INFORMATION AND COMMUNICATION TECHNOLOGY FOR SUSTAINABLE SMALL-SCALE SWEET POTATO FARMING: A CASE OF VHEMBE DISTRICT IN LIMPOPO PROVINCE, SOUTH AFRICA.

BY

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DECLARATION

I, Mathivha Nduvho Sharon (student no: 14000817) a MSMMC student in Business Information System in the Department of Management Science at the University of Venda, hereby declare that this dissertation titled "Information and Communication Technology for Sustainable Small-scale Sweet Potato Farming: A Case of Vhembe District in Limpopo Province, South Africa" is my own work and it has not been submitted by anyone to any university. All the information used in this dissertation is acknowledged and referenced.

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DEDICATION

I dedicate this dissertation to the Almighty God for guiding me through this journey and giving me the wisdom and strength to complete my dissertation in record time.

ACKNOWLEGMENT

Firstly, I would like to thank, Almighty God for giving me wisdom to complete this dissertation. I would like to express my sincere gratitude to my supervisor, Dr W. Munyoka and co-supervisor Mr D. Tutani for their motivation and support throughout this journey. Thank you so much, may God continue to bless you. I would also like to thank my family and friends for supporting me. Lastly, I would like to thank all the respondents who took their time to complete the questionnaires and all the interviewees who gave me time to interview them; thank you very much.

ABSTRACT

Nowadays Information and Communication Technologies (ICTs) has become an indispensable tool for enhancing farming. It is considered an important factor in disseminating farming information to small-scale sweet potato farmers. Farming information is regarded as a critical factor for decision making for small-scale sweet potato farmers. In South Africa, small-scale sweet potato farmers access farming information through ICT channels. However, the lack of knowledge and skills in using ICTs prohibits small-scale sweet potato farmers from accessing farming information. This study evaluates the effects of facilitating conditions, technical aspects, cost of accessing the internet and socio-cultural issues on sweet potato farmers' behavioral intention to adopt ICTs for sustainable farming (BI-ICT4SF). Thus, this study aims to assess the effects of these factors on small-scale sweet potato farmers' BI-ICT4SF and use behavior of ICT4SF. This study adopts a mixed method approach. Qualitative data was collected from 10 small-scale sweet potato farmers using semi-structured interview; while quantitative data was collected from 150 respondents using structured questionnaires from small-scale sweet potato farmers in Vhembe Rural District, Limpopo Province. Quantitative data was analyzed using IBM SPSS while qualitative data was analyzed thematically. The findings of this study showed that price value, performance expectancy, facilitating conditions, socio-cultural value and technical information are strong predictors of BI-ICT4SF; while BI-ICT4SF has a positive influence on use behavior of ICT4SF. Effort expectancy was not a significant predictor of BI-ICT4SF. These findings add new insights and awareness to small-scale sweet potato farmers on the best practice of using ICTs and skills they would require for accessing farming information. The proper adoption of ICTs will enhance sustainable small-scale sweet potato farming.

Keywords: Information and Communication Technologies, Sustainable farming, small-scale sweet potato farmers, Farming information and ICT channels

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1. CHAPTER ONE: INTRODUCTION

1.1 Background of the Study

Information and Communication Technologies (ICTs) play a major role in disseminating information on farming activities to enhance their productivity (Kante, Oboko & Chepken, 2019). ICTs connect small-scale farmers with expert and markets (Abdi, Jacob & Chesambu, 2017). Information exchange and ICT-based approaches of learning are essential platforms for gaining access to information and improving awareness about sustainable techniques for intensifying and expanding farming (FAO, 2017). Using ICTs, small-scale farmers can also be informed on the latest updates on farming, weather reports, different types of inputs and methods of increasing productivity (Singh, Ahlawat & Sanwal, 2017). The use of ICTs has the potential to increase farming productivity and enhance the living standards of small-scale farmers (Ajani & Agwu, 2012). Moreover, ICTs allow small-scale farmers to access latest farming information faster and simpler, if they have the right skills (Nmadu, Aiyelitsoya & Sallawu, 2013). According to Nwafor, Ogundeji and van der Westhuizen (2020), information channels such as mobile phones, farming applications (farming apps), social networking technologies, digital technologies and the Internet are only used by the small sector of small-scale farmers in South Africa to access information. If farmers do not frequently access latest farming information, they are most likely to be disadvantaged due to limited access to latest farming methods and lucrative markets for their produce. Failure to access information through ICTs may prohibit farmers from implementing appropriate agricultural technologies or inputs resulting in catastrophic losses (Freeman & Mubichi, 2017).

Across the world, farming has a long-standing history of reducing poverty, provides food security and creates job opportunities for people in rural areas (Anyan & Frempony, 2017). The majority of rural people in developing countries rely on farming as the primary source of livelihood (Ajani & Agwu, 2012). For example, more than fifty percent of South Africa's hectarage are used for farming, plantations and game reserves; and its impact on the economy is well documented (Oladele, 2015). Farming information is a crucial element for enhancing small-scale farming and improved remuneration, economic growth, contributing to better living standards of rural people, and food security (Abdi *et al*., 2017). Small-scale farmers are market actors who use all the information at their disposal for decision making on what types of crops to grow (FAO, 2017). Across several markets in many African countries, small-scale farmers are considered to be the primary drivers of food security (Mutero, Munapore & Seaketso, 2016). This study focuses on establishing the effects of selected factors (i.e. effort expectancy, performance expectancy, facilitating conditions, technical aspects, cost of accessing the internet and socio-cultural issues) on small-scale sweet potato farmers' behavioral intention towards and the actual use behaviour on ICTs sustainable farming in the Vhembe District of Limpopo Province in South Africa.

1.2 Problem Statement

Small-scale sweet potato farmers face various challenges that inhibit the growth of their agricultural activities such as limited access to business information, market exposure and input price among others (Singh *et al*., 2017). Most of the small-scale sweet potatoes farmers either have limited or do not have access to the latest crucial farming information such as input/market costs and the most lucrative markets to sell their products (Singh *et al*., 2017). Small-scale sweet potato farmers also face challenges associated with the effective use of ICTs for farming practices (Lokeswari, 2016). There are latest technologies that provide essential platforms and channels for accessing such latest farming information, however, not every small-scale rural sweet potato farmer has the right skills to use such technologies for sustainable farming (Silvestri, Richard, Edward, Dharmesh & Dannie, 2020). Most small-scale rural farmers are illiterate, with a poor command of English language; and thus, they find it very hard to take advantage of ICTs and use them effectively to access the latest farming information (Parmar, Soni, Kuwornu & Salin, 2019). According to Langat, Litondo and Ntale (2016), the main issue for most small-scale farmers is how to infuse ICTs in their everyday farming activities; while lack of access to latest farming information due to limited ICTs capabilities is a major stumbling block to sustainable farming. Furthermore, the lack of exposure to ICTs can prohibit small-scale farmers from embracing innovative farming techniques (Freeman & Mubichi, 2017). With these kinds of issues, one may wonder what could be done to ensure that small-scale sweet potato farmers could adopt and use ICTs for sustainable farming in rural settings in South Africa? This study is going to cover the aspect which is not included in the UTAUT model like technical information.

Thus, this study seeks an in-depth understanding on this narrative and discourse. Furthermore, this study is going to cover the gap of using technology in farming.

1.3 Aim

This study investigates factors affecting small-scale sweet potatoes farmers' behavioral intention and actual use behaviour of ICTs for sustainable farming with an aim of proposing a framework for guiding these farmers and policy makers in government on agriculture on ways to improve farming practices in the Vhembe Rural District of Limpopo Province in South Africa.

1.4 Research Questions

- How do small-scale farmers use ICTs in accessing farming information in Vhembe District?
- What are the challenges of using ICTs in small-scale sweet potatoes farming?
- Which ICTs are used by small-scale farmers in Vhembe District to access farming information?
- What is the utilization level of ICTs for sustainable farming by small-scale sweet potato farmers?
- How can small-scale sweet potatoes farmers in Vhembe Rural District best use ICTs for sustainable farming?

1.5 Objectives

- To assess the use of ICTs by small-scale farmers in Vhembe District of Limpopo province in South Africa.
- To identify the hindrances to the use of ICTs for information accessing by small-scale sweet potatoes farmers in Vhembe District of Limpopo province in South Africa.
- To identify ICTs channels that are being used to access farming information by small-scale farmers in Vhembe District of Limpopo province in South Africa.
- To establish the adoption and use levels of ICTs for sustainable farming by small-scale sweet potato farmers.

- To propose an ICT framework that could be used by small-scale sweet potatoes farmers for sustainable farming in Vhembe Rural District of Limpopo province in South Africa.

1.6 Justification

ICT can effectively close the knowledge gap between farmers and agricultural extension workers since it gives farmers quick access to relevant information. The study is anticipated to contribute to the existing body of literature by providing new insights, in the form of a framework that could be used by small-scale sweet potatoes farmers on the best ways to use ICTs for accessing farming information. Furthermore, empirical finding of this study is intended to provide valuable information to policy makers in government, especially, local government and other stakeholders like Agricultural Economics Association of South Africa etc. on the best possible ways to assist these 'valuable-miniature' farmers to embrace sustainable farming practices.

1.7 Scope of the Study

This study focuses on the effects of ICTs, specifically digital technologies like smartphones and mobile applications on small-scale sweet potatoes farmers in accessing farming information in Vhembe District of Limpopo Province. This study also focuses on smart farming using Internet of Things, advanced sensor irrigation and drone.

1.8 Definition of operational concepts

1.8.1 Small-scale farmers

Aaron (2012) defined small-scale farmers as all other producers who own small-scale field on which they produce livelihood plants and one or two farm products that depend on household labour. In the context of this study, small-scale farmers refer to subsistence farmers cultivating on less than 1 hectors, run by one or two households, or employing less than ten workers (Zantsi & Bester, 2019).

1.8.2 Information and Communication Technologies (ICTs)

According to Tamilselvan, Sivakumar and Sevukan (2012) Information and Communication Technologies (ICTs) is a telecommunication technology which offer direct exposure to information. This covers mobile phone, radio, TV and computer. In the context of this study, ICTs refers to the technologies that are used to access farming information.

1.8.3 Farming Information

According to Parmar, Soni, Kuwornu and Salin (2019), farming information is the data gathered, published and unpublished on the farming industry. In the context of this study, farming information is details needed by small-scale farmers such as market price, weather reports and farming methods.

1.8.4 Sustainable Farming

Alshaal and El-Ramady (2017) defined sustainable farming as an interconnected solution for long-term farming activities that belong to both animals and plants. In the context of this study, sustainable farming is production of plants continuously while maintaining a good economic return.

1.8.5 Livelihood

According to Su, Saikia and Hay (2018), livelihood includes the capacities, financial and activities needed for a way of life, such as subsistence and income. In the context of this study, livelihood is defined as the way small-scale sweet potato farmers earn profit and use it for living through continuous farming of sweet potatoes.

1.9 Structure of Dissertation

Chapter 1: Introduction

The first chapter contains the background, problem statement, aim, research questions and objectives of the study. It also includes justification and scope of the study.

Chapter 2: Literature review

The second chapter reviews existing literature on the use of ICTs by small-scale farmers, challenges and benefits related to the use of ICTs and ICT channels used by small-scale sweet potatoes farmers in accessing farming information.

Chapter 3: Methodology

The third chapter provides the research methodology used in this study and explains how data was collected.

Chapter 4: Data Analysis

This chapter provides the data analysis and the results.

Chapter 5: Thematic Analysis

In this chapter, the findings of the study are discussed using the themes.

Chapter 6: Conclusion

In the last chapter, an overview of the entire research is discussed. The research questions that were defined in the first chapter are answered. Limitation of the study and recommendations are provided. Future research direction is discussed.

