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Adoption of ICT to support rural small-holder farmers : A Systematic Review

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Research Paper

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ABSTRACT

Access to Information and Communication Technologies (ICTs) are slowly becoming more available to rural communities given a number of innovative approaches over recent years such as the implementation of Community Networks (CNs). Consequently, ICTs are able to become more meaningful in support of livelihoods of these communities, such as in agriculture production. Potential benefits to smallholder farmers include increase yields and reduced effort. However, there is very little evidence of smallholder farmers integrating ICTs into their livelihood activity. In this paper a Systematic Literature Review is used to explore the challenges faced in this sector. A total of 83 articles were initially identified, and after a screening process 28 articles were subjected to further scrutiny using a qualitative coding process. Codes were assigned to the constructs of the Unified Theory of Acceptance and Use of Technology. The findings indicate that effort expectancy, performance expectancy, social influence, facilitating conditions, price value and perceived trust as factors that are potentially relevant to smallholder farmers' intentions to adopt ICTs. The findings are important in that they inform how digital ecosystems in rural areas, post the deployment of CN network infrastructure, can become conducive for smallholder farmers to utilise ICTs.

Keywords

ICT adoption, Community Networks, ICT4D, rural agriculture, rural farming, smallholder farmers, Mobile applications

INTRODUCTION AND BACKGROUND

We are currently in the midst of a revolution driven by Information and Communications Technologies (ICTs) and the internet, which provides powerful tools for efficiency and effective business operations (Lubua, 2022). ICTs are projected to be economically and socially revolutionary in the future, as technology penetrates and fosters fundamental change in all aspects of life (Jorgenson & Vu, 2016). ICTs can be used to address problems in rural communities and, simultaneously, achieve the Sustainable Development Goals (SDGs) set out by the United Nations (UN) (Jacobs-Basadien et al., 2022). Over recent years, a number of innovative models to deploy internetworking infrastructure have taken root, in

the form of Community Networks (Rich & Pather, 2021). Thus, with the availability of broadband internet, the potential in the agricultural sector for ICTs to provide smallholder farmers with valuable information to improve agricultural practices has significant improved, as compared to a decade ago. Benefits to farmers include weather forecasting to improve planting, cultivating, and harvesting, among others.

However, even though ICTs have great potential for development, we still find that most of the projects implemented to be unsuccessful (Mamba & Isabirye, 2015). Some of the factors that hinder the adoption of ICTs among rural people include the cost of procuring ICTs, a lack of a proper infrastructure to enable the use of ICTs, and a lack of the necessary education and skills to properly use ICTs. A major issue concerning the adoption ICTs is the cost associated with acquiring ICTs. People in rural communities find it difficult to purchase ICTs because they earn relatively low salaries and are often dependent on government aid, in the form of social grants, to provide for their essential needs (Buthelezi et al., 2021). Additionally, the lack of a proper infrastructure in rural communities adds to the problem (Ayim et al., 2022; Kumar & Singh, 2012). Moreover, to effectively use the range of ICTs available in the market, education and appropriate digital skills are required.

In light of the foregoing, the problem around ICT adoption in rural communities must be better understood especially to improve the potential to achieve the SDGs in respect of food security. While there is now demonstrated successful models to deliver broadband internet to rural areas such as in the form of Community Networks, there is not yet sufficient knowledge to support and catalyse ICT-facilitated livelihood activities. Therefore, the objective of the paper is to understand the ICT adoption behaviour among smallholder farmers in rural to semi-rural communities. The paper seeks to recommend ways in which government, policy makers, NGOs, and any other interested parties could deal with the challenges concerning ICT adoption in rural communities.

LITERATURE REVIEW

The Importance of ICT to Promote Agriculture Growth in South Africa

The agriculture sector is considered very important in South Africa. It is believed that agriculture plays a vital role in fostering economic growth, reducing poverty, and improving food security by (United States Agency for International Development, 2021). The sector is crucial to the survival of rural people as it is a means to meet not only their dietary needs, it is also a primary source of income for most people residing in rural communities (Ayim et al., 2022; Khan et al., 2022). Agriculture is significantly susceptible to climate change and as such increasing climatic risks are causing severe distress to farming communities worldwide (Gangopadhyay et al., 2019). An increase in temperature changes, in rainfall patterns, and incidence of extreme climate events, such as floods, droughts, and heat/cold waves, could negatively impact decision making in agricultural activities (Khatri-Chhetri et al., 2017), ultimately affecting produce. These conditions require a more sophisticated means to assist in the decision making process of smallholder farmers and the use of ICTs in this regard are therefore important.

