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Perceptions of Small-scale Farmers on the Adoption of ICTs for Accessing Agricultural Information in Mahikeng, Northwest Province, South Africa

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ABSTRACT

Information and Communication Technology (ICT) tools such as mobile phones, the internet, and radio can significantly improve small-scale farmers' access to agricultural information, enhancing decision-making and productivity. However, in rural regions like Mahikeng (Northwest Province, South Africa), the extent of ICT adoption and farmers' perceptions of these technologies remain underexplored. This study aimed to assess small-scale farmers' perceptions of ICT adoption for accessing agricultural information and to identify the key factors influencing these perceptions. A quantitative, descriptive survey was conducted with 121 randomly selected small-scale farmers. Data were collected through structured questionnaires and analysed using chi-square tests and binary logistic regression. Respondents were predominantly male with limited formal education, and the majority (86%) used ICT tools especially television, radio, and mobile phones to obtain agricultural information. Overall, perceptions of ICT use were positive: approximately two-thirds agreed on its value for driving agricultural change, improving productivity, profitability, and enhancing market access. Chi-square analysis revealed significant associations between perception of ICT use and level of education ($p = 0.046$), awareness of ICTs ($p = 0.000$), and Direct use of ICT (($p = 0.004$). Logistic regression showed that level of education ($P \leq 0.01$), ICT awareness ($P \leq 0.05$), and ease of use ($P \leq 0.05$) positively influenced perceptions, while gender ($P \leq 0.10$) and reliance on traditional information sources ($P \leq 0.10$) had negative associations. The study recommends expanding farmer education, ICT awareness, and access to user-friendly tools to strengthen adoption and support sustainable agricultural growth in rural communities.

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1. INTRODUCTION

1.1 Background

Adoption of Information and Communication Technology (ICT) in agriculture has the potential to revolutionise how small-scale farmers access and utilise agricultural information. Tools, such as mobile phones, internet platforms, and radio broadcasts, have effectively provided real-time data, market trends, and expert guidance, ultimately enhancing agricultural productivity and decision-making (Mapiye *et al*., 2023; Misaki *et al*., 2018). Despite these benefits, the perception and actual adoption of ICT among small-scale farmers in rural areas, such as Mahikeng, Northwest Province, South Africa, remain underexplored. Previous studies in the region have largely focused on perspectives of agricultural extension officers (Mabe, 2012; Oladele, 2015), leaving a critical knowledge gap on the experiences and perceptions of small-scale farmers towards ICT.

Small-scale farmers in Mahikeng represent a vital, yet vulnerable agricultural community, characterised by limited resources, infrastructure deficits and constrained access to modern farming techniques. Given the increasing penetration of mobile phones and internet connectivity in rural areas (Ndimbo *et al*., 2023), these farmers stand to gain significantly from ICT-driven solutions that can improve productivity, profitability and market competitiveness (Nasir and Khan, 2022). Nonetheless, adoption rates remain inconsistent, influenced by critical factors, such as education, income levels, digital literacy and availability of infrastructure (Van Greunen & Fosu, 2022; Aker, 2021).

Understanding the perceptions of farmers on the adoption of ICTs, is, therefore, essential in designing targeted policies and interventions to bridge the digital divide effectively. This study addresses these concerns by examining attitudes, challenges and determinants of adoption of ICT among small-scale farmers in Mahikeng. By identifying specific facilitators and barriers, the research aims to inform interventions that can reduce information asymmetry, empower marginalised farmers and promote sustainable agricultural development (Hanson and Heeks, 2020). Such insights will be crucial for policymakers, agricultural extension services and technology developers seeking to enhance digital inclusivity within agriculture.

1.2 Statement of the problem

In Mahikeng, there is limited empirical data on how small-scale farmers perceive the use of ICT to access agricultural information. Understanding their perceptions is essential in designing targeted interventions that encourage the adoption of ICTs to simprove agricultural outcomes. Previous research has highlighted that while some farmers view ICT as a valuable tool to enhance productivity and access to markets, others face significant challenges, such as high costs of devices, poor network coverage and lack of technical know-how (Nyakudya *et al*., 2024). These challenges are particularly prevalent in rural areas where infrastructure and literacy levels may limit the effective use of ICT tools.

1.3 Aim, objectives and hypothesis

This study aims to assess the perceptions of small-scale farmers in Mahikeng on the use of Information and Communication Technology (ICT) in accessing agricultural information. The key objectives were to identify socio-economic characteristics of small-scale farmers within Mahikeng Local Municipality and explore how these characteristics influence their perceptions of the use of ICTs to access agricultural information. The following hypotheses were tested in this study:

Null hypothesis (H_0): There is no significant association between farmers' socio-economic characteristics (education, gender, awareness of ICT, perceived ease of use, sources of information) and their perceptions of ICT adoption for accessing agricultural information.

Alternative hypothesis (H_1): There is a significant association between these socio-economic characteristics and farmers' perceptions of ICT adoption.

2. METHODOLOGY AND PROCEDURES

2.1 Study area

Mahikeng Local Municipality, in South Africa's Northwest Province, covers 3,703 km² with 28 wards and over 100 villages, and has a population of 270,000–350,000 (Mahikeng Local Municipality, 2024; Municipalities of South Africa, 2024). About 70% of the municipality is rural, with more than 40 remote villages dispersed up to 120 km from the urban centre (Municipalities of South Africa, 2024). While 97% of households have electricity, only half have piped water or flush toilets (Municipalities of South Africa, 2024). The area faces high

unemployment (35.7%) and a youthful demographic, with modest educational attainment, 26% have matric and about 7% have no formal schooling (Municipalities of South Africa, 2024).