1.10 Chapter Summary

This chapter gave an overview of the background of the study, problem statement, and aim of the study. It outlined the research questions, objectives and justification of the study. The next chapter (2) presents the literature review for the study.

2. CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter reviews the literature relevant to the study based on the use of ICTs in accessing farming information by small-scale farmers, challenges and benefits of using ICTs in accessing farming information, ICT channels used, adoption and use of ICTs for sustainable farming as presented next.

2.2 Small-scale sweet potato farming in South Africa

Sweet potato is a significant agricultural root crop providing an alternative breakfast food to bread in South Africa and a common traditional crop in the country's northern subtropical areas (Laurie, Faber, Adebola & Belele, 2015b). It is grown on mounds, ridges, or flat areas and is planted in a 30cm gap within plants and 1 m between ridges (Stathers, Carey, Mwanga, Njoku, Malinga, Njoku, Gibson & Nmanda, 2013). It typically needs a 4-5 month growing season with optimum temperatures of 20 C – 25 C (Stathers *et al*., 2013). Figure 2.1 shows small-scale sweet potato farmers planting sweet potatoes on ridges.

Figure 2.1: Small-scale sweet potato farmers. (Source: Makini, Mose, Kamau, Salasya, Mulinge, Ongala & Fatunbi, 2018).

Sweet potato plays a major part in developing markets and in most countries, they serve as a source of food (Mmasa, Elibariki & Melchion, 2013). It is produced by commercial farmers as well as small-scale farmers in various South African regions (Laurie, Tjale, Van den Bery, Mtileni & Labuschagne, 2015). It has significant potential as an effective and affordable energy source in Sub-Saharan Africa (Yusuf & Wuyah, 2015). Sweet potato properly known as Yam is a big, starchy, sweet-tasting, tuberous root, and food source in certain parts of America (Adeyonu, Ajala, Adigun, Ajiboye & Gbotosho, 2016). It is high in protein, lipid, calcium, and carotene (Anyaegbunam & Nto, 2011) (see Figure 2.2).

Figure 2.2: Sweet Potato. (Source: Stathers *et al*., 2013)

Nigeria is Africa's highest sweet potato manufacturer with 3.46 million metric tons and China's second-largest global producer (Omoare, Fakoya & Oyediram, 2015). Furthermore, sweet potato is a significant emerging food source in Nigeria, which has the most significant potential to improve the households and national food security, health, and livelihood of small-scale farmers (Adeyonu *et al*., 2016). The overall estimated area of South African sweet potato production is between 2000 and 3000 ha (Zulu, Adebola, Shegro, Laurie & Pillay, 2012). In South Africa, the main producing regions of sweet potato are Northern Cape, Western Cape, Limpopo, Free State, Eastern Cape, and Gauteng (DAFF, 2012). Figure 2.3 shows the production of sweet potato from 2008 to 2017 in South Africa.

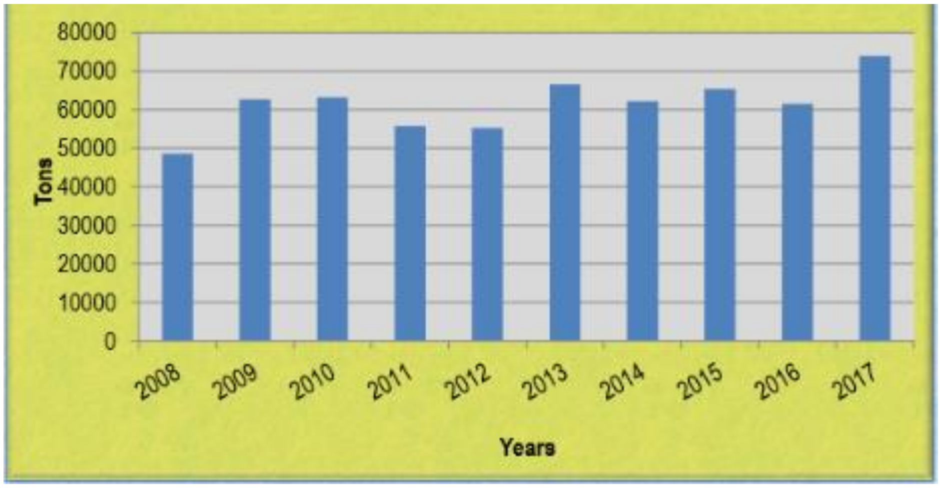


Figure 2.3: Source: (Statistics and Economic Analysis, DAFF, 2018)

From 2008 to 2017, the production of sweet potato in South Africa was over 48 500 tons. In 2009 and 2010, the production of sweet potatoes was high compared to 2008. Production decreased during 2011 and 2012, and it was below 60000 tons. During 2013, the growth of sweet potatoes increased and it was above 67 500 tons. In 2014, the production dropped. During 2015, the growth of sweet potato increased compared to 2014. In 2016, there was a decrease of sweet potato production. In 2017, there was an increased in production of sweet potato and it was over 70000 tons.

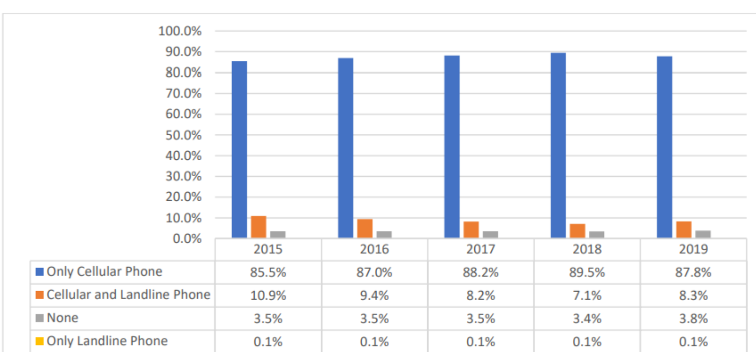
2.3 The use of ICTs in accessing farming information

In farming, the use of ICTs has now become extremely essential because of its ability to increase farming production through functioning as a pedestal for accessing essential farming information (Anyan & Frempong, 2018). Small-scale sweet potato farmers use ICTs to overcome challenges that are affecting them. For instance, small-scale sweet potato farmers lack access to farming information. However, by using ICTs, they can access farming information such as market price, weather reports and farming methods. Using ICTs helps small-scale sweet potato farmers to access advanced farming techniques and market information which in return improves their level of production (Jairath & Yadav, 2012). Furthermore, using affordable and widely available ICTs devices such as cellular technologies enables farmers to decide when, where, or how much to market their goods (Chavula, 2014).

It is important to raise awareness among small-scale farmers and promote the use of ICT channels to keep them updated on farming guidance, commodities for an informed decision, proper planning, and improved production (Masuka, Matenda, Chipomho, Mapope, Mupeti, Tatsvarei & Ngezimana, 2016). ICTs have a significant role in disseminating correct farming information to small-scale sweet potato farmers. Lokeswari (2016) suggests that the adoption of ICTs enables small-scale farmers to remain updated with the latest farming information, hence reducing the number of issues that they face. Furthermore, ICTs allow small-scale sweet potato farmers to access information about the right type of fertilizers and pesticides to be used on their crops.

A study by Sobalaje and Adigun (2013) found that television, radio, and mobile phone were the main ICTs favoured by the yam small-scale farmers to acquire agricultural inputs due to the connectivity. A study by Rahman, Hoque, and Osman (2015) showed that farmers utilized three forms of media, including mobile phones, the internet via the Agricultural Information and Communication Centre (AICC), and the internet via smart phones to access farming information. A 95,8 % of small-scale farmers revealed that usage of mobile phones enhanced their productivity as they could obtain timely information and alerts on environmental issues, crop plants cultivate, and when to plant them (Batani, Musungwini & Rebaniwako, 2019). Furthermore, Nwafor, Van der Westhuizen and Ogundeji (2020) studied the main ICTs used to access farming information were radio and mobile phones. Based on the RIA ICT survey conducted in South Africa, the findings indicate that the mostly used ICTs were television and radio (see Table 2.1).

Table 2.1: Access of ICTs by households



	2015	2016	2017	2018	2019
Only Cellular Phone	85.5%	87.0%	88.2%	89.5%	87.8%
Cellular and Landline Phone	10.9%	9.4%	8.2%	7.1%	8.3%
None	3.5%	3.5%	3.5%	3.4%	3.8%
Only Landline Phone	0.1%	0.1%	0.1%	0.1%	0.1%

Source: (The Independent Communications Authority of South Africa [ICASA], 2021).

Table 2.1 shows the results of survey which were conducted on the access of ICTs in South Africa. Based on the survey conducted in 2008, 2012 and 2017, it can be concluded that television and radio were the mostly used ICTs. In 2017, households with television were 80% and it was high compared to 2008 and 2012. While in 2008, radio was mostly used compared to 2012 and 2017. In 2012, households with desktop and laptop were 24% and it was high compared to 2008 and 2017. Households with tablet and internet in 2012 were 20% and 5% in 2008.

2.4 Challenges related to the use of ICTs

A study conducted by Razaque and Sallah (2013) found that small-scale farmers faced several issues, barriers, and difficulties with the use of ICTs devices like smartphones. One of the identified biggest challenges facing most small-scale farmers is the inclusion of ICTs in their agricultural activities due to limited knowledge in ICTs use (Langat, Litondo & Ntale 2016). For instance, most small-scale sweet potato farmers struggle to access the latest lucrative markets, produce prices, weather reports, and farming methods. Despite some efforts by government and private organizations to link rural small-scale farmers with ICT technologies such as reliable internet connection and broadband suppliers, providing them with network-based information remains complicated (Mbagwu, Benson & Onuoha, 2017). Lack of network connectivity makes it difficult for small-scale sweet potato farmers to access farming information through mobile agricultural apps. Similarly, the exorbitant cost of accessing Internet broadband makes it difficult for most small-scale sweet potato farmers in rural set-ups (*Mbagwu et al.*, 2017). Almost all small-scale farmers and rural entrepreneurs lack internet connectivity or the ability to make use of mobile phones in accessing important farming information (FAO, 2017). A study conducted by Hasan, Rahman, Hoque, Kamruzzaman, Rahman, Mojumder, and Talukdar (2019) found that limited broadband, internet speed, and limited ICT services are the major issues faced by small-scale farmers on the use of ICTs.

Some of the challenges also include language issues, high price of ICT tools, poor education, and lack of proper ICTs skills (Lwesya & Kibambila, 2017). Another study by Tegega and Dafisa (2017), also establish that language has a significant function in influencing both internet and mobile use. Most small-scale sweet potato farmers struggle to understand the English language due to their poor level of education and this hinders them to access market information through mobile apps. For instance, maintenance costs for mobile phones are too high for small-scale sweet potato farmers. Furthermore, the application of IoT in farming has many costs, which can be divided into setup costs and operating costs (Elijah *et al*., 2018). Lack of knowledge on the use of various mobile farming apps hinders small-scale sweet potato farmers to access the latest farming information. Furthermore, the lack of proper IoT knowledge and skills mainly among rural farmers is a significant factor delaying IoT adoption in agricultural (Elijah, Rahman, Orikumhi, Leow & Hindia, 2018). In South Africa, load shedding is another problem which may affect small-scale farmers' access to crucial information through mobile phones on farming that may help them to gain more knowledge on farming methods. Furthermore, it also hinders them to check weather reports. Farmers also experienced high data rates that do not fit their budget (Khou & Suresh, 2018).

The critical problem facing small-scale sweet potato farmers on the use of ICTs in the transmission of farming information and knowledge includes lack of access to ICTs infrastructure and facilities (Saidu, Clarkson, Adamu & Mohammed, 2017). Lack of training infrastructures and ICT-based infrastructures hinders small-scale farmers in accessing ICT-based media (Khalak, Sarker & Nasir Uddin, 2018). Furthermore, a lack of confidence in ICTs application also hinders small-scale sweet potato farmers in accessing market information through mobile apps. According to Syiem and Raj (2015), studies found a lack of confidence in ICTs application, power shortage, and poor internet access adversely affect the efficient use of ICTs.