In India, for example, Android applications on an expert system in five crops (paddy, banana, coconut, ragi, and sugarcane) and cattle were created to provide a decision support system in the form of a crop doctor for diagnostics of pests and diseases, and an information system to provide knowledge for better farming (Kumar & Kathikeyan, 2019). Other examples concerns point the use of mobile ICTs to reduce cross-market price dispersion and increased profits of fisherman in Kerala, India by 8%; in decreased grain price dispersion by 6.4% and intra-annual price variation in Niger by 12%; and increased their economic returns by 4% after switching to a mobile phone-based procurement system in

Bangladesh (Alam and Wagner, 2016). These are but a few of the successes demonstrating how ICTs can positively impact the spectrum of economic and social related activities in Agricultural settings.

Challenges Concerning ICT Adoption in Rural Communities

Even though there are multiple benefits in implementing ICTs, rural communities still find it challenging to adopt these technologies due to various barriers. In an attempt to use mobile-based services to access timely and accurate agriculture information, Ayim et al. (2022) believe that the services are constrained by inadequate infrastructure, inappropriate policies on ICT, and low-capacity levels, especially among farmers, in using technology. Additionally, Saidu et al. (2017) highlight that basic ICT skills, lack of awareness, absence of content in local language on the internet, and insufficient personnel to handle ICT facilities are additional barriers to ICT adoption. Furthermore, the cost of using ICTs is one of the major factors that have a bearing on the intention of technology adoption among rural people. People in rural communities are price sensitive, making them sensitive to even the smallest change in the price of ICTs. This could be attributed to the fact that people in rural communities earn relatively low salaries, and some of them rely heavily on social grants they receive from the government (Buthelezi et al., 2021, p. 461). ICTs that are associated with high cost or high transactional cost is less likely to be adopted by smallholder farmer. Recently, a study by Lubuc (2022) found that lack of knowledge, unreliable infrastructure perceived usefulness and ease of use influence uptake and use are factors preventing uptake of ICTs.

Towards an ICT Adoption Framework for Rural South Africa

In light of the research problem concerning rural development and agriculture, the investigation into factors that contribute to the resistance of ICT adoption was pursued through the lens of the Unified Theory of Acceptance and Use of Technology (UTAUT) framework. UTAUT emanated from the seminal work of was founded by Venkatesh et al. (2003). The UTAUT model has four core constructs; effort expectancy, performance expectancy, social influence, and facilitating conditions (Venkatesh et al., 2003). The latter were determined to be determinants of behavioural intention and, ultimately, use behaviour. The UTAUT model has been tested many times over and is considered a better theoretical model than other models given that it can accounts for a high percentage of the variance in usage intention (Rodrigues et al., 2016). The results of empirical research by Venkatesh et al. (2003) explained a more significant percentage (70%) of the variance of 'intention to use' and 'usage behaviour' than any other model (Al-Gahtani et al., 2007; Rodrigues et al., 2016). The UTAUT model's suitability, validity, and reliability in technology adoption have been studied in various contexts, such as, mobile banking (Alain, 2019; Dass & Sujoy, 2011) and agriculture (Fox et al., 2018; Okoroji et al., 2021).

THEORETICAL FRAMEWORK: THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY (UTAUT) FRAMEWORK

An extended version of the UTAUT model (Figure 1), framed this study. Two more constructs, being *price value* and *perceived trust,* were incorporated to the original UTAUT model. Price value is considered relevant given that the cost of adopting ICTs and the income farmers realise is positively correlated (Jain & Rekha, 2017). This mean that the amount of income smallholder farmers earn has a direct bearing on their intention of adopting ICTs. Smallholder farmers, and rural people in general, earn relatively low income resulting in low disposable income which makes it difficult to adopt ICTs (Buthelezi et al., 2021; Khan et al., 2022; Okoroji et al., 2021; Rahman et al., 2020). Additionally, perceived trust plays a vital role for people in rural communities as they are used to having up close and personal interactions with their peers. Farmers who find it challenging to adopt technology highlight that

they need to know and trust the technology provider before considering adopting available technologies (Fox et al., 2018). This implies that there is a close relationship between trust and that of some element of personal interaction which fosters ICT adoption.

