones and the internet for online networking, advertising, and communicating with each other. The level of education was found to be significant with a $p<0.020$ and positively associated with accepting ICT with $\beta= 0.565$. This result implies that any increase in the level of education or additional ICT training offered to smallholder farmers will increase the probability of accepting the use of ICT by 0.565 times. The result is supported by the previous finding of Kabir (2015), who found that achieving the highest level of education was a very important predictor of ICT acceptance. According to Karanja et al. (2020), education changes how people approach situations and make decisions. The variable ICT support was significant with a $p<0.014$, and $\beta= -0.286$, which indicates that it is negatively associated with acceptance of ICT. This result suggests that for every unit increase in ICT support received, there is a decrease in the *log* odds of ICT acceptance by 0.286

times. This result contradicts the previous findings by Kante, Oboko, and Chepken (2019), who found that farmers who received ICT support had more capacity to use and apply ICT effectively in their farm activities. Furthermore, ICT support groups serve as social systems where farmers can exchange information about different technologies they use. However, Cox and Sseguya (2015) stated that the type of ICT support provided to farmers may not always be preferred, as smallholder farmers' needs and situations vary. Moreover, despite receiving technological support, some farmers still prefer traditional and manual methods. The variable contact with extension advisors was also significant with a $p < 0.019$, and a coefficient of $\beta = -0.433$, which means negative influence for accepting ICT by smallholder farmers. These results imply that a unit increase in the frequency of contact with extension advisors will decrease the probability of ICT acceptance by 0.433 times. In contrast, Agholor and Nkosi (2020) posited that extension services play a crucial role in disseminating information, introducing farmers to innovations, and creating social relationships among smallholder farmers.

Table 3: Logistic Regression Showing ICT Education and Determinants of Acceptance Amongst Smallholders Farmers

Independent variables	B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Gender	-.276	.337	.671	1	.413	.759	.392	1.470
Age	1.071	.249	18.504	1	.000	2.919	1.792	4.755
Marital status	-.142	.157	.817	1	.366	.868	.638	1.180
Level of education	.565	.243	5.387	1	.020	1.759	1.092	2.835
Household size	-.419	.217	3.737	1	.053	.657	.430	1.006
Employment status	.097	.277	.123	1	.726	1.102	.640	1.899
Farming experience	.124	.188	.438	1	.508	1.132	.783	1.637
Farm size	-.410	.245	2.796	1	.095	.664	.411	1.073

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Farm income	.505	.313	2.604	1	.107	1.657	.897	3.059
Type of farming	.039	.276	.020	1	.887	1.040	.605	1.787
Lack of ICT skills	.062	.102	.378	1	.539	1.064	.872	1.299
No access to ICT and infrastructure	.121	.106	1.296	1	.255	1.129	.916	1.391
ICT support	-.286	.116	6.098	1	.014	.751	.599	.943
Contact with extension advisors	-.433	.185	5.472	1	.019	.648	.451	.932
Perceived benefits of ICT adoption	-.131	.098	1.811	1	.178	.877	.724	1.062
Nagelkerke R^2	.314							
Cox and Snell	.234							
McFadden	.194							

Significant at P<0.1 (*); P<0.05 (**); or P<0.01 (***)

4. CONCLUSION AND RECOMMENDATION

From the results of the study, the majority of the respondents are elderly persons and unmarried. Furthermore, most respondents have small farm sizes and low farm incomes. The results also showed that respondents do not have other forms of employment, and the majority were practising crop production. The ICT tools that were most accessible to the respondents were radio, mobile phones, and television, and the conventional ICT tools were available for households. However, contemporary ICT tools such as the internet and flash drives were less accessible to the respondents. There are certain factors which hinder the respondents from using ICT effectively. Furthermore, factors such as age and level of education, as well as social and institutional factors such as farmer support, also affect ICT acceptance by the respondents. These variables have negative and positive levels of significance in influencing the acceptance of ICT by smallholder farmers. Therefore, the paper concludes that ICT is useful in improving farm productivity. The effective application of ICT provides farmers with greater access to information and knowledge, which helps improve their decision-making, thus improving their income and rural livelihoods.

Based on the findings, the study recommends that:

I. Radio and television should consistently be used to distribute relevant and timely information to smallholder farmers because these are affordable and more accessible to farmers.

II. Adequate education, training and workshops should be provided for those with low literacy levels to teach them how to use different ICTs.

III. The government and mobile service providers find ways to improve the network connectivity in rural areas that would allow rural farmers to use ICTs that require a network connection effectively.

IV. Smallholder farmers with access to mobile phones should be educated on using other social media, such as Facebook and WhatsApp, for easier communication and the marketing of their farm produce.

V. Radio and Television programmes should be specialised to fit the needs of smallholder farmers. This includes scheduling programmes to play when smallholder farmers are available and providing content in languages that smallholder farmers understand.

VI. The cost of airtime and data bundles should be considered because the high cost was identified during our focus group discussion as a major challenge for smallholder farmers in using ICT.

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