The typical difficulties with ICT adoption in rural sectors are the availability of related ICT literacy and the localization of material in their language, simple and inexpensive accessibility, and other problems such as knowledge and willingness amongst people in rural areas to adopt innovations (Mishra, Yadav, Yadav & Pratap, 2020). Challenges faced by small-scale farmers on the use of ICTs include lack of ICT device usage expertise and usage of ICTs causes visual disorders as well as other health risks (Shanthya & Elakkiya, 2017). Jayanthi and Asokhan (2016) found that small-scale farmers used the M-Kisan SMS portal to obtain agriculture information, but there were certain difficulties they encountered like lack of necessary information, lack of detail on market price-fixing.

2.5 Benefits related to the use of ICTs

An interconnected ICTs for information and knowledge exchange in farming reinforces the production process and benefits the small-scale farmers by operational costs fees (Anyan & Frempong, 2018). Furthermore, a solid, and good connectivity is the primary forum for producers to engage in creating critical financial growth decisions (Langat *et al.*, 2016). Similarly, through ICTs, producers are kept up to date with the latest information on farming, climate, new crop varieties, and new methods of growing productivity and quality control (Singh, Ahlawat & Sanwal, 2017). ICTs in farming provides a wide variety of answers to such agricultural issues (Mishra, Yadav, Yadav & Pratap, 2020). The rapid adoption and usage of mobile phone applications by small-scale farmers have contributed to the growth of specific and innovative approaches to the use of these applications in addressing any of the significant problems faced by farmers (Ogbeide & Ele, 2015). Furthermore, through mobile agricultural applications, small-scale sweet potato farmers can get all the necessary information that can help them to sustain their crops. Rural poor producers can use ICTs to access updated pricing information about their products, which enables them in making essential sales decisions (Magesa, 2015).

Tonny, Palash, and Moniruzzaman (2019) suggest that ICTs links-up small-scale farmers to the market and offers them the latest market information. The adoption of ICTs in farming can increase overall economic development by enabling farming production within the specified time frame (Saidu, Clackson, Adamu, Mohammed & Jibo, 2017). ICTs now have the potential to improve market visibility and prices, minimize farming risk, increase profits, easily link farmers and consumers, reduce production rates and delivery costs (Girma & Abebe, 2019). Using ICTs, small-scale sweet potato farmers also access information services on plant production, crop productivity, and prevention of fungal diseases (Syiem & Raj, 2015). Small-scale sweet potato farmers access weather reports through ICTs which enables them to make the right decision at the right time (Chauhan, Patel & Vinaya Kumar, 2016). Furthermore, small-scale farmers can use mobile phones to receive notice of weather threats (Ogbeide & Ele, 2015).

Usage of mobile phones can build confidence among small-scale farmers, minimize marketing expenses, and enable them to get better prices (Tadesse & Godfrey, 2015). According to Ogbeide and Ele (2015), the adoption and usage of mobile phones is one of the ways to increase productivity in the agricultural supply chain. Mobile phones ensure that small-scale farmers can settle negotiations with buyers and strengthen their schedule for marketing their products (Huq, Farhana & Rahman, 2017). Furthermore, it has enabled small-scale farmers to get connected with market sources (Sikundla, Mushunje & Akinyemi, 2018). Mobile applications make things much easier for small-scale farmers to meet their everyday needs (Nirojan & Vithana, 2017). It provides them with market prices and can reduce market failures and assist farmers in plan production (Trendov, Varas & Zeng, 2019).

Small-scale farmers also benefit from using e-marketing in accessing market information. According to Mahaveer and Com (2018), the benefits of e-marketing to farmers are as follows:

- Farm owners can market their goods around the world.
- The online market is open 24 hours a day, allowing small-scale farmers to market their goods whenever they intend to sell.
- No loss of agricultural commodities.

Internet of Things (IoT), sensors, smartphone devices are advanced innovations that allow farmers to understand their farmland condition, the amount of water required, soil temperature, humidity, and weather (Amalraj, Banumathi, & John, 2019). The application of IoT in farming involves supporting farmers with decision-making tools and automation innovations that combine goods, information, and services seamlessly to boost production, quality, and income (Elijah *et al*., 2018). The latest IoT applications resolve the challenges faced by small-scale sweet potato farmers. Smart farm fertilization helps to accurately measure the required nutrient dose and eventually mitigate its harmful impact on the ecosystem (Ayaz, Ammad-Uddin, Sharif, Mansour & Aggoune, 2019). IoT can allow tasks in the farming and agriculture sector quite effective by reducing human interaction through automation (Madushanki, Halgamuge, Wirasagoda & Syed, 2019). Furthermore, it offers an automated system for small-scale farmers that can work without any human intervention and can alert them to take the right choice to interact with various types of challenges they may encounter throughout agriculture (Doshi, Patel & Kumar Bharti, 2019).

2.6 ICT channels

Various ICTs are used in accessing the latest farming information across South Africa. Nowadays small-scale farmers access market information through mobile phones, farming applications (farming apps), social networking technologies, and many others. ICT devices like mobile phones provide farmers with a modern way to preliminary decisions; making it much easier than ever before (Razaque & Sallah, 2013). Farming apps make things easier for small-scale sweet potato farmers to access the latest market information.

2.6.1 Mobile Phone

Mobile phones enable individuals to access information frequently and play the biggest role in the request for information (Goyal, 2013). It has now equipped small-scale farmers with a new approach to preliminary decisions (Huq, Farhana & Rahman, 2017). Mobile phones provide small-scale farmers with market opportunities, exposure to the market, and forecast updates in rural areas (Chhachhar, Qureshi, Khushk & Ahmed, 2014). It also provides producers with new methods and strategies to market their products, instead of relying solely on radio or television to disseminate information on farming (Razaque & Sallah, 2013). Small-scale farmers also use mobile phones to enhance agricultural productivity and other rural businesses and develop trust in export markets (Huq *et al*., 2017). Mobile phone is the mostly used in accessing farming information. A study by Gillwald, Mothobi and Rademan (2018) found that amongst a group of studied ICT users accessing the internet, 72 % accessed it via mobile phone, 26% via laptops while only 2 % used tablets (see Figure 2.4).

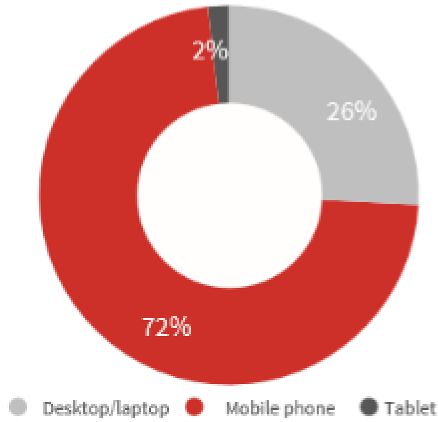


Figure 2.4: Internet Access via various ICTs (Source: Gillwald *et al*., 2018)

Furthermore, it has given small- scale farmers new possibilities to gain information and knowledge on farming challenges, concerns, and its usage for agricultural production (Razaque & Sallah, 2013). Using mobile phones for farming activities can lead to successful outcomes if producers have expertise on how to best use other pertinent applications (apps) such as social media, online banking, online payment, and weather information (Razaque & Sallah, 2013). For instance, in the South African context, small-scale farmers may gain the valuable latest information on a variety of farming information from apps like Mobile Agribiz, Agtag Rural eMarket Farmer Connect, and AgroSim (Maumbe, 2010). Mobile phones only need basic education and are thus available to a wide segment of the community (Goyal, 2013) (see Figure 2.5).

Figure 2.5: Small-scale farmer using mobile phone. (Source Laureys, 2016)

2.6.2 Mobile applications

Many mobile applications could be used to access the latest and pertinent information on sustainable farming, i.e. information related to the latest technologies and method to identify the right pests and diseases control measures, to provide weather report in real-time, early warnings of storms, lucrative markets for produce and inputs (Mendes, Pinho, Neves dos Santos, Sousa, Peres, Boaventura-Cunha, Cunha & Morais, 2020). For example, the Kisan Suvidha is a mobile app (with multi-lingual options) that assist farmers by providing useful information like market price, seeds, and weather in India (Bhaskar, Murthy & Sharma, 2017). Mobile applications assist small-scale sweet potato farmers to be always updated with the latest market price and weather report. The weather app offers temperature changes, agricultural climate change news, and weather parameters for the coming 7 days (Barh & Balakrishnan, 2018) (see Figure 2.6).

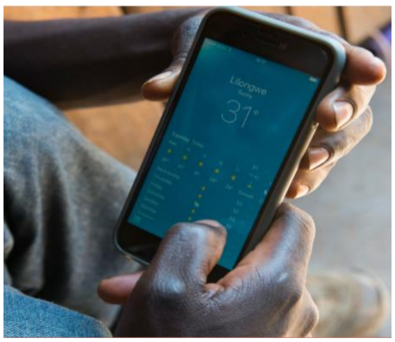


Figure 2.6: Weather App. (Source: Laureys, 2016)

Agri-market is a mobile app that is used to get selling prices for crops in the marketplace within 50km of the location of the device (Meena, Jirli, Kanwat & Meena, 2018). Agri-market is an app that provides farmers with information about identifying market daily sales prices and selling their different agricultural products at fair prices (Barh & Balakrishnan, 2018). Small-scale sweet potato farmers also need access to information on the type of fertilizers and pesticides to be used, so that they can sustain their crops. Agri-app provides small-scale farmers with detailed information on crop growth, crop safety, and all relevant information on smartphones (Meena *et al*., 2018). Disease management app is used to monitor plant growth and plant fungus (Barh & Balakrishnan, 2018). Small-scale sweet potato farmers also communicate with each other on how to sustain their crops, how to access the latest market price etc. In the context of South Africa, there are several agricultural-based applications and online sites that provide updated farming information to small-scale farmers and these include among others; Agtag (electronic magazine on farming), PANNAR Sprout mobile app (provides detailed information of various types of PANNAR seeds and the suitable climate for cultivation), Farmboek (a web-based application that provides agriculture information and markets for different farmers) and the ARCHub (provide information on the best-practice knowledge to enables farmers to be productive, economically viable and contribute to the nation's food basket) (KLK Landbou, 2020).

Mendes *et al.* (2020) suggest that whilst these mobile apps provide the latest and relevant farming information; small-scale rural farmers are nevertheless likely to benefit since most of them either do not have the right type of digital devices or the skill sets to access and use them. Hence, several scholars echoed the need for carrying out more studies on factors impeding small-scale farmers' desire and capability to accept and use ICTs for sustainable farming in developing nations (Barh & Balakrishnan, 2018; Meena *et al*., 2018; Bhaska *et al*., 2017).

Mobile agriculture applications demonstrate a tremendous opportunity for farming market modernization in developed and developing countries (Costopoulou, Ntaliani & Karetsos, 2016). Agri-app provides information in three languages, together with essential farming updates for small-scale farmers through call as well as chat (Barh & Balakrishnan, 2017). In Kenya, small-scale farmers use the m-farm app which aims to improve transparency mostly in the farming market by supplying market rate information and promoting seed production and product price (Fendji, Ebongue, Hamidoullah & Yenke, 2018). In Uganda, small-scale farmers browse for farming advice through an SMS-based database that covers updates on crops, pest & disease control, cultivation, harvesting strategies, and weather forecasts (Brugger, 2011). Nokia Life platform aims to address small-scale farmers' information needs by offering information about crops, fertilizers, pesticides, market prices, and weather through their mobile apps (Belakeri, Prasad, Bajantri, Mahantesh, Maruthi & Rudresh, 2017). Furthermore, it offers producers with customized information on market rate of neighbouring market place, community updates, relevant scheme and subsidy information, detailed and localized crops and daily consulting services (Sylvester, 2013). Figure 2.7 and 2.8 shows the interface of Nokia Life platform.