Agriculture is central to Mahikeng's economy, focused on cattle, sheep, goats, maize, and sunflower, and is highly vulnerable to drought (Setshedi & Modirwa, 2020). Mahikeng, with its main suburb Mmabatho, serves as the administrative and commercial hub, but many surrounding villages remain underserved in terms of infrastructure and services (Mahikeng Local Municipality, 2024). Its location near the Botswana border and major routes to Gauteng provides potential for improved market and digital connectivity.

Mahikeng was selected for this study due to its large, socio-economically challenged smallholder farmer population and recent government agricultural interventions. For example, the Northwest Department of Agriculture and Rural Development (DARD) established a modern livestock-handling facility in Ditshilo village and supported community vegetable gardens in Ottoshoop under the Thuntsha Lerole food-security programme. Additionally, a farmer in Setlopo received breeding Boer goats from the Department (Food for Mzansi, 2024; Northwest DARD, 2024).

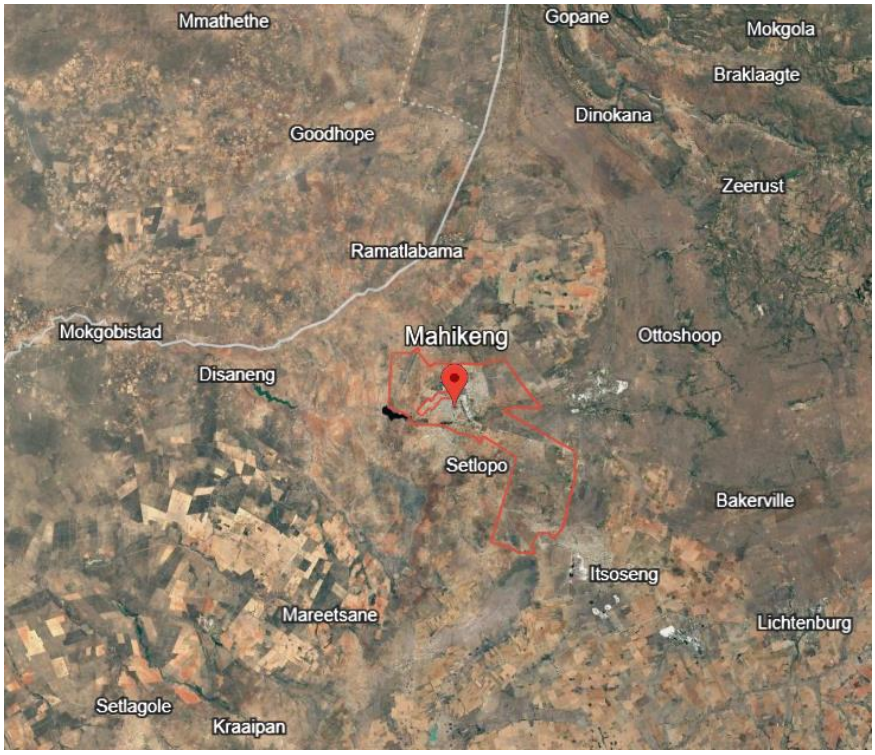

Figure 1: Map of Mahikeng Capital of Northwest Province. Source: Googles Maps (2025)

2.2 Research design

A descriptive, quantitative cross-sectional research design was adopted for this study. In this approach, numeric data on farmer demographics and ICT-related perceptions and awareness were systematically gathered and summarized. Structured questionnaire was employed for data collection, which ensured consistent measurement of socio-economic variables and ICT-related responses across all participants. This aligns with quantitative methodology, allowing use of statistical analysis to describe trends and test hypotheses (Dulock, 1993). Descriptive statistics (means, percentages, frequency tables) were first used to characterize the farmer sample and their ICT perceptions. To test relationships, inferential techniques were applied consistent with the design. Chi-square tests were used to examine associations between categorical variables (e.g. education level vs. positive ICT perception). Chi-square is appropriate here because both the socio-economic factors (like sex, education, farm type) and the outcome (agreement vs. disagreement on ICT value) were measured categorically (Mohajan, 2020). Significant chi-square results point to factors linked with ICT perceptions. Finally, binary logistic regression was employed to model the probability of a farmer having a positive perception of ICT use (treated as a binary outcome) as a function of multiple predictors (education, age, income, ICT awareness, etc.). Logistic regression aligns with the quantitative framework by providing an inferential test of how each factor affects ICT adoption likelihood. In summarys, the structured survey collected quantitative data, descriptive analysis summarized farmer characteristics, chi-square identified significant pairwise associations, and logistic regression assessed combined effects of predictors, all reinforcing a cohesive quantitative-descriptive methodology.

2.3 Population of the study

The study population comprised all small-scale farmers in the selected area of Mahikeng Local Municipality. According to records obtained from the Mahikeng local agricultural office of the Northwest Department of Agriculture and Rural Development (NWDARD), the total population of smallholder farmers (including those in livestock and crop production) was 1,449. This official figure defined the total population for the research. From this population, a random sample was drawn. In other words, “a population size of 1,449 small-scale farmers was obtained from the Mahikeng local agricultural office of NWDARD for the specified area of study.” Utilizing the complete registry ensured the sample was representative of the local smallholder community, consistent with the study’s quantitative and descriptive objectives.