Figure 1

Research Model

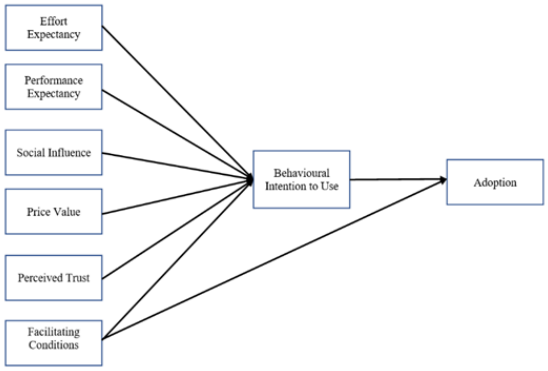

Table 1 discusses the research model (Figure 1) by defining the UTAUT construct and explaining how each construct is applied in this study.

Table 1

Conceptual framework

Independent Variable	**Description**	**Application in this study**
Effort Expectancy (Venkatesh et al., 2003)	"The degree of ease associated with the use of the system."	In this study Effort Expectancy is the degree of ease associated with the use of ICTs by smallholder farmers. These questions framed the SLR inquiry: 1. What is the nature of effort expectancy in ICT adoption in marginalized communities? 2. How the perception of farmers related to effort expectancy can be influenced in positive way to improve the adoption of ICTs in rural communities
Performance Expectancy (Venkatesh et al., 2003)	"The degree to which an individual believes that using the system will help him or her to attain gains in job performance."	In this study performance expectancy is the perception that smallholder farmers will attain gains in their job performance when adopting ICTs in their daily activities. These questions framed the SLR inquiry: 1. What is the nature of performance expectancy in ICT adoption in marginalized communities? 2. How the perception of farmers related to performance expectancy can be influenced in positive way to improve the adoption of ICTs in rural communities
Social Influence (Venkatesh et al., 2003)	"The degree to which an individual perceives that important others believe he or she should use the new system."	In this study social influence is the impact the perception of important others has on smallholder farmers concerning ICTs adoption. These questions framed the SLR inquiry: 1. What is the nature of social influence in ICT adoption in marginalized communities? 2. How the perception of farmers related to social influence can be influenced in positive way to improve the adoption of ICTs in rural communities
Perceived Trust (Hosmer, 1995)	The consumer's expectations that the technology provider is trustworthy and can be relied on to deliver on its promises	In this study perceived trust is the belief of the smallholder farmers that the ICTs will provide the services promised by the service provider. These questions framed the SLR inquiry: 1. What is the nature of perceived trust in ICT adoption in marginalized communities? 2. How the perception of farmers related to perceived trust can be influenced in positive way to improve the adoption of ICTs in rural communities
Price Value (Venkatesh et al., 2012)	"Consumers' cognitive trade-off between the	In this study price value is the financial trade-off made by smallholder farmers in the adoption and continual use of ICTs. These questions framed the SLR inquiry:

Independent Variable	Description	Application in this study
	perceived benefits of the applications and the monetary cost for using them."	1. What is the nature of price value in ICT adoption in marginalized communities? 2. How the perception of farmers, related to price value can be influenced in positive way to improve the adoption of ICTs in rural communities
Facilitating Conditions (Venkatesh et al., 2003)	"The degree to which an individual believes that an organisational and technical infrastructure exists to support use of the system."	In this study facilitating conditions is the availability of the proper infrastructure and workshops to support the adoption of ICTs among smallholder farmers. These questions framed the SLR inquiry: 1. What is the nature of facilitating conditions in ICT adoption in marginalized communities? 2. How the perception of farmers related to facilitating conditions can be influenced in positive way to improve the adoption of ICTs in rural communities

METHODOLOGY

The unit of analysis for this study is the individual small holder farmer. A Systematic Literature Review (SLR) was used to examine factors that relate to why individuals, in a rural and semi-rural context, have been challenged in the adoption of ICTs to assist them in their farming activities. For the purpose of the study, a smallholder farmer is someone who farms primarily for food security and who sell their excess produce to earn an income.