Figure 2.7: Nokia Life platform. (Source: World Bank, 2017)

Figure 2.8: Source (Sylvester, 2013)

Mobile applications allow all the different information to be allocated in one location and accessible to farmers (Mendes, Pinho, Neves dos Santos, Sousa, Peres, Boaventura-Cunha, Cunha & Morais, 2020). Agri app offers small-scale farmers full information on various agricultural services, including crop production and protection (Mendes *et al*., 2020). OneSoil scouting enables farmers to track their crops and makes it possible to imagine weather forecasts, helps farmers to determine the best time to spray or harvest crops (Mendes *et al*., 2020). The FarmersGrid app provides material on subjects including organic agriculture, planting, sustainability, cultivation of various crops and veggies, enhancement of production, guide and resources (Bhaskar *et al*., 2017). FarmersGrid app provides farmers with a chance to communicate, learn, and share information worldwide and per geographical zone (Bhaskar *et al*., 2017). It contains information on concepts such as sustainable agriculture, planting, recycling, producing various crops and vegetables and improving production (Bhaskar *et al*., 2017) (see Figure 2.9).

Figure 2.9: Source (Bhaskar, Murthy & Sharma, 2017)

2.6.3 Online Portals

Agmarket is an online, national information system focused on the internet, serving diverse information requirements (Khizer, 2017). It offers a variety of items for market information such as; market profile and information on the infrastructure (Khizer, 2017). Agmarknet platform enables the development and transfer of prices, information on the delivery of goods from agriculture products markets, and web-based distribution to manufacturers, customers, investors, and law makers clearly and rapidly (Mahaveer & Com, 2018). Furthermore, M-shamba is an online portal that is used in Kenya, it provides small-scale farmers with information regarding growth, harvesting, marketing, credit, weather, and climate using of the mobile phone (Fendji *et al*., 2018). E-marketing of agricultural commodities means the marketing of farm products online, from farmers to any small business or ultimate customer (Mahaveer & Com, 2018).

2.7 Use level of ICTs by Small-scale farmers

ICTs have a long-standing history of a positive impact on distributing farming information to small-scale sweet potato farmers (Palmer, 2012). A study by Ali, Jabeen, Nikhitha, and INDIA (2016) shows a positive impact of ICTs on agricultural production. The attitude of small-scale farmers towards the use of ICTs is determined by their level of knowledge regarding ICTs. For instance, Kabir (2015) posits that the attitude of farmers towards ICT-based agriculture is likely to be positive if their knowledge level is adequate and related to their needs. Furthermore, Lokeswari (2016) noted that when individuals are exposed to ICTs regularly, they will be well-informed about the useful and helpful role of ICTs to them, and thus, are likely to have a positive attitude towards the use of ICTs.

A mobile phone is the most used ICTs by small-scale farmers in accessing various farming information like market price. They use mobile phones to access various mobile apps like weather app which enables them to be always updated. Using the weather app helps small-scale sweet potato farmers to know when to plant and harvest crops. Syiem and Raj (2015) found that almost all farmers used mobile phones and it was the main commonly utilized ICT. Farmers have extensively used mobile phones for social networking, calling intermediaries for product marketing, and informing shipments promptly to obtain farming advice (Syiem & Raj, 2015). A study by Nzonzo and Mogambi (2016) revealed that there are many motives for the use of ICTs, including quick exposure to information, accessibility, and reduced prices for obtaining information on agricultural output. Sikundla, Mushunje, and Akinyemi (2018) found that farmers who earn government social security grants as their key source of earnings are even less willing to use a mobile phone to sell their agricultural commodities. Furthermore, results from a study by Khalak, Sarker, and Nasir Uddin (2018) on farming activities in Africa have suggest that 50% of farmers have restricted exposure to mobile phones for farm inputs while 18% also do not have access to mobile phones. According to the study by Fosu and Van Greunen (2020) mobile phone (100%), radio (58.3%) and television (18.8%) were the most frequently used ICT tools.

2.8 Sustainable Farming

Sustainable farming is a primary concept focused on a method of growth that supports sustainable growth (Siebrecht, 2020). It helps to sustain optimal crop quality, maintain soil, agricultural land protection, and restoration environmental balance and diversity in agricultural ecosystems (Sharma, Aravind & Sharma, 2019). In farming, sustainability can be accomplished by using little or no harmful substances, preserving natural resources, and lower greenhouse gas pollution (Santiteerakul, Sopadang, Yaibuathet, Tippayawong & Tamvimol, 2020). A farm is regarded as sustainable when growing good quality products, is good for the environment, and satisfying farmers, and is productive (Sharma *et al*., 2019). The key focus of sustainable farming is on promoting synergies among farm growth, preservation, and rural livelihoods (Blignaut, De Wit, Knot, Midgley, Crookes, Drimie & Nkambule, 2014).

2.8.1 Greenhouse

A greenhouse is a plastic or glass-covered structure that prolongs crop production and improves food production (Biek, Chung & Menta, 2015). It preserves crops both from the midday sun, cold night, and from regular temperature variations which could disrupt crop processes (Biek *et al*., 2015). Greenhouse coverage preserves crops from airborne chemicals, along with appropriate technology, influences and eventually modifies the crop weather system, thereby increasing the product's market availability, improving its quality and enabling better yields (Vox, Teitel, Pardossi, Minuto, Tinivella & Schettini, 2010). Furthermore, it artificially offers the right environment for crop production and enhances farm production and sustainability (Jadhav & Rosentrater, 2017). It also offers small-scale farmers the chance to produce high-value crops in a regulated environment over the year (Antony, Leith, Jolley, Lu &Sweeney, 2020). Greenhouse vegetable production can allow people residing in cold environments to enjoy clean, nutritious vegetables during the colder months (Ahamed, Guo & Tanino, 2018) (see Figure 2.10).

Figure 2.10: Greenhouse. (Source: Shweta, 2019)

The internet of things (IoT) greenhouse automation systems is a technological solution that facilitates farmers by automating and regulating the greenhouse climate, like crop health monitoring (Lakshmi & Gayathri, 2017). Greenhouses are very essential because they are liable for the successful growth of crops that are either required for feeding the community or essential for any country's economic growth (Shweta, 2019). The IoT-enhanced greenhouse-based agricultural system for management and surveillance would increase both yield and productivity, as anticipated by the marketplace (Jaiswal, Bhadoria, Agrawal & Ahuja, 2019). The development and implementation of greenhouse IoT contribute to intelligent device automation and internal system monitoring scientifically and effectively (Sahana & Sowmya, 2020). Smart greenhouse implementation IoT-based system enables to track and manage the environment without any need for human input (Lakshmi & Gayathri, 2017).

Figure 2.11: Automated greenhouse. (Source: Shweta, 2019)

2.8.2 Polyhouse

A polyhouse is a structure that grows crops and is mostly utilized to grow fruits and vegetables (Raja, 2018). It is a method of preserving farming production, plastic is utilized to protect the structure and allows high-value plants to be cultivated in the agriculture structure (Tripathy & Dash, 2020). Furthermore, the polyhouse farm is monitored by a mobile app linked to the internet, making it simple for farmers to access it from all over the world (Devekar, Raut, Kumbhar, Waidande & Patil, 2018). The polyhouse process grows most crops than the usual method and is more sustainable (Devekar *et al.*, 2018).

2.8.3 Use of ICTs for sustainable farming

Worldwide, both small and large-scale farmers are embracing electronic farming for sustainable farming and economic growth (Kintoki, 2017). Sustainable farming is an interconnected solution for long-term farming activities that belong to animals and plants (Alshaal & El-Ramady, 2017). ICTs are essential components for enhancing farming development and productivity (Chhachhar *et al*., 2014). ICT developments provide small-scale farmers with reliable, relevant, appropriate information, and utilities (Mahant, Shukla, Dixit & Patel, 2012). There are many different applications available to assist farming with their farming acting. Mobile Agribiz is a mobile platform and SMS program where small-scale farmers can determine when and how to produce food (Fendji, Ebongue, Hamidoullah & Yenke, 2018). It offers small-scale farmers with product prices. Rural eMarket is a platform for the transmission of price information through smartphones, tablets, or computers to enhance accessibility and market information access (Fendji *et al*., 2018). The mobile app is also one of the sites in which small-scale farmers get all the information in one touch (Barh & Balakrishnan, 2017). For instance, the agri-crop application provides relevant information regarding new methods, the marketplace, and the weather (Barh & Balakrishnan, 2017).

Nowadays, mobile phones have given small-scale farmers the much-needed latest knowledge and awareness on the best markets, quantity, and quality of specific commodities (Razaque & Sallah, 2013). Through the utilization of ICTs, small-scale sweet potato farmers can access market prices on time; thus, greatly boosting their returns. Awareness and directly relevant information, competencies, innovations as well as methods, play an important role in sustainable farming (Serbulova, Kanurny, Gorodnyanskaya & Persiyanova, 2019). The appropriate use and monitoring of dielectric soil moisture sensors can make agricultural production sustainable (Adeyemi, Grove, Peets & Norton, 2017). ICT-based decision support system allows small-scale farmers to improve productivity level thus reducing production expenses (Serbulova *et al*., 2019).

ICTs play a significant role in developing farming production using of different devices to achieve economic sustainable growth (Saidu, Clarkson, Adamu, Mohammed & Jibo, 2017). Farming information must be disseminated to ensure that small-scale farmers have relevant skills to meet their requirements and maintain growth (Musa *et al*., 2013). ICTs provide the ability to improve production, profitability, sustainability, and development across different aspects of farming production (Chikaire, Anaeto, Emerhirhi & Orusha, 2017). Enhancing access to information, network infrastructure and access to markets by small-scale farmers is essential to enhance agricultural productivity (Girma & Abebe, 2019). Access to farm prices and marketing information is an important factor in fostering market economies and enhancing the growth of the agricultural market (Magesa, Michael & Ko, 2014).

2.8.4 Small-scale farmers Agricultural Funding

Small-scale sweet potato farmers need government support to maintain their farms. In South Africa, a variety of farmer support programs are being introduced to reduce the possibility of a shortage of capacity and economic/financial expertise in small farms (Sikwela & Mushunje, 2013). The South Africa Agri-Academy trains small-scale farmers from all over the world in marketing, management, computer skills, market, and financial expertise (Okunlola, Ngubanei, Cousins & Du Toit, 2016). Through different organizations like IDC, Micro Agriculture Financial Institutions South Africa (MAFISA), Comprehensive Agricultural Support Programme (CASP), Land Bank & DBSA, South African small-scale farmers are experiencing the development of support programs and this assistance presents a good opportunity to promote farming growth in South Africa, particularly between small-scale farmers who have already been deprived of support after South Africa achieved its independence (Sikwela & Mushunje, 2013). CASP offers diverse assistance to small-scale farmers through assistance at agricultural production (FAO, 2018). Furthermore, the goal of the CASP program has been to extend the delivery of farming support programs and to facilitate and encourage agricultural production through targeting small-scale subsistence farmers and African commercial farmers from historically underprivileged backgrounds (DAFF, 2019). Micro Agriculture Financial Institutions South Africa (MAFISA) is a financial scheme to meet the needs of the small-scale farmers & agribusinesses for financial support and it offers loans to improve farming production (DAFF, 2019). Government-funded banks like the Southern African development bank and Landbank give farmers credit towards sustainable agriculture development activities (Sebola, 2018). In South Africa, commercial banks like First National Bank (FNB), Amalgamated Bank of South Africa (ABSA), Nedbank and Standard Bank have formed long and short-term loans to future farmers (Sebola, 2018).