2.4 Sampling procedure and sampling size

The sample size for this study was determined using Krejcie and Morgan's (1970) sample size table, which recommended a sample of 302 participants from a total population of 1,449 small-scale farmers. Simple random sampling was employed to ensure that each farmer had an equal chance of being selected, thereby enhancing representativeness of the sample. However, due to voluntary participation constraints, only 121 respondents participated in the study. While this represents a lower response rate than initially planned, the obtained sample size remains methodologically justifiable for several reasons.

Krejcie and Morgan's sample size determination is based on a 95% confidence level and a 5% margin of error. Although the final sample of 121 respondents was lower than the intended 302, it still falls within an acceptable range for statistical reliability when analysing perceptions of small-scale farmers. According to Kotrlik *et al*. (2001), anticipated response rates should be considered when determining appropriate sample sizes in voluntary survey-based research. Thus, the achieved response rate of 40% in this study is within acceptable limits.

2.5 Data collection

Data for this study were collected using a structured, researcher-administered questionnaire designed to assess small-scale farmers' perceptions and use of Information and Communication Technologies (ICT) in Mahikeng Local Municipality. The questionnaire was divided into several sections, including demographic information, farming characteristics, ICT awareness and use, perceptions of ICT, and constraints to adoption. The main dependent variable was the perception of ICT adoption, measured on an 11-item Likert scale. Independent variables included education level, gender, ICT awareness, perceived ease of use, and sources of information. Each variable was defined and selected based on relevant literature, with the following expected influences:

Table1: Descriptions Of Variable, Measurement and Expected Outcomes

Variable	Measurement	Expected Influence on ICT Perception
Dependent Variable	Perception of ICT adoption (1 = positive, 0 = negative)	Outcome variable modelled using binary logistic regression
Level of Education	Categorical (5	Positive: Higher education expected to enhance ICT perception

Variable	Measurement	Expected Influence on ICT Perception
Gender	Male = 1, Female = 0	Context-dependent; often males may have greater access (positive), but may vary
Awareness of ICT	Awareness/knowledge of ICT applications	Positive: Greater awareness likely to increase favourable perception
Perceived Ease of Use	Likert-scale (ease of using ICT tools)	Positive: Higher ease of use expected to improve perception
Sources of Information	Number/variety of ICT information channels (e.g., extension, radio, peers)	Positive: More sources expected to increase positive perception

2.5.1 Justification for Selection of Variables

The selection and definition of independent variables in this study were guided explicitly by established theoretical frameworks and empirical studies on ICT adoption and perception. Specifically, the Technology Acceptance Model (TAM), Diffusion of Innovations Theory, and related empirical findings informed the inclusion of education, gender, ICT awareness, perceived ease of use, and sources of information as critical predictors of ICT adoption. Prior studies underscore that education level significantly enhances farmers' capacity and confidence to effectively use ICT tools (Kumar et al., 2023). Gender is acknowledged in literature as an influential determinant, highlighting that female farmers often face distinct barriers or may respond differently to ICT-based interventions compared to their male counterparts (Aduwo et al., 2017; Mpiima et al., 2019). Awareness and perceived ease of use have consistently been validated as strong determinants of positive attitudes towards ICT (Freeman & Mubichi, 2017; Hendrawan et al., 2023). Moreover, the choice of information sources (traditional versus digital) is recognized as shaping openness to technological change (Hoang & Tran, 2023). Collectively, these theoretical justifications and prior empirical evidence substantiate the relevance and appropriateness of the selected variables in this study.

2.6 Validity and reliability

A face validity of the questionnaire was done by a panel of experts in Agricultural Extension and Development Studies. The panel consisted of a Senior Lecturer in Agricultural Extension, Community and Senior Management Officers in the Northwest Department of Agriculture and

Rural Development (NWDRAD) as well as other researchers. Additionally, the questionnaire was piloted with 12 small-scale farmers in Mahikeng, selected based on their availability and willingness to participate. These farmers were not included in the final sample. Feedback from the pilot led to several refinements, including rewording ambiguous items, adjusting the structure of some questions, and standardizing the response scales. These steps enhanced the instrument's clarity, internal consistency, and suitability for the target population. The reliability of the 11-item Likert-scale measuring farmers' perceptions of ICT use was assessed using Cronbach's alpha, which yielded a value of 0.79, indicating acceptable internal consistency. The mean total scale score was 41.94 (SD = 5.76). Inter-item correlations ranged from –0.15 to 0.67, and item-total correlations ranged from 0.32 to 0.64. Deleting any single item reduced Cronbach's alpha to a minimum of 0.76, suggesting all items contributed meaningfully to the scale.

Table 2: Reliability Analysis of Likert-Scale Items Measuring Perceptions of ICT Use

Statistic	Value
Number of items	11
Cronbach's alpha (α)	0.79
Mean of total scale score	41.94
Standard deviation of total scale score	5.76
Inter-item correlation (range)	-0.15 to 0.67
Item-total correlation (range)	0.32 to 0.64
Lowest alpha if item deleted	0.76

2.7 Data analysis

Data was analysed using the Statistical Package for the Social Sciences (SPSS) and STATA. Descriptive statistics was used to summarise the socio-economic characteristics of respondents, and their perceptions of the use of ICT in accessing agricultural information, and the data presented in tables.