The data sources comprised published research articles drawn from these publishing houses: Sage Journals, Elsevier, Taylor & Francis Online, Scopus, Science Direct, and Springer. The methodology for the SLR incorporated the stages of Scoping; Planning; Identification, Screening and finally determining eligibility. The inclusion and exclusion criteria that we adopted are shown in Table 2.

Table 2

Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Language	Must be written in English	Written in a language other than English
Period	Published between 2007 - 2021	Published before 2007
Resource type	Peer-reviewed journal articles, proceedings, books, and completed theses	Articles that are not peer reviewed
Setting of the study	Studies that focus on a rural to semi-rural context and similar context (impoverished communities) in urban areas	Studies that focus on communities that are considered proper urban areas (communities that are not impoverished in urban communities)
Nature of ICT	ICTs that are accessible and affordable to smallholder farmers	ICTs that are too expensive or is of no benefit for smallholder farmers
Access	Articles that are published and is fully accessible	Articles that are not fully accessible

Keywords, that framed the search included: "ICT adoption challenges", "rural agriculture", "rural farming", "ICT use in agriculture", "ICT adoption", and "mobile application". The keywords were used via the search engines of the publication portals. After screening, all potential articles were exported to Mendeley after which eligibility was determined through inspection of the abstract, introduction, the findings and the conclusion. All articles that did not fully meet the inclusion criteria was excluded from the study.

Data Collection

First, the researchers analysed the eligible journal articles to identify the main data points in the articles and assigned codes where relevance was determined.

The initial search for journal articles resulted in the collection of 83 articles which was imported to Mendeley. In the first screening process the abstract, introduction and conclusion of each journal article was read to determine if it would be eligible for the study. This resulted in 28 journal articles being eligible. Thereafter, the full text of the 28 journal articles were analysed to determine the number of articles to be analysed and used to write the findings of the paper. A total of 17 journal articles were channelled into the final list for analysis. A summary of the selected journal articles is presented in the table below.

Table 3

Summary of selected articles

Variable	Frequency	Percentage
Geographic location		
Europe	3	18%
Africa	9	53%
Asia	3	18%
Australia	1	6%
N/A	1	6%
Type of ICT in the study		
Mobile application	4	24%
Mobile banking/Finance	6	35%
Mobile Phone	2	12%
Other	5	29%
Sample size		
501+	2	12%
251-500	3	18%
0-250	11	65%
N/A	1	6%
Technology Adoption Models used		
Technology Acceptance Model	6	35%
UTAUT	1	6%
Other	9	53%
N/A	1	6%

Data Analysis

Qualitative Content Analysis (QCA) is a research approach for describing and interpreting textual data using a systematic coding process (Assarroudi et al., 2018). Using Atlas.ti, the process advocated by Saldana (2013) was followed to undertake analysis. The papers were exported to atlas.ti 9 for the application of QCA which generated recurring concepts which were in turn coded and grouped into categories that were a-priori drawn from the research framework, namely: effort expectancy, performance expectancy, facilitating conditions, social influence, price value, and perceived trust. The sorted data was used as a basis for the findings.

RESEARCH FINDINGS

Based on the data analysis process described above, the following categories were derived from the coding process described. The following table presents a summary of the key findings.

Table 4

Summary of findings

UTAUT Constructs	Categories (findings)
Effort Expectancy	Physical Design Lack of education (Lack of Knowledge, Lack of Technical ability, Language barrier)
Performance expectancy	Mobility Access to Useful information
Social influence	Social Groups Means of Communication
Price Value	Transaction Cost (Service Fees, Maintenance Cost, Internet Cost) Cost of Technology (Low income)
Perceived Trust	Trust between Farmer and Service Provider Trust in Technology
Facilitating Conditions	Lack of infrastructure (Poor Network Quality, Lack of required Institutions, Lack of electricity supply) Lack of Support Programs (Lack of training, Lack of Technology Awareness)

SUMMARY OF FINDINGS

In this section we present the key findings that derived from the data analysis. This summary is based on the codes generated from the data analysis.