2.9 Smart Farming using Internet of Things

Smart farming is a new farming production theory with IoT technology intended to improve agricultural productivity (Doshi, Patel & Kumar Bharti, 2019). It includes the utilization of ICT, IoT and relevant big data analytics to resolve agricultural issues through electronic crop tracking, and associated environment, soil, fertilizing, and watering conditions (Jayaraman, Yavari, Georgakopoulos, Morshed & Zaslavsky, 2016). It has a significant opportunity to deliver the most productive and sustainable agriculture growth, centered on a much more detailed and resource-efficient approach (Gorli & Yamini, 2017). Furthermore, smart agriculture and advanced farming technology have been identified as innovative techniques to improve crop productivity without compromising the quality of production (Aravind, Raja & Pérez Ruiz,2017).

2.9.1 Advanced Sensor Irrigation

Irrigation is an important process in farming that influences plant growth (Swetha, Nikhitha & Pavitra, 2017). Smart irrigation management for precise agricultural irrigation is important for increasing agricultural productivity and reducing costs, thus adding to the sustainability of the ecosystem (Kamienski, Soininen, Taumberger, Dantas, Toscano, Salmon Cinotti, Filev Maia & Torre Neto, 2019). A sensor-based advanced irrigation system offers an innovative approach for farming activity management (Amalraj, Banumathi & John, 2019). Water waste can be managed using of new technologies and sensor network technology (Naik, Katti, Kumbi & Telkar, 2018). Using IoT and android applications, small-scale farmers can inform essentially the health of the crops, the amount of water needed for crops, and the fertilizers necessary to sustain the crop alive (Manimegalai, Little Judy, Gayathri, Ashadevi & Mohanapriya, 2020). Advanced fustigation system incorporates drip irrigation and fertilizer application to distribute water and nutrients specifically to crop roots, to synchronize the application with crop demands, and to preserve the optimal concentration and delivery of ions and water in the soil (Chaware, Panse, Raut & Koparkar, 2015).

Figure 2.12: Soil sensor based irrigation. (Source: Yadav, Sharma, Thao & Goorahoo, 2020)

2.9.2 Drone

Drones are autonomous robots programmed or remotely operated aerial devices, either from a remote control but are known as connected robotic innovations (Ahmed, Muneer, Alam & Mani, 2018). In the agriculture sector, drones are used to sprinkle pesticides successfully, particularly whenever the crops have various heights given the tough terrain (Ayaz, Ammad-Uddin, Sharif, Mansour & Aggoune, 2019). Drones are not only utilized to analyze soil and crops but also to plant a seed and collect crop nutrients from the soil (Kurkute, Deore, Kasar, Bhamare & Sahane, 2018). Before planting the crops, drones generate accurate information to evaluate the soil, which helps to identify the best suitable crops, helping to identify the most suitable crops for specific land (Ayaz *et al*., 2019). Farm activities supported by drones include soil quality evaluation, spraying, plantation, scouting reports, wheat nitrogen measures, and soil condition analysis (Farooq, Riaz, Abid, Abid & Naeem, 2019). Furthermore, on farms, aerial and ground-based farming drones are utilized for spraying and health evaluation, time-efficient, and productive crop irrigation tracking, soil testing, and plantation (Shruthi, Manasa & Lakshmi, 2019) (see Figure 2.13).

Figure 2.13: Drone spraying. (Source: Aydoğan, 2018)

2.10 Theory underpinning this study

This study is going to be guided by two main theories which are Diffusion of innovation theory (DOI) and unified theory of acceptance and use of technology (UTAUT). This theory (DOI) has been used in similar studies by Mburu (2013), Shemfe (2019) and Sennuga (2019) and UTAUT theory has been used in similar studies by Kahenya, Sakwa and Iravo (2014) and Lutuli (2019). This study is based on a modified version of UTAUT model for the adoption of use technology in farming. This study is going to provide the following variables; performance expectancy, effort expectancy, facilitating condition, price value, socio-cultural value and technical information which are relative to the study. Discussion are the two theories which are relative to the study.

2.10.1 Diffusion of Innovation Theory

In this study, the diffusion of innovation theory has been selected as the theoretical framework. This theory states that an innovation is communicated over time between the members of the social system through certain channels (Rogers, 2010). The Rogers (1995) theory has been used to analyze the diffusion of agricultural innovation. The theory relies on four elements; innovation, communication channel, time, and social system (Rogers, 2010).

Innovation is a concept, practice, or object that is perceived by the individual or other unit of adoption as new (Rogers, 2010). Characteristics of innovation include; relative advantages, compatibility, complexity, trialability, and observability (Rogers, 2010). A communication channel is defined as a way in which a message is exchanged from one individual to another. Mass media channels are often the fastest and more reliable way of informing the audience of potential adopters of the existence of innovation, that is, of raising awareness (Rogers, 2010). Media channels are mostly the means of transmitting messages involving mass media, such as radio, television, and so forth, enabling the source of one or few individuals to attain many audiences (Rogers, 2010).

The innovation decision-making process is the framework whereby an individual moves from first awareness of innovation to an attitude towards innovation, the decision to accept or decline, the application and utilization of the latest concept as well as the affirmation of that decision (Rogers, 2010). The innovation decision-making process has 5 stages, namely; knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2010). In the knowledge stage, the individual learns about the existence of innovation and gains some knowledge of how it works (Rogers, 2010). However, even after individuals gain knowledge on the use of innovation, they need to be convinced to use it, since they do not see the need to use it in their activities. The implementation stage is when an individual puts an innovation into use (Rogers, 2010). The final stage is confirmation, it occurs when an individual tries to improve an innovation-decision already made (Rogers, 2010).

The social system is the fourth element in the diffusion of innovation theory. A social system is defined as a collection of interconnected entities that are involved in joint problem-solving to achieve a common goal (Rogers, 2010).

2.10.2 Unified Theory of Acceptance and Use of Technology

A unified theory of acceptance and use of technology (UTAUT) acted as a reference model and has been applied in both organizational and non-organizational settings to the study of several technologies (Venkatesh, Thong & Xu, 2012). UTAUT has 4 key constructs; performance expectancy, effort expectancy, social influence, and facilitating conditions that guide behavioral intention to utilize a technology (Venkatesh *et al*., 2012).

Performance expectancy is defined as the extent whereby a person thinks that utilizing the system will enable him or her to achieve work performance improvements (Venkatesh, Morris, Davis &

Davis, 2003). The performance expectancy construct includes; Perceived usefulness, extrinsic motivation, job fit, relative advantage, and outcome expectation. In perceived usefulness people believes that using a system in their job would make it easier and increase their productivity (Venkatesh *et al*., 2003).

Effort expectancy is defined as the level of convenience related to the utilization of the system (Venkatesh *et al*., 2003). Three effort expectancy constructs include; perceived ease of use, complexity, and ease of use. Perceived ease of use is the level to which an individual think that utilizing a system would be simple and easy (Venkatesh *et al*., 2003). Complexity is when a system is hard to understand and utilize (Venkatesh *et al*., 2003). Ease of use is the level to which a system is complicated to use (Venkatesh *et al*., 2003).

Social influence is defined as the extent wherein any person believes essential others should use the new system (Venkatesh *et al*., 2003). Facilitating conditions are defined as the level whereby a user perceives that there is an organizational and technological infrastructure to enable the use of the system (Venkatesh *et al*., 2003). Three facilitating conditions include; perceived behavioral control, facilitating condition, and compatibility. Perceived behavioral control represents views of internal and external behavioral constraints, and self-efficacy, resource facilitating, and technology facilitating conditions (Venkatesh *et al*., 2003). Compatibility is the level to which an innovation is in line with current principles, desires, and perceptions of potential adopters (Venkatesh *et al*., 2003). Price value refers to the cost of accessing the internet, access to ICT, and the price of buying ICT devices. The price value is positive if the benefits of using innovation are higher than the monetary cost and such price value has a positive effect on the intention (Venkatesh *et al*., 2012).

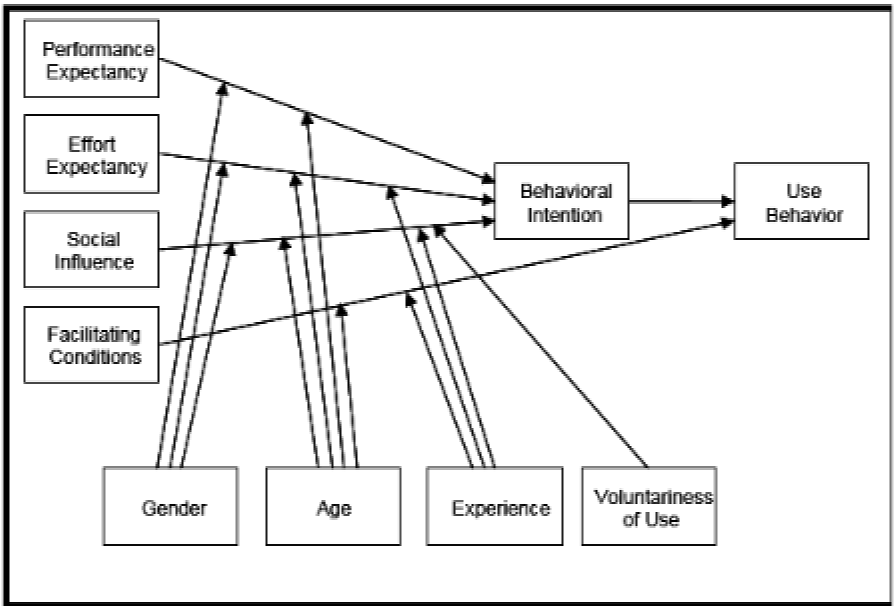


Figure 2.14: Unified Theory of Technology Acceptance Model (UTAUT) Source: (Venkatesh *et al*., 2003)

Figure 2.14 is the original model which was proposed by Venkatesh, Morris, Davis & Davis. It consists of four constructs, wherein three constructs namely; performance expectancy, effort expectancy and social influence affect behavioral intention and facilitating conditions affect use behavior of technology. Performance expectancy is moderated by gender and age, effort expectancy is moderated by gender, age and experience. Social influence is moderated by gender, age, experience and voluntariness of use and facilitating conditions is moderated by age and experience.

2.11 Conceptual Framework

Based on the studied literature review and relevant theories and models, a conceptual framework is proposed to guide this study (see Figure 2.15). Osanloo and Grant (2016) defined a conceptual framework as the researcher's perception of how to correctly investigate the research issue, the path the analysis would have to follow, as well as the connection within several various variables used in the study. The study identifies, performance expectancy, effort expectancy, facilitating conditions, price value, socio-cultural values, and technical information as the relevant variables making up the conceptual framework, as illustrated in Figure 2.15.