Additionally, chi-square analysis was used to explore the relationships between socioeconomic characteristics of small-scale farmers and their perceptions on the adoption of ICT to access agricultural information. Chi-square was chosen due to its effectiveness in determining associations between categorical variables, making it particularly appropriate for analysing the

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relationship between socio-economic characteristics (such as sex, level of education and marital status) and perceptions on the use of ICT (Rana and Singhal, 2015).

Given the categorical nature of both dependent and independent variables, chi-square analysis facilitated an initial exploration of these relationships, identifying variables potentially influencing perceptions of farmers. This analysis provided insights into specific socio-demographic factors that significantly affect readiness of farmers to adopt ICTs, thereby guiding further in-depth analysis using binary logistic regression.

2.7.1 Chi-square formula

The mathematical representation of the Chi-square statistic used is given by:

$$\boldsymbol{x^2 = \sum \frac{(O - E)^2}{E}}$$

Where:

- X_2 = Chi-square statistic
- O = Observed frequency (actual number observed in each category)
- E = Expected frequency calculated as:

$$E = \frac{\text{(row total)} \times \text{(column total)}}{\text{grand total}}$$

2.7.2 Binary logistic regression model and assumptions

In this study, the Likert scale was collapsed, where "Strongly Agree" and "Agree" categorised as negative perceptions, while "Undecided" was considered a non-response. Positive perceptions were coded as 1, and negative perceptions coded as 0. The binary logistic regression model was used to analyse factors that influence perceptions of small-scale in adopting the use of ICT. This model is appropriate when the dependent variable is binary (i.e., 1 = Positive Perception, 0 = Negative Perception). It estimates the probability of an event occurring using a logistic function, which transforms a linear combination of predictors into a probability bound between 0 and 1. The model equation is given as:

$$P(Y) = \frac{e^{(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n)}}{1 + e^{(\beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n)}}$$

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Where:

- Y = Dependent variable (Perception of ICT, coded as 1 for positive and 0 for negative)
- $X_1, X_2 \ldots X_n$ = Independent variables (e.g., education level, gender. Awareness, ease of use)
- β_0 = Intercept
- $\beta_1, \beta_2 \ldots \beta_n$ = Coefficient of predictors
- e = Euler's number (≈2.718)

2.7.3 Assumptions of the binary logistic regression model

The binary logistic regression model in this study adhered to key assumptions to ensure accuracy and reliability. The dependent variable was strictly dichotomous, categorising perceptions of farmers on adoption of ICT as either positive (1) or negative (0). Independence of observations was maintained, preventing correlation between responses.

To address multicollinearity, Variance Inflation Factor (VIF) and Tolerance values were analysed, confirming that all VIF values were below 10 and Tolerance values exceeded 0.1, ensuring no excessive correlation among predictor variables.

Additionally, the sample size met statistical guidelines, as 121 respondents satisfied the minimum threshold for reliable logistic regression estimation (Peduzzi *et al*., 1996). These considerations ensured the robustness of the findings of the model.

2.7.4 Model fit and limitations

The overall fit of the model was assessed using the Likelihood Ratio Chi-Square test (LR χ^2 = 60.76, $p < 0.0001$), confirming that it significantly explains variations in the perceptions of farmers on the adoption of ICT. Additionally, the Pseudo R^2 value of 0.3720 showed that approximately 37.2% of the variance in perception was accounted for by the predictor variables. The log-likelihood value and marginal effects analysis further validated the robustness of the model, demonstrating its effectiveness in explaining the relationship between the independent variables and the perception of farmers regarding the use of ICTs. The limitation of the study is as follows: While the sample of 121 respondents was adequate for analysis, expanding the sample size in future studies could strengthen generalisability of the results and enhance the predictive power of the model. A larger dataset would offer a more

comprehensive representation, reducing the likelihood of biases thus, increasing the robustness of the conclusions.

2.8 Ethical considerations

Ethical clearance for this study was received from the Research Ethics Regulatory Committee of the North-West University (Ethics Approval Number: NWU-00323-18-A9). Prior to participation, all respondents were provided with an informed consent form outlining the objectives, significance and ethical considerations of the study. Participants were assured of their right to voluntary participation and were informed that they could withdraw from completing the questionnaire at any point without any consequences.

3. RESULTS AND DISCUSSIONS

3.1 Descriptive statistics of socio-economic characteristics of small-scale farmers in Mahikeng Local Municipality

As illustrated in *Table 1*, the study revealed that the majority of respondents in the study area are male, with 63% male and 37% female. This indicates that small-scale farmers are predominantly male in the area. Majority of respondents have primary school education, with 31% having secondary education. Informal education is also prevalent, with 20% of respondents in this category. Majority of respondents are married (51%), while 33% are single. The age range of respondents is 20 to 50 years and above, with 49% over 50 years old.

Majority of respondents have a household size of 4-6 members, with 39.67% having a farming experience of 11-20 years. Majority of respondents have an estimated annual income of 10,000-30,000, with 32.2% having an income of 31,000-50,000. Only 10% have an income of 51,000-70,000, 4.1% have an income of 71,000-90,000, and 7.4% have an income of 91,000 and above.

Majority of respondents practise both animal and crop production, with only 16% practising only animal production. Majority of respondents (36%) consider fellow farmers as the most prominent source of agricultural information, while another 35% use extension agents as their main source. Twenty-nine percent of respondents use radio a source of agricultural information.

The selection of agricultural information was based on multiple choices, with 92% being aware of the use of ICT for the delivery of extension services. Majority of respondents use ICT to access extension services and agricultural information, while 14% do not use this service.