Effort Expectancy

It is commonly found that people in rural communities have low levels of formal education which makes it difficult for them to understand and use ICTs (Islam, 2011; Jere, Thinyane, Boikhutso & Ndlovu, 2013). The findings show that smallholder farmers are willing to use ICTs but they experience difficulty in using ICTs. Smallholder farmers who resisted the adoption of technology expressed that they do not have the required knowledge and skills to use the technology. This is supported by Benard et al. (2020), where one of the farmers cited in the study said;

"In my home, I have a television connected to satellite dish that was bought by my daughter but I cannot operate it, I always ask my daughter to do it for me, and if she is not there, I cannot operate it."

The findings show that the physical design of devices impact the use of ICTs. More than often, smallholder farmers find it difficult to use available devices in the field. Some mobile devices are not ideal for use in the field due to their physical attributes, such as the type and size of the keypad and screen, and device durability. Rose et al. (2016) suggest that it is easier for the users to use Decision Support Tools (DST) at home rather than a mobile device, to convert data it into information that can assist in decision making and problem solving in agricultural practices.

Performance Expectancy

The findings show that great benefits arise from the use of ICTs in farming activities. The use of ICTs allows smallholder farmers to do all sorts of activities remotely which save them a lot of time and effort. The use of ICTs can help reduce stress and exhaustion accompanied by doing tasks manually which allow smallholder farmers to manage their time more efficiently and lead a more flexible and balanced lifestyle. This is evident in the words of a farmer, in a study by Kenny & Regan (2021), who express the benefits of using ICTs:

"Sure do you know touch of a button there you have a lot of useful information to know about your cows, about your herd, what's going on kind of thing. And I suppose using your app, whatever it is for recording… I suppose basically. It makes life an awful lot easier and you can have it done registering calves. Have it done there, a couple of seconds and there's no sort of

running out of paper, wondering did you put it in wrong, what did you do like. Sending off photos into the post box and that sort of thing."

Access to useful information refers to the accessibility of valuable information via ICTs which smallholder farmers can leverage to attain economic gains. The findings show that accessing information by traditional means are time consuming and very difficult (Okoroji et al., 2021). The advent of ICTs deals with this issue by providing smallholder farmers a platform that cater for all their needs. ICTs allow smallholder farmers to gain access to all sorts of information without having to read volumes of printed material and having to travel vast distances. Benard et al. (2020) provide evidence of how a smallholder farmer derives expresses benefit of a mobile phone:

"With a mobile phone I can communicate with fisheries extension officers and ask for some information related to weather, market, credits, fish pond construction, fish feeding, source of fingerings and other information without necessarily travelling a long distance to meet them."

Social Influence

The findings show that social influence plays an important role among rural people in general. Due to extensive social interactions over the years, smallholder farmers have developed a relationship of trust with people in their social groups, resulting in them relying on these people to assist them with their daily needs. Smallholder farmers, especially in the older groups, are resistant to the adoption of ICTs. Some of the reasons they find it difficult to adopt ICTs is because of bad experiences in the past, distrust in corporations, and technology phobia. The findings show that smallholder farmers are more open to accepting a recommendation made by people around them (Dass & Sujoy, 2011; Fox et al., 2018; Islam, 2011). Smallholder farmers who have adopted ICTs expressed that they did so because someone in their social group use or recommended an ICT.

Price Value

The findings indicate that the cost of ICTs is not merely limited to the procurement of it. In fact most cost is incurred post purchase in the form of transactional costs. The income of smallholder farmers are relatively low with them relying on social grants to help them subsist their daily needs. When a smallholder farmer earns little money, they become price sensitive, meaning a small change in price triggers a reaction. If the price of ICTs increase, smallholder farmers are forced to stick to their conventional methods of accessing information because they cannot afford purchasing ICTs. Moreover, if the cost of adopting ICTs is fully on smallholder farmers, they will feel the financial repercussions of their decision months after initial adoption. This is evident in the words of a woman of Dwesa, in a study by Jere et al. (2013), who expressed the impact the cost of ICTs has on ICT adoption. She said:

"I wish to own a computer, but the money I get from the government social grant is not even enough for food, so do you think I will buy a computer? I will have to rely on the school to open the computer lab".