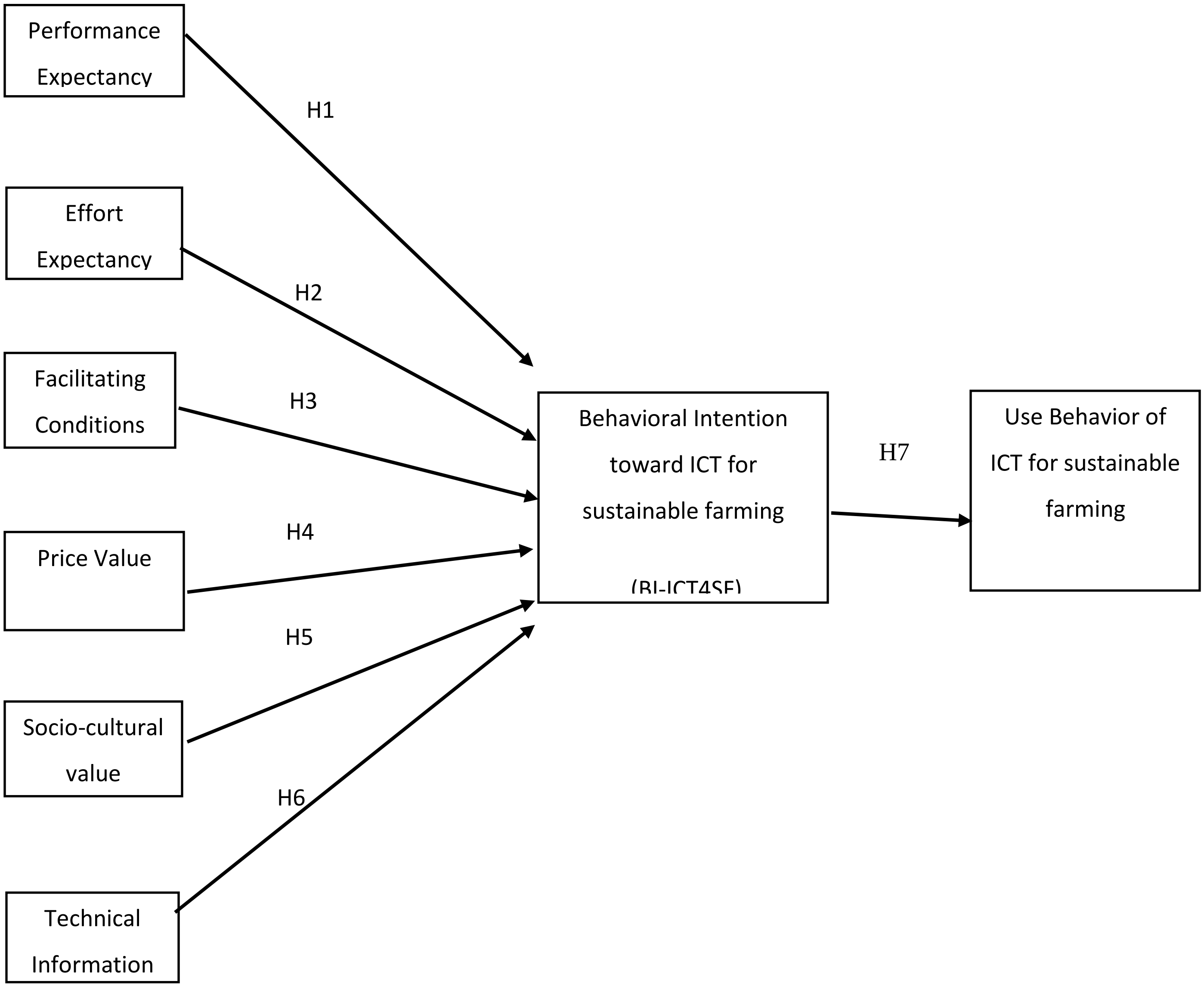


Figure 2.15: ICT for Sustainable Farming Conceptual Framework

2.12 Research Hypotheses

Based on the proposed conceptual model for this study (see Figure 2.15), the following null hypotheses were formulated:

H10: Performance Expectancy (PE) does not influence behavioral intention toward ICT for Sustainable Farming (BI-ICT4SF).

H1A: Performance Expectancy (PE) influences (BI-ICT4SF).

H20: Effort Expectancy (EE) does not influence (BI-ICT4SF).

H2A: Effort Expectancy (EE) influences (BI-ICT4SF).

H30: Facilitating Condition (FC) does not influence (BI-ICT4SF).

H3A: Facilitating Condition (FC) influences (BI-ICT4SF).

H40: Price Value (PV) does not influence (BI-ICT4SF).

H4A: Price Value (PV) influences (BI-ICT4SF).

H50: Socio-cultural value (SC) does not influence (BI-ICT4SF).

H5A: Socio-cultural value (SC) influences (BI-ICT4SF).

H60: Technical Information (TI) does not influence (BI-ICT4SF).

H6A: Technical Information (TI) influences (BI-ICT4SF).

H70: Behavioral Intention toward ICT for sustainable farming (BI-ICT4SF) does not have an influence on the Use Behavior of ICT for sustainable farming (UB-ICT4SF).

H7A: Behavioral Intention toward ICT for sustainable farming (BI-ICT4SF) has an influence on the Use Behavior of ICT for sustainable farming (UB-ICT4SF).

2.13 Chapter Summary

This chapter provides an overview of the ICT channels used by small-scale sweet potato farmers in accessing market information, use level of ICTs and use of ICTs for sustainable farming. With the increase use of ICT channels, the chapter provides the benefits and challenges that are affecting small-scale farmers in accessing farming information. This chapter outlines the agricultural funding available for small-scale farmers in South Africa and use of Internet of Things in farming. Two theories; Diffusion of innovation theory and Unified theory of acceptance and use of technology were selected as the theoretical framework for this study. The proposed conceptual framework for this study was presented. The next chapter (3) outlines the methodology guiding this study.

3. CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This chapter focused on the research design and methodology used to carry out the study. According to Kothari (2004), a research methodology is a step-by-step roadmap for addressing the study problem scientifically. Its purpose is to guide the study. This chapter covered the research paradigm, research design, target population, sampling technique and size. The chapter also covered the methods that were used to collect and analyze data.

3.2 Research Paradigm

A paradigm describes a collection of systematically associated hypotheses, theories or proposals that direct thoughts and scientific studies (Siddiqui, 2019). Paradigms reflect the views and values of researchers about the universe, a manner they interpret the universe and how they function in the universe (Kamal, 2018). Makombe (2017) suggests that the research paradigm is all about the framework wherein the study is performed. Some of the widely used research paradigms include: positivism, interpretive and pragmatism. Qualitative methods are based on interpretivist approach while quantitative methods are based on a positivist approach (Antwi & Hamza, 2015). The paradigm of interpretive can handle different opinions and variants of facts (Thanh & Thanh, 2015). Positivists seek to comprehend the nation of society like the natural universe (Rehman & Alharthi, 2016).

Mixed method researchers support pragmatism as a paradigm by implying that it specifically relates to the requirements of research into mixed methods (Kaushik & Walsh, 2019). Mixed approaches are based on ontologies and epistemologies of pragmatism (Siddiqui, 2019). Pragmatism focuses on the researcher's effective function in the development of data and hypotheses (Goldkuhl, 2012). Pragmatism research paradigm has powerful interconnections with mixed research methods (Cameron, 2011). In this study, pragmatism paradigm was used because it is suited to mixed methods approach that was used in this study (Makombe, 2017).

3.3 Research Design

Akhtar (2016) defines a research design as a proposal of the research study being proposed. A research design is not only a work plan, but also ensures that the evidence gathered allows the researcher to answer as unambiguously as possible to the research questions (Jongbo, 2014). The goal of a research design is to give responses to the validity of the study question, scientifically, correctly and financially, and to act as a monitoring platform, optimize structural variance and reduce error (Jongbo, 2014). This study adopted a case study design. A case study is a theoretical methodology that is designed to create an in-depth analysis of a specific problem in the framework of its actual existence (Crowe, Cresswell, Robertson, Huby, Avery & Sheikh, 2011). It is helpful in providing answers to the ‘how?’ and ‘why?’ research questions (Yazan, 2015). It addresses tiny minority issues and focuses on a specific problem (Rahi, 2017). Furthermore, a study by Mahdi and Nassar, Almuslamani (2020) indicated that the case study method is distinct in that it is based on actual events, offers relevant facts and documents for analysis, and poses an open-ended query or issue in search of a potential solution. The case study research approach was used in this study to produce an in-depth investigation of the difficulties small-scale farmers have had in accessing farming information. The purpose of this study was to provide a framework for assisting small-scale sweet potato farmers to improve their farming practices in the Vhembe Rural District of Limpopo Province.

3.4 Research Methodology

The qualitative method focuses on understanding, instead of measuring and trying to understand the truth, as individuals or groups perceive it from what they think and how they react (da Silva, 2017). It is used to gather in-depth information on a certain topic (Rahi, 2017). Quantitative method involves the use and evaluation of numerical data utilizing specific statistical techniques to address questions like who, what, where and how (Apuke, 2017).

This study adopted a mixed methods approach. Johnson and Onwuegbuzie (2004) defined a mixed method research as an effort to legitimize the use of various methods in addressing the research questions, instead of limiting or reducing the option of researchers. A mixed methods approach uses both quantitative and qualitative approaches to investigate a phenomenon (Brannen, 2005). In this study, quantitative method was in the form of structured questionnaire and qualitative was in the form of semi-structured interview questions. The aim of mixed approaches is not to substitute any of these methods, but instead, to focus on the strengths and mitigate the limitations among both single research methods (Johnson & Onwuegbuzie, 2004). A mixed method study has the benefit of enhancing scientific studies (Jing & Huang, 2015). It also has the extra impact that implies utilizing certain research approach's strength to strengthen another method (Maarouf, 2019). It addresses a wider and much more detailed research questions (Siddiqui, 2019). Furthermore, theoretical and practical information, both quantitative and qualitative, are integrated in a mixed approach to achieve the research goal by taking different viewpoints and perspectives (Almeida, 2018). This approach suited this study because the study of small-scale sweet potatoes farming is complex and required the mixing of these methods to understand the phenomena.

The researcher used questionnaires and interviews to collect data from participants. The questionnaire was made up of five sections. The first section consisted of demographics details and in the second section, participants were asked to give information on ICTs used in accessing farming information. In the third section, participants were expected to provide information on the challenges associated with the use of ICTs in accessing farming information and in the last section, participants were required to provide information about their behavioral intention towards ICTs for Sustainable Farming.

This study has benefited from using mixed method approach; the qualitative research method has helped the research to answer the questions on the why and how, while quantitative research method addressed its how many and to what extent questions. The researcher has gathered information regarding demographics, ICTs used to access farming information, and difficulties that small-scale farmers encountered when utilizing ICTs to access farming information through qualitative research method. The researcher has collected data about demographics details, ICT used in accessing farming information, challenges associated with the use of ICT and farmers behavioral intention towards ICTs for sustainable farming using the quantitative research method.

3.5 Target Population

Majid (2018) defined population of interest as the target population of the research which the researcher aims to investigate. Compared to the general population, the target population is much more specific on the principle of having no feature that contradicts a study premise, meaning or objective (Asiamah, Mensah & Oteng-Abayie, 2017). Without a specific target population for the study, resources are expected to be misused (Murphy, 2016). This study targeted small-scale sweet potato farmers from Tshakhuma and Matangari villages in the Vhembe Rural District in Limpopo province of South Africa.

3.5.1 Study Area

The Vhembe District Municipality is in Limpopo province of South Africa. It is bordered by Zimbabwe to the north, Botswana to the northwest and Mozambique to the east. It is one of the six district (Capricorn, Sekhukhune, Waterberg, Bohlabela, Mopani and Vhembe) of the Limpopo province of South Africa. Vhembe District Municipality consisted of four Municipalities namely, Makhado, Thulamela, Musina and Collins Chabane (see Figure 3.1).

Figure 3.1: Map of the study area (Vhembe district)

3.6 Sampling and Sample size

Sampling is the process of selecting a small group of interest (i.e. sample) from the population. The entire population is intended to be divided up into small groups comprising all aspects of the sample to acquire outcomes of the research. Sampling data from a community sample is a sensible approach (Munyoka, 2017). Sampling techniques can be subdivided into two categories which are probability sampling and non-probability sampling (Etikan & Bala, 2017). Probability sampling is often referred to as random sampling, a sampling that allows any specific object in the world to have an equivalent probability of being present in the sample (Etikan & Bala, 2017). Non-probability sampling is a form of sampling that does not provide a basis for any view of the possibility that items in the world will be involved in the sample population (Etikan & Bala, 2017). In this study, snowball sampling, purposive sampling and random sampling were used. Since the actual number of small-scale sweet potato farmers in the Limpopo province are unknown, the researcher used both snowballing and purposive to have a sample with people of interest. The study adopted a combination of purposive and snowball sampling techniques to identify the participants for interviews because the researcher wanted to identify small-scale sweet potato farmers of interest i.e. with more than 1-year experience in farming and with exposure and experience in using any form of ICTs in their farming activities. Random sampling technique was used to identify respondents for the quantitative strand. In this study, 158 small-scale farmers were chosen to be part of the study. Eight of these farmers were interviewed, and 150 completed questionnaires. With more participants, the study's findings will be more precise, and the parameter estimate will be more accurate. In this study, the participants were chosen from two villages in Vhembe Rural District, which are Tshakhuma and Matangari.