Majority of respondents use television (30.87%), radio (27.7%), and mobile phones (27.18%) as their major ICT tools to access agricultural information for farm management.

The selection of various ICT tools used was based on multiple choices, with majority of respondents using television (30.87%), radio (27.7%), and mobile phones (27.18%) as their major ICT tools to access agricultural information for farm management. Only a few respondents use the internet (8.97%), personal computers (3.96%), DVD and CDS (0.53%), digital cameras (0.53%), and video conferencing (0.26%).

Table 1: Descriptive statistics of socio-economic characteristics of small-scale farmers (n=121)

Socio-economic variable	Categories	Frequency	Percentage
Sex	Male	76	63%
	Female	45	37%
Level of education	Informal	24	20%
	Primary	40	33%
	Secondary	38	31%
	College	11	9%
	University	8	7%
Marital status	Single	40	31%
	Married	62	51%
	Divorced	19	16%
Age	21-30 years old	4	3%
	31-40 years old	10	8%
	41-50 years old	48	40%
	50 years and above	59	49%
Size of household	1-3 members	28	23%
	4-6 members	72	59.5%
	7-10 members	20	16.5%
	11-13 members	1	1%
	14 members and above	0	0
Farming experience	2-10 years of experience	40	33.06%
	11-20 years of experience	28	39.67%
	21-30 years of experience	24	19.83%
	31-40 years of experience	6	4.96%
	41-50 years of experience	2	1.65%
	51 and above years of experience	1	0.83%
Size of farm (ha)	0-2 hectares	57	47%

	3-6 hectares	47	39%
	7-10 hectares	11	9%
	11-15 hectares	2	2%
	16 and above	4	3%
Annual income (ZAR)	10,000-30,000 rands	56	46.3%
	31,000-50,000 rands	39	32.2%
	51,000-70,000 rands	12	10%
	71,000-90,000 rands	5	4.1%
	91,000 rands and above	9	7.4%
Type of farm enterprise	Crop production	15	12%
	Livestock production	19	16%
	Both	87	72%
Sources of information	Extension agents	111	35%
	Fellow farmers	114	36%
	Radio	92	29%
Awareness on the use of ICTs	Yes	111	92%
	No	10	8%
Use of ICTs for information access	Yes	104	86%
	No	17	14%
ICTs used by small-scale farmers	Radio	105	27.7
	Television	117	30.87
	Mobile phones	103	27.18
	Internet	34	8.97
	Video conferencing	1	0.26
	Personal computer	15	3.96
	DVDs and CDs	2	0.53
	Digital cameras	2	0.53
	Telecentres	0	0

3.2 Perception of small-scale farmers on the use of ICTs to access agricultural information

The perception of respondents was measured using a 5-point Likert scale, with the following response options: Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), and Strongly Disagree (SD), corresponding to values of 5, 4, 3, 2, and 1, respectively. The scale comprised 11 statements. The assigned values were used to analyse this section with the following mathematical representation: (5+4+3+2+1)/5 = 15/5 =3

Therefore, a mean of 3 and above was adjudged okay and accepted while any value below 3 was not accepted.

Table 2 shows that most respondents strongly agreed (65%) and agreed (29%) that Information and Communication Technology (ICT) is a valuable tool to implement change in farming. This is supported by findings from Kante *et al*. (2017) & Singh and Khan (2020) that majority of farmers view ICT as a valuable tool to implement change, increase access to agricultural information, and improve productivity. Majority (62.8%) agreed that ICT increases farmers' access to agricultural information, while 63.6%) agreed that it increases farmers' productivity. Majority (61.1%) agreed that ICT reduces travel time and expenses, increases farmers' profitability through access to good markets and product prices, and leads to a broader network (70.2%). This is supported by findings from Naik and Navaneetham (2024) that ICT reduces travel time and expenses, increases profitability through better access to markets, and broadens farmers' networks. However, 30.6% of respondents were undecided whether ICT helps farmers make good decisions during transactions, while 56.2% agreed it does. Thirty-six percent of respondents found ICT easy to use, 17% were undecided while 28% disagreed. However, 53% agreed that ICT improves the quality of services rendered to farmers. Table 2 shows that majority of respondents have a positive perception of ICT with regard to farm management, with none of the mean being below 3.

Table 2: Perception on the use of ICT with regard to farm management

STATMENTS	**Strongly agree Frq (%)**	**Agree Frq (%)**	**Undecided Frq (%)**	**Disagree Frq (%)**	**Strongly disagree Frq (%)**	**Mean**	**SD**
ICT is a valuable tool to implement change in farming.	79(65)	35(29)	5(4)	1(1)	1(1)	4.57	0.69
ICT increases farmers' access to agricultural information.	37(30.6)	76(62.8)	7(5.8)	0(0)	1(0.8)	4.23	0.58
ICT is easily accessible by farmers.	22(18)	43(36)	17(14)	30(25)	9(7)	3.15	1.46
ICT enables farmers to reach new markets.	21(17)	77(64)	17(14)	5(4)	1(1)	3.91	0.83
ICT enhances agricultural productivity of farmers.	20(16.5)	89(73.6)	9(7.4)	2(1.7)	1(0.8)	4.02	0.65