Transactional cost is the cost incurred by smallholder farmers while using an ICT. These costs include service fees, subscription fees, maintenance cost, and internet cost. The findings show that high internet cost, subscription fees, and service fees all negatively impact the adoption behavior of smallholder farmers.

Perceived Trust

Trust in Technology is concerned with the level of trust smallholder farmers have in technology itself. Smallholder farmers are used to conducting their daily activities manually. Even though ICTs allow for higher productivity, if not used properly it may change the dynamics among smallholder farmers. By using ICTs, the reliance of smallholder farmers on their peers are minimized. This poses a threat to the

trust relationship among smallholder farmers. When using ICTs, smallholder farmers expose themselves to risks they do not understand. If the risk they took are met with undesirable results, they could be more resistant towards the adoption ICTs in the future. This evident in a study by Kenny & Regan (2021), where a farmer draws from a past experiences to expressed his reason for not being in favor of using ICTs in his daily operations:

"If you're dependent on the phone, I had problems when the phone just went dead and I lost everything, that's one thing that I'd prefer to have the paperwork rather than depending on the phone. And it has happened me twice and I lost valuable information. So I don't have the confidence of the phone."

Trust in Service Providers is the trust relationship that exist between smallholder farmers and service providers. Service provider includes companies that provide services such as mobile applications and internet services to the people of the community. Smallholder farmers, especially among the older group, find it difficult to trust service providers because they believe that service providers exploit the people of their community. They are concerned about their data that is being shared when using ICTs and how service providers can gain financially from their data. This is supported by Kenny & Regan (2021), who highlight that many among the older farmers are resistant to ICT adoption because they are not satisfied that app developers are profiting from their data.

Facilitating Conditions

Rural communities, in general, face various problems such as low supply of electricity, a lack of network infrastructure, and a lack of support structures, including institutions and agents. All of the latter have a bearing on the adoption of ICTs. The findings show that smallholder farmers appreciate the opportunity to have access to ICTs, but low electricity supply and poor internet connectivity is a barrier to adoption. Due to the lack of infrastructure smallholder farmers also face the problem of access to connectivity. Poor internet connectivity force smallholder farmers to use multiple devices and multiple internet plans to ensure they have good network quality at all times (Marshall et al., 2020), which in turn adds to the financial burden on smallholder farmers.

Support programs include ICT awareness programs and training courses that can be implemented to assist with the awareness and consequent adoption of ICTs among smallholder farmers. If farmers are not aware of the availability of a service it will be impossible for them to decide if it is useful or not. This is evident in a study by Islam (2011), where it was found that less than 1% of the farmers in his study was aware of a government sponsored web-based agricultural market information service. Even though some smallholder farmers have a mobile device, they are unable to use it effectively because they did not receive proper training on how to use it. This resulted in limiting the extent of use among smallholder farmers, and therefore reducing the concomitant benefits of ICTs.

IMPLICATION OF FINDINGS TO PRACTICE

In relation to effort expectancy, smallholder farmers have an interest in using, ICTs but they face difficulty in operating them. Therefore, there should be emphasis on rural programs delivering short courses to promote digital literacy. The development of applications using local languages is important. Services should also be developed in a way that it incorporates a voice-based service to allow for more effortless use of ICTs. Additionally, government could consider making suitable devices available to smallholder farmers as part of agricultural promotion. The need for devices that are waterproof, easy to clean and with appropriate screen sizes must allow for more effortless use.

In relation to performance expectancy, smallholder farmers should be made aware of the full capabilities of ICTs to reduce resistance towards the use of ICTs. This can be done by demonstrating via a

smartphone or computer how smallholder farmers can access valuable information related to the market, best practices, and weather forecast for example. Smallholder farmers would also be more inclined to adopting ICTs if a single platform caters for all their needs. If a single platform can provide the needs of smallholder farmers such as weather forecasting, crop planning, best practices, price setting, and law compliance, they would perceive ICTs to be useful and be more inclined towards adopting ICTs. Furthermore, ICTs has the capability to convert information into visual aids such as graphs, charts, and tables. The use of visual aids in reporting information could be used to decrease the time needed to read and interpret information to allow for more efficient and effective decision making.