3.6.1 Snowball Sampling

Snowball sampling is a technique by which information is gathered to access specific sections of the populations (Naderifar, Goli & Ghaljaie, 2017). It is useful whenever the researcher knows far less about group of people (Etikan & Bala, 2017). In snowball sampling, the researcher requires first interactions with a small group of individuals who are important to the subject of the researcher and afterwards utilizes them as guides to communicate with others (Rahi, 2017).

Furthermore, snowball sampling means requesting participants that have previously chosen to appoint other participants for the research (Omona, 2013). This sampling method is widely utilized in quite specific cultural studies and is often utilized in circumstances where research respondents are unusual or very difficult to access (Etikan & Babatope, 2019). In this study, the identified respondents referred to other small-scale sweet potatoes' farmers in these two villages, hence making it easier to find people of interest.

3.6.2 Purposive Sampling

A purposive sampling method is a form of non-probability sampling which is more efficient whenever it is appropriate to research a certain cultural field with experts (Tongco, 2007). Purposive sampling uses a respondent's personal decisions and judgement regardless of the characteristics which the respondent must identify the participants (Etikan, Musa and Alkassim, 2016). The selection of the sample elements in purposive sampling is based on the judgment or experience of the researcher (Sarstedt, Bengart, Shaltoni & Lehmann, 2018). Furthermore, in purposive sampling, items are chosen based on unique features besides the accessibility that enable them applicable to the target of the research (Baltes & Ralph, 2020). In qualitative research, purposeful sampling was commonly adopted to define and select information-rich cases relevant to the phenomenon being studied (Palinkas, Horwitz, Green, Wisdom, Duan & Hoagwood, 2015). In this study, the participants were selected based on the experience that they have on the use of ICTs in accessing farming information. Participants were initially asked if they had any experience in utilizing ICT to access farming-related information. For this study, 8 purposive selected small-scale sweet potato farmers that were interviewed from two villages in Vhembe Rural District. With this number of interviewees, the study's findings will be more precise.

3.6.3 Simple Random Sampling

In simple random sampling, each item of a population has the equal possibility of being selected in the study and all potential samples of a specified size have the similar probability of being selected (West, 2016). Furthermore, the choice of the participant may not influence the choice of any participant (Omona, 2013). In this study, a simple random sampling was used to select the targeted population of the study. In the Vhembe Rural District, Tshakhuma and Matangari were randomly selected. In this study, Vhembe district was selected as the study area since it is suitable for sweet potato production. A study by Libago (2017) indicated that the agricultural sector is one of the key sources for rural development in the Vhembe area, which is distinguished by many small-scale farmers engaged in the production of a variety of crops, including sweet potatoes.

3.7 Sample Size

The sample size is an essential aspect of every research aimed at making population conclusions from a sample (Singh & Masuku, 2014). According to Malone, Nicholl and Coyne (2016), a sample size is acceptable if it helps the researcher make an unambiguous judgment that numerical findings are accurate to the extent selected. The total population of small-scale sweet potato farmers in Tshakhuma and Matangari village was not clear. The Slovin's formula (see Equation 1) was used to define the sample size for this study.

Equation 1: Slovin's (2018) formula for sample size:

n= N/ (1+Ne2)

Whereas;

n= is the sample size;

N= population size;

e= is the margin of error

Therefore, 240/ (1 + 240 * 0.05*0.05) = 150

The researcher assumed that there are 240 small-scale sweet potato famers from both villages. The study consisted of two sample size because mixed method was used in this study. For quantitative strand, 150 questionnaires were distributed to randomly identified small-scale sweet potato farmers from two villages in Vhembe district.

3.8 Data Collection

This study adopted the explanatory sequential strand of the mixed methods design (Creswell, 2014). Quantitative data using questionnaires were collected and analyzed first, then followed by qualitative data gathered using semi-structured interview guides to gain in-depth understanding of the aspects raised and in the quantitative data. The questionnaire was divided into four sections where participants were required to provide information on how they used ICTs in accessing farming information. Interview was conducted with the aim of finding out on what type of information small-scale sweet potato farmers access through ICTs.

3.8.1 Semi-structured Interview

Semi-structured interview contains a combination of closed-ended and open-ended questions and addresses quite basic areas or ideas (Kielmann, Cataldo & Seeley, 2012). It is often a good way of gathering open-ended data from respondents (DeJonckheere & Vaughn, 2019). Semi-structured interviews, starts with a specific collection of open-ended questions, however, spends significant time evaluating participant answers, allowing them to offer context and clarity; these data are normally evaluated qualitatively (Harris & Brown, 2010).

The main aim of using semi-structured interview was to collect data from specific sources with relevant experiences, behaviors, expectations and opinions relevant to the subject of interest (DeJonckheere & Vaughn, 2019). This study used semi-structured interview focused on gathering insights on how small-scale sweet potato farmers used ICTs in accessing farming information and enhancing their farming practices. In this study, the qualitative method was in the form of a semi-structured interview because small-scale sweet potato farmers were asked questions that were associated with the use of ICTs on accessing farming information in Vhembe Rural District.

3.8.2 Structured Questionnaire

In structured questionnaires, respondents reply on questions through choosing among specified response like multiple choice answers and giving a specific response and the data are usually evaluated quantitatively (Harris & Brown, 2010). In this study, the quantitative research strand was in the form of structured questionnaire. The principal means of gathering quantitative primary main data was a questionnaire (Roopa & Rani, 2012). The questionnaire was distributed to small-scale sweet potato farmers in the two villages of Tshakhuma and Matangari to understand how ICTs were used in accessing farming information.

The questionnaire consisted of four sections:

Section A: gathers data on respondent's demographics; while

Section B: gathers data on the usage of ICTs.

Section C: section gathers data related to challenges on the use of ICTs and

Section D: gathers information on factors affecting farmer's behavioral intention to adopt and use ICTs for sustainable farming. A five-point Likert scale ranging from strongly agree (1) to strongly disagree (5) was used. The questionnaire is provided in Annexure E.

3.9 Data Quality Control

The accuracy and consistency of the questionnaire is an important part of the research methodology classified as validity and reliability (Taherdoost, 2016). Validity is defined as the level to which a theory is measured (Heale & Twycross, 2015). The validity relies on the sample (Newman, Lim & Pineda, 2013). Internal validity deals with the extent whereby the researcher observes and tests what should be tested while external validity is concerns with the relevance of the results in many other settings (Zohrabi, 2013). Content validity makes sure that the questionnaire contains a necessary group of elements that expend on the framework (Mohajan, 2017).

Reliability is defined as the level to which a research instrument reliably delivers the same outcomes when used repeatedly in the same context (Heale & Twycross, 2015). In this study, the questions were piloted with 10 people, which were randomly selected from Tshakhuma farmers. Based on their feedback, the questionnaire was corrected, ready for full scale deployment. Cronbach's Alpha was used to test reliability for the quantitative strand.

To achieve the reliability and validity of the qualitative strand, this study adopted Shenton's (2004) four trustworthiness criteria of credibility, transferability, dependability and confirmability. Credibility examines the issue of "How consistent are the results with reality?" while in transferability, the reader must decide how much they can trust the results and conclusion offered to be applied to other circumstances (Shenton, 2004). In dependability, the techniques in the study should be described in detail so that future research can repeat the work while the qualitative researcher's equivalent of objectivity's issue is the idea of confirmability (Shenton, 2004). To achieve this aspect, the researcher gave back the findings to the interviewees (i.e., member check) to confirm if they are in line with what they said. Similarly, the researcher provided a detailed outline of all the procedures adopted in data cleaning, coding, analysis and meaning derived from the themes. This ensures that transferability was achieved by ensuring whoever wants to follow and apply procedures adopted in this qualitative data analysis find it easier. This was achieved by detailing the process of data collection, data analysis and interpretation of data.

3.10 Data Analysis and Presentation

Data analysis is the process of bringing order and logic by defining, explaining, condensing, recapturing and presenting data (Sharma 2018). Qualitative data collected using interviews were analyzed thematically, which enables pattern derivation from data. Thematic analysis is a form of qualitative analysis which analyzes category and existing data patterns to derive meaning (Alhojailan, 2012). The latest version of IBM Software Package for statistical analysis (SPSS) was used to analyze the quantitative data collected using a structured questionnaire. Regression analysis using ANOVA was used to establish the effect of predictor variables on the dependent variables (behavioral intention toward ICT for Sustainable Farming (BI-ICT4SF) and Use Behavior of ICT for sustainable farming (UB-ICT4SF). Quantitative data was presented using descriptive statistics i.e. percentages, frequencies, tables, pie charts and graphs. To establish how-well the proposed conceptual framework fits the collected data, several analyses were used in this study: incremental fit measure (i.e. using R-Square (R2)), ANOVA tests and coefficients of independent variables using Beta (β) and p-values (significant) values of the constructs.

3.11 Ethical Considerations

This study was guided by an Ethical Clearance Letter issued by the University Ethical Committee (see Appendix 2), which stipulates the protocols and procedures to be adhered to. Before conducting the interview, the researcher first explained the aim of the study to the participants. The respondents were issued with a consent letter stipulating that their participation in this study is purely voluntary with no financial gains. The researcher assured them that data collected from them was anonymously presented and used strictly for academic purposes. Their rights and concerns were respected and considered during their participation in the study. For a detailed participant letter of information and consent letter (see Appendix 3).

3.12 Chapter Summary

This chapter outlined the research methodology for the study. A mixed method research strategy was used. The study targeted small-scale sweet potato farmers from Tshakhuma and Matangari villages in Vhembe Rural District, Limpopo province of South Africa. In this study, three sampling techniques; snowball sampling, purposive sampling and random sampling were used to build up a sample. Semi-structured interview and structured questionnaire were selected as data collection methods. Qualitative data was analyzed thematically. SPSS was used to analyze the quantitative data collected using structured questionnaire.

CHAPTER FOUR: ANALYSIS AND INTERPRETATION

4. Introduction

This chapter presents the results of the study. The aim of this study was to investigate the factors affecting small-scale sweet potatoes farmers' behavioral intention and actual use behavior of ICTs for sustainable farming and then propose a framework that guides the farmers to improve their farming practices. The data was captured using SPSS and analyzed using descriptive statistics and regression analysis.

4.1 Demographic

This section presents data related to gender, age and level of education of the respondents.

4.1.1 Gender

Figure 4.1 presents the gender of the respondents. In this study, the results show that 57, 33% of respondents were female while 42, 67 % were male. This shows that more females than males were willing to engage in this farming-related survey. The findings of this study concur with findings of a study done by Macire (2017) which established that 75.23% of respondents were female while 25.28% were male.