ICT reduces travel time and expenses.	23(19)	74(61.1)	19(15.7)	3(2.5)	2(1.7)	3.93	0.79
ICT increases farmers' profitability through access of good markets and prices of products.	22(18)	80(66)	16(13)	3(2.5)	0(0)	3.98	0.73
ICT leads to broader networks.	15(12.4)	85(70.2)	17(14)	4(3.3)	0(0)	3.88	0.55
ICT helps farmers to make good decisions during transactions,	15(12.4)	68(56)	37(31)	1(1)	0(0)	3.79	0.68
ICT are easy for farmers to use.	14(11.57)	44(36)	20(17)	34(28)	9(7)	2.96	1.42
ICT improves the quality of services rendered to farmers,	16(13.22)	64(53)	26(22)	11(9)	4(3)	3.58	1.06

3.3 Chi-Square analysis of socioeconomic characteristics and perceptions on adoption of ICT by farmers

As shown in Table 3, level of education emerged as a significant factor that influences perceptions of small-scale farmers on the adoption of ICT ($p = 0.046$). This aligns with existing literature, which suggests that small-scale farmers with higher levels of education have greater cognitive capacities to effectively evaluate and integrate new technologies, thereby enhancing their propensity to adopt ICT (Alant *et al*., 2021).

The highly significant associations identified with awareness on the use of ICT ($p = 0.000$) and direct utilisation ($p = 0.004$) underscore the critical role that direct exposure and practical experience play in shaping favourable perceptions towards adoption of ICT among small-scale farmers. These findings are consistent with previous research which revealed that practical engagement significantly enhances users' confidence and increases the perceived usefulness of ICT tools, thus positively influencing their behaviour on adoption (Freeman and Mubichi, 2017).

Furthermore, as seen in Table 3, marital status presented a marginally significant association ($p = 0.069$), suggesting potential implications linked to household decision-making structures or resource allocation dynamics influencing adoption of ICT decisions among small-scale farmers. Although the result was not statistically robust, the trend merits further exploration in

subsequent studies. Seemingly, Olaitan *et al*. (2024) found that marital status did not significantly affect the use of ICT among women farmers in North-Eastern Nigeria.

Additionally, types of ICT tools utilised by small-scale farmers, exhibited marginal significance (p = 0.102). This finding highlights the potential relevance of the type of ICT tool in influencing farmers' perceptions and adoption decisions. Recent studies emphasise that user friendly, accessible, and contextually relevant ICT tools significantly encourage adoption among small-scale farmers (Mapiye *et al*., 2023). ICT tools commonly used by farmers include mobile phones, agricultural mobile applications, social media platforms, radio broadcasts, and internet-based information portals. Each tool offers unique features and accessibility options that can either facilitate or hinder adoption depending on individual farmer characteristics and contexts (Coggins *et al*., 2023). Therefore, detailed research into the specific attributes and perceived benefits of different ICT tools could provide valuable insights to better tailor ICT interventions to the needs and preferences of small-scale farmers.

Table 3: Chi-Square analysis of socioeconomic characteristics and perceptions on the adoption of ICT by farmers

Variable	Chi-square (χ^2)	Degrees of freedom (df)	p-value	Significance
Sex	1.3605	1	0.243	Not significant
Level of education	9.7127	4	0.046	Significant
Marital status	5.3570	2	0.069	Marginally significant
Age	3.5299	3	0.317	Not significant
Size of household	3.1139	3	0.374	Not significant
Farming experience	3.2407	5	0.663	Not significant
Farm Size	2.4022	4	0.662	Not significant
Annual income	2.0597	4	0.725	Not significant
Type of farm enterprise	1.7089	2	0.426	Not significant
Source of information	5.5705	5	0.350	Not significant
Awareness on the use of ICT	13.5252	1	0.000	Highly significant
Do you use ICT?	8.1155	1	0.004	Highly significant
Type of ICT used	23.4459	16	0.102	Marginally significant

3.4 Multicollinearity test

Statistical anomalies must be examined prior to executing a binary logistic regression model. This is necessary to ensure that statistical conclusions derived from the model are reliable and accurate. A prevalent issue in binary logistic models and other statistical models is multicollinearity (Senaviratna and A Cooray, 2019). Multicollinearity emerges when significant linear intercorrelations and inter-associations exist among the data, resulting in the formation of variables (Shrestha, 2020). The presence of multicollinearity in the input data will render output statistical inferences to be inaccurate and unreliable (Kim, 2019).

In this study, Tolerance and Variance Inflation Factor (VIF) values were used to detect multicollinearity (Senaviratna and A Cooray, 2019). These researchers assert that the Tolerance value must not be lower than 0.1, and the VIF must not surpass 10.VIF and Tolerance test for variables, such as education, age, sex, farm experience, annual income, information sources, awareness of the use of ICT in the delivery of extension services, ICTs as a valuable tool to implement change, ICTs leads to broader network, ICTs help make good decisions, ICTs are easy to use and ICTs improve quality of extension services, were ran in the model. The collinearity statistics of variables are presented in Table 3.

Table 3: Multicollinearity test of variables

Variables	VIF	Tolerance	Eigenvalue
Level of education	1.69	0.5929	0.3226
Sex	1.15	0.8682	0.2426
Sources of information	1.81	0.5515	0.0700
Awareness on use of ICT in the delivery of extension services	2.15	0.4652	0.0593
Easy to use	1.57	0.6361	0.0142
Mean VIF	1.58		

Source: Authors' compilation from the computer printout of Multicollinearity Test

3.5 Results of binary logistic regression and the model

The outcomes of the binary logistic regression model provide in-depth insight on the perception of small-scale farmers on the use of ICT. The model fit is demonstrated by the LR chi^2 (12) = 60.76 with a p-value of 0.0000, signifying statistical significance and rejecting the

null hypothesis that all predictor variable coefficients are equal to zero. The Pseudo $R^2 = 0.3720$ indicates that the model is valid and has adequate explanatory power (Table 4).