In the initial stages of ICT adoption in a community, it is important to assist smallholder farmers by showing them how to operate ICTs, instead of providing information on how to use it. This can be done through group meetings and training sessions with smallholder farmer networks or a group of individual smallholder farmers. When smallholder farmers face a problem, they can seek assistance by family, friends, peers, and agents they interact with regularly who already adopted ICTs. Moreover, to overcome the issue of advertisement using technology, trusted sources such as community leaders and existing institutions should be in partnership with the media to promote ICTs to increase the chances of adoption among the resistant group.

In relation to price value, to assist with the issue of high-cost, government and other organizations should make efforts to subsidize devices and access to broadband internet. Government should also introduce a reasonable price cap to ensure the price of accessing services, internet for instance, is beneficial to both consumers and service providers. Rural internet services should be provided in a different model to the rest of the country. Additionally, providing services that do not require internet to operate and no fee models could also positively impact the adoption behavior of smallholder farmers. Also, more small internet service providers should be encouraged, through subsidization, to enter the market in rural areas to make it more competitive, which will reduce the cost of accessing services.

In relation to perceived trust, community leaders, government officials, and organizations who have been working in the community for years should be part of projects that focus on persuading people about the benefits of ICTs to gain a sense of trust. This can be done by allowing community leaders to advertise or present how the adoption of ICTs have benefit them. Service providers should also be transparent about how data generated by smallholder farmers are used and how it could benefit the community. Service providers should have a more customer orientated approach to service delivery to ensure smallholder farmers get the best service possible. Given that many rural communities face problems with electricity supply, services, mobile applications for example, should have some kind of backup that can be recovered once the device of a smallholder farmers run out of power to ensure valuable information are not lost.

CONCLUSION

The paper set out to identify factors, evident in extant studies, that potentially have relevance in the South Africa context in relation to the adoption of ICTs among smallholder farmers. By understanding the challenges in play concerning ICT adoption, the objective was to recommend ways in which existing challenges could possibly be dealt with.

The results show that effort expectancy, performance expectancy, facilitating conditions, social influence, price value, and perceived trust are all important areas concerning the adoption of ICTs. The major issues regarding the adoption of ICTs are related to the knowledge and technical ability of smallholder farmers, the usefulness of ICTs, and the supporting infrastructure to use ICTs. Smallholder

farmers find it difficult to use ICTs due their lack of education and their inability to understand and operate ICTs. Furthermore, smallholder farmers are sceptical about how exactly the available ICTs will benefit them. This suggests that the role of awareness programs in relation to the use and benefits of ICTs is important. The findings also indicate that the use of technology to promote ICT adoption were not well received by rural people. This could be related to the lack of trust that exist in rural communities towards technology and service providers.

Given that we have evidence of reasonable success of deploying broadband internet into rural areas, such as through Community Networks, this study provides direction into how the digital ecosystems in such areas may be catalysed. Our experience in a real-world project such as Zenzeleni Networks[1], suggests that we cannot take for granted to process between network accessibility and that of livelihood outcomes. Therefore, while the continued investment in telecommunications infrastructure projects is important, so too are interventions to promote effective use of the network. To promote the adoption of ICTs, efforts should be put in the awareness of benefits, and the relatively low threshold toward use of cloud-based applications. With the low levels of literacy in rural communities, it is best to provide face-to-face training in a practical manner to allow smallholder farmers to gain confidence in using ICTs. There is an existing network of public schools in rural areas, and they could provide an environment for community-based learning. In addition, community based public access ICT centres may also be uself. When smallholder farmers gain enough knowledge and skills, they can share it with others in their community as this will in turn positively influence uptake and use.

We recommend that future research should be conducted in rural areas who have recently benefited from the deployment of networks. Such research should include probing the notion of trust, among others, and what impact it has on related factors in the adoption of ICTs.

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