A strong positive impact of education on the use of ICT was identified, with a significant positive correlation (coefficient = 1.190649, P≤0.01) (Table 4). This suggests that farmers with higher educational backgrounds are more likely to adopt ICT for agricultural activities. Education equips individuals with the necessary skills to navigate ICT tools effectively, an indication that ICT literacy is tied to level of education. Higher education enhances understanding and usability of digital tools, making it easier for these farmers to access vital agricultural information. This is supported by Ilić-Kosanović *et al*. (2019), who found that perceptions of small-scale farmers with regard to using ICT in agriculture are influenced by their level of education. However, a study by Hoang (2020), conducted in Vietnam, revealed that education has no significant effect on the perception of smallholders on the use of ICT for agricultural information.

Gender of small-scale farmers indicates a negative relationship with perceptions on the use of ICTs, as revealed by the negative coefficient (-1.081679, P≤0.10) (Table 4). This points to possible gender-related barriers in the use of ICTs, where male farmers seem less likely to engage with technology compared to female farmers. This could be influenced by various cultural, social, or access-related factors that need to be addressed to ensure gender equity in the adoption of ICT. Studies on gender and adoption of ICT in agriculture presents mixed findings. While some studies suggest that women farmers are less likely to adopt new technologies due to limited access to resources, education and extension services (Aduwo *et al*., 2017), others indicate that women may be more receptive to ICT-enabled agricultural information (Mpiima *et al*., 2019).

Reliance on traditional information sources, such as word-of-mouth from fellow farmers, or non-digital resources like extension training and visit, negatively impacts the perception of small-scale famers on the use of ICTs (coefficient = -0.4438458, P≤0.10) (Table 4). Small-scale farmers who continue to depend on non-ICT sources may find it challenging to integrate new technologies into their farming practices. This is supported by findings from Hoang and Tran (2023) that reliance on traditional information sources negatively impacts perceptions and use of digital agricultural technologies of small-scale farmers in Vietnam. This suggests a need for transitioning farmers away from traditional sources and increasing their trust and familiarity with digital platforms.

Awareness on the Use of ICTs for extension services was positively significant (coefficient = 4.261418, P≤0.05) (Table4). This suggests that farmers who are more aware of the benefits and availability of ICTs for extension services, are more likely to have a positive perception towards the use of ICTs. This underscores the importance of creating awareness campaigns and training programmes to highlight how ICT can enhance farm productivity. This finding aligns with that of OBENG *et al*. (2019) that small-scale farmers' awareness of ICT benefits for extension services positively impacts their perception on the use of ICT. However, studies by Kante *et al*. (2017) posit that perceptions of farmers on the use of ICT and quality of information, not awareness, are the main factors that determine their use of ICTs, for information on agricultural input in developing countries.

Table 4: Results of the binary logistic regression model

Variables	Coefficient	Std error	Z	P>|z	Marginal effect	Tolerance
Level of educational	1.190649	0.3477275	3.42	0.001*	0.2717101	0.5929
Sex	-1.081679	0.5867735	-1.84	0.065***	-0.2468429	0.8682
Sources of information	-.4438458	0.2641827	-1.68	0.093**	-0.1012872	0.5515
Awareness of the use of ICT in extension	4.261418	2.073414	2.06	0.040***	0.4254344	0.4652
Easy to use	0.36816	0.2114253	1.74	0.082***	0.0840154	0.6361
Constant	-7.084194	3.715509	-1.91	0.057		
Number of observations	121					
LR chi ^{2} (12) =	60.76					
Prob > chi ^{2}=	0.0000					
Psuedo R^2 =	0.3720					
Log likelihood =	-51.290358					
Marginal effects after logit=	0.35236353					

Note*, ** and * represents 1%, 5% and 10% levels of significance respectively**

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Ease of use was a critical factor in perceptions of farmers, with a positive significance (coefficient = 0.36816, P≤0.05) (Table 4). If ICT tools are perceived as user-friendly, small-scale farmers are more likely to adopt and regularly use them. Therefore, simplifying ICT interfaces and offering user support can greatly increase their accessibility and uptake among farmers. This finding aligns with Bontsa *et al*. (2024) that ease of use is a critical factor in ' perceptions of farmers on adoption of ICT, with a positive significance. However, findings by Hendrawan *et al*. (2023) suggest that perceived usefulness of ICT is more important than perceived ease of use for smallholder farmers' adoption of technology.

The null hypothesis that no significant relationship exists between socioeconomic characteristics and perceptions on the use of ICT by small-scale farmers' can be confidently rejected. The evaluation highlights key socioeconomic factors, such as level of education, sex, reliance on traditional sources of information, awareness, and ease of use, all of which show significant relationships with perceptions of farmers on the use of ICT. Level of education and awareness of the benefits of ICT positively influence adoption of ICT, while reliance on traditional sources of information and sex of farmers negatively affect adoption. These findings underscore the importance of targeting specific socioeconomic factors to enhance adoption of ICT among small-scale farmers.

4. SUMMARY

Small-scale farming in Mahikeng is predominantly male driven, with most farmers engaged in both crop production and livestock farming. Their primary sources of agricultural information are fellow farmers and extension agents, reflecting a reliance on traditional networks. Notably, small-scale farmers in the region demonstrate considerable awareness of Information and Communication Technology (ICT) and perceive it as highly beneficial for to access agricultural information.

The findings reveal that education plays a statistically significant role, showing a positive relationship with farmers' perceptions of ICT. This is an indication that higher levels of education enhance the likelihood of adoption of ICT. Conversely, both sex of farmers and sources of information are statistically significant but exhibit a negative relationship with perceptions on the use of ICT.

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Additionally, awareness of ICTs and their ease of use are positively correlated with perceptions of small-scale farmers, an indication that greater awareness and perceived user-friendliness significantly promote adoption of ICT within this agricultural community.

5. CONCLUSION

The study confirms the significant role of Information and Communication Technology (ICT) in transforming small-scale farming. Majority of respondents recognise ICT as a valuable tool for change, aligning with previous research (Kante *et al*., 2017) and (Singh and Khan, 2020). The ability ICT to enhance access to agricultural information, increase productivity, and reduce travel time and costs was widely acknowledged, with majority agreeing on its positive impact on productivity and its role in expanding market networks. These findings reflect the capacity of ICT to improve farm profitability through better access to markets, as supported by (Naik and Navaneetham, 2024).

Educational attainment emerged as a key factor on perception on the use of ICT, with a positive correlation between higher levels of education and the likelihood of using ICT. This highlights the importance of educational initiatives to equip farmers with digital literacy skills. However, gender disparities suggest potential barriers to male farmers' perception on the use of ICT, a trend that requires further exploration to address equity in adoption of technology.

Farmers' reliance on traditional sources of information negatively impacted their perception of ICT, underscoring the need to transition from traditional to digital platforms. Awareness of the benefits of ICT and their ease of use were positively significant, indicating that awareness campaigns and user-friendly technologies can impact perceptions of ICT positively, and drive higher rates of adoption.

In conclusion, the study emphasises that improving levels of education, increasing awareness, and streamlining ICT tools are essential strategies to positively shape farmers' perceptions on the use of ICT. These factors play a crucial role in facilitating greater adoption of ICT among small-scale farmers, which, in turn, can enhance agricultural productivity and profitability. By equipping farmers with the necessary knowledge and making ICT solutions more accessible and user-friendly, these interventions can foster a more technology-driven farming environment, ultimately leading to sustainable agricultural growth.

6. RECOMMENDATIONS

Based on these findings, tailored recommendations are proposed to enhance adoption of ICT among small-scale farmers in Mahikeng, Northwest Province, South Africa. There is need for the Department of Agriculture, Land Reform and Rural Development (DALRRD) to develop targeted educational programmes and practical workshops focused on ICT literacy for farmers, particularly those with limited education. Continuous training sessions demonstrating practical ICT applications are essential to build farmers' familiarity and confidence in using these tools.

There is need for local municipalities and agricultural extension services to organise regular ICT awareness campaigns, clearly demonstrating the practical benefits of ICT to farmers. Establishing community-based ICT demonstration centres could provide valuable hands-on experience, significantly enhancing adoption of these technologies.

There is also the need for the Northwest Provincial Government to collaborate closely with private sector entities to invest in robust ICT infrastructure improvements. This includes enhancing network connectivity, offering affordable data plans, and providing accessible ICT hardware devices tailored for rural areas. Public-private partnerships should also be encouraged to optimise service delivery and infrastructure maintenance.

There is need for agricultural research institutions, such as the Agricultural Research Council (ARC) and the North-West University, South Africa, to conduct comprehensive assessments of specific ICT tools, identifying their strengths, limitations, and overall effectiveness within local agricultural contexts. Findings should be disseminated to farmers through easily accessible and interactive platforms.

The Northwest Department of Agriculture and Rural Development (NWDARD) department should facilitate capacity-building initiatives that integrate traditional agricultural knowledge with modern ICT tools, promoting peer-to-peer learning platforms for sharing best practices among farmers.

Technology developers and ICT companies are encouraged to prioritise the development of affordable, user-friendly ICT solutions explicitly designed for the small-scale farming community in Mahikeng. Additionally, these companies should offer sustained after-sales support, regular training, and technical assistance to ensure farmers effectively adopt and benefit from ICT tools.

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Through these coordinated actions, stakeholders can significantly enhance adoption of ICT among small-scale farmers, ultimately improving agricultural productivity and socio-economic development in the region.

7. SUGGESTIONS FOR FUTURE RESEARCH

Future studies should expand the sample size to include a larger and more diverse group, thereby enhancing the generalisability and reliability of findings related to perceptions on the adoption of ICT among small-scale farmers in Mahikeng Local Municipality. Conducting qualitative studies could also yield deeper insights into farmers' perceptions, attitudes, and specific challenges faced regarding the use of ICT, providing richer context and complementing quantitative findings. Further research is recommended to perform impact assessments of specific ICT tools, such as mobile applications, internet portals, and radio broadcasts, to identify their unique attributes, benefits, and potential barriers within the small-scale farming context. Investigating the effectiveness of targeted educational interventions designed to enhance ICT literacy among farmers could guide future capacity-building initiatives effectively. Additionally, future research on perceptions can incorporate Knowledge, Attitudes and Practices (KAP) studies. KAP studies provide comprehensive data on farmers' understanding, attitudes, and behaviours, which are instrumental in guiding effective programme planning, implementation and evaluation (Phagava and Mchedlishvili, 2022).

By addressing these areas, future research can contribute substantially to policies and practices aimed at maximising the adoption and benefits of ICT tools among small-scale farmers.

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