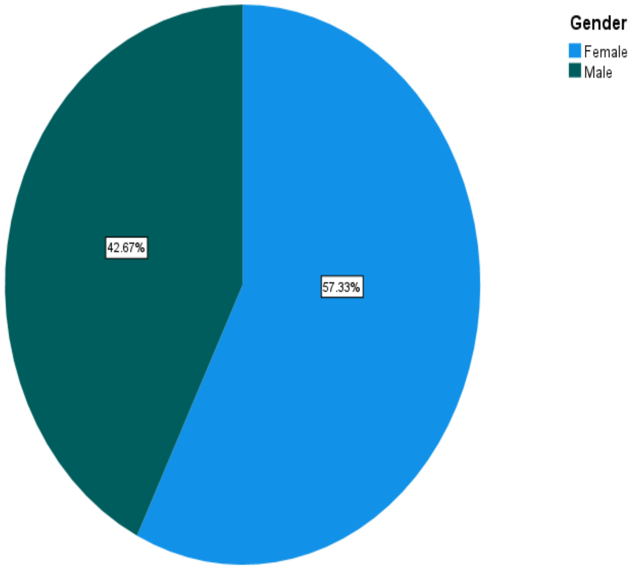


Figure 4.1 Gender

4.1.2 Age

Figure 4.2 presents the age of the respondents. The results show that 26% of the respondents were aged between 20 and 29 years, while 24% were between the ages of 30 and 39. Most the respondents (32%) were aged between 40 and 49. The 50 to 59 years' age group represented 13.33% of the entire respondents. The respondents with the lowest response rate (4.67%) were over 60 years. This finding is in-line with Alant and Bakare (2021) who found that most small-scale sweet potatoes farmers were between the age of 40-49 (48.6%) followed by 50-59 (25.7%).

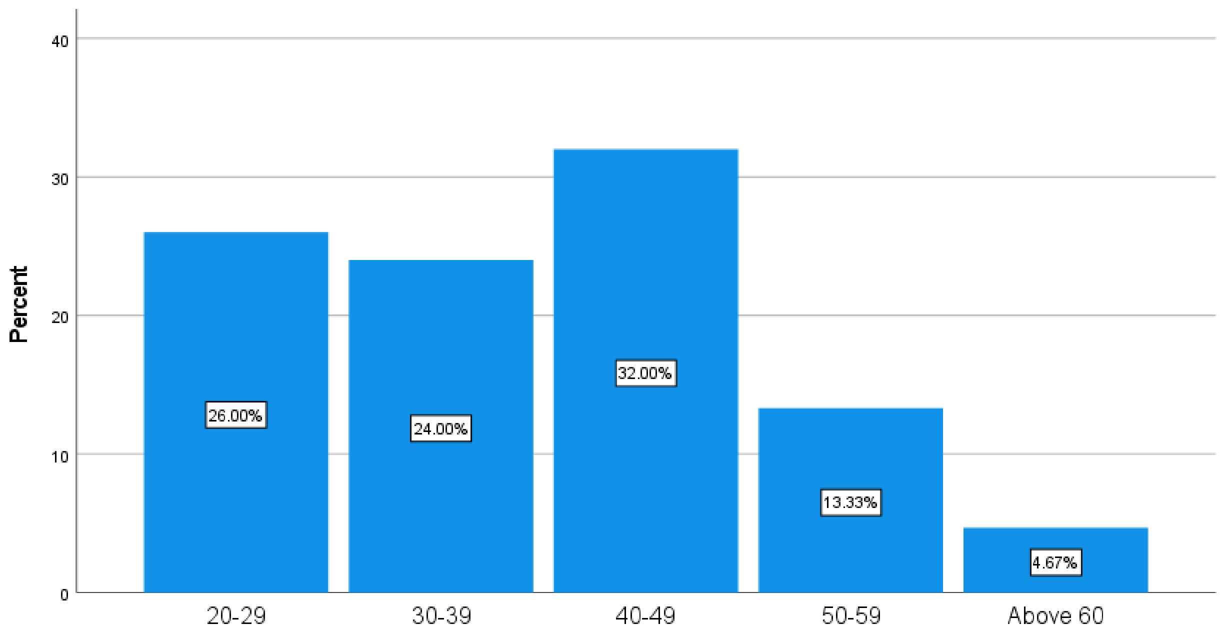


Figure 4.2 Age

4.1.3 Level of education

Figure 4.3 shows that most respondents (57.33%) had a university degree, while 29.33% had completed some form of farming training. Respondents without any formal education qualifications represented 6%, while those with secondary education constituted 5.3%. Respondents with primary education represented the lowest percentage of (2%). These findings indicate that most the respondents were well-educated. This finding is in-line with Kabir (2015) who found that most small-scale sweet potatoes farmers have some form of education and knowledge.

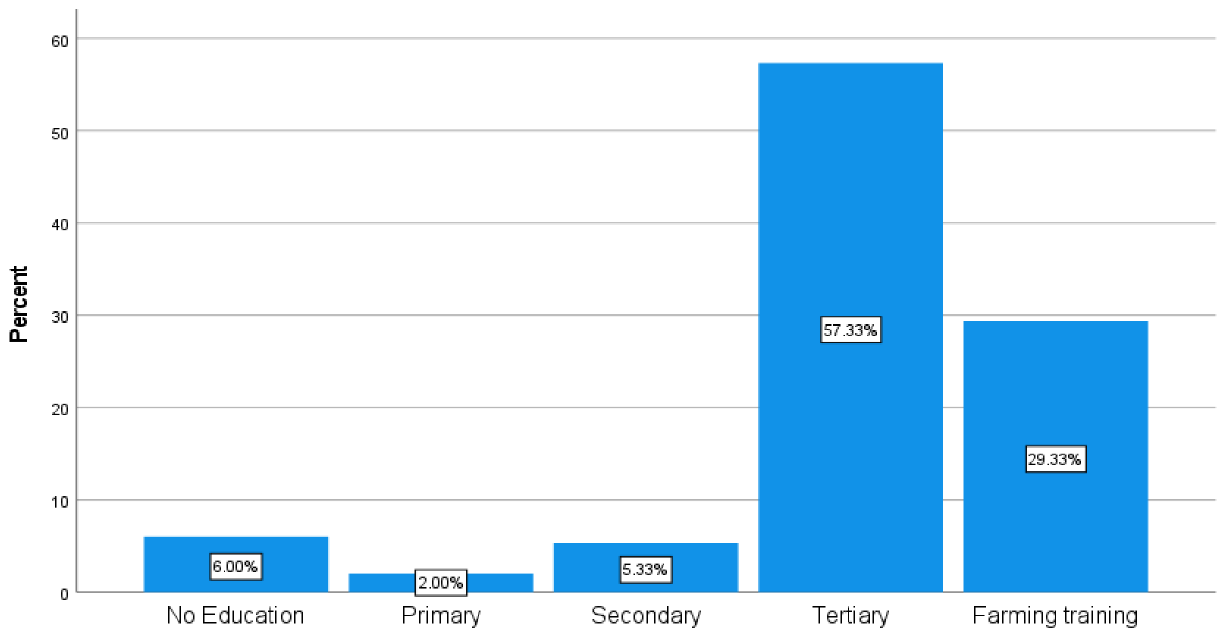


Figure 4.3 Level of Education

4.2 ICT platform used to access farming information

This section presents the data related to ICTs used to access farming information as well as various types of farming information.

4.2.1 Farming application

Figure 4.4 shows the percentage of respondents who have a farming application (farming app) on their phone versus those who did not. Figure 4.4 shows that 52% of the respondents had a farming app while 48% did not.

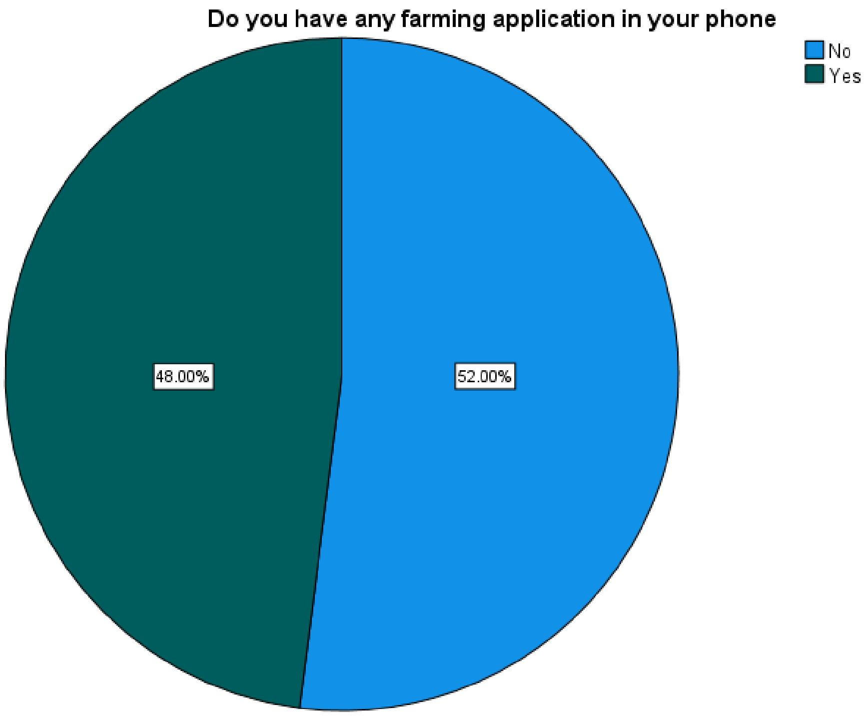


Figure 4.4: Farming application

4.2.2 Awareness on the use of mobile application for accessing farming information.

Figure 4.5 shows the results on the applicants' 'level of awareness of the use of mobile applications to access farming information. The findings indicate that many respondents (71.33%) were aware of the use of mobile application in accessing farming information, while 28.67% were unaware. The findings of this study concur with findings of a study done by Gaikwad, Mudholkar and Probhu (2018) which established that more than half of the respondents were aware of various farming apps used to access farming information.

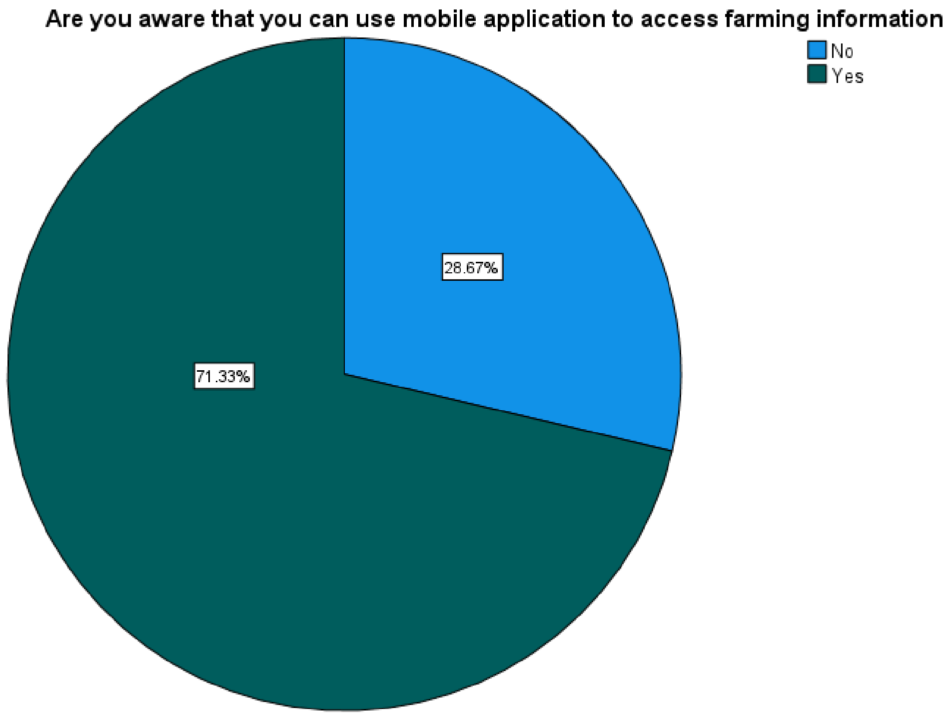


Figure 4.5: Awareness on the use of mobile application for accessing farming information

4.2.3 Various types of ICT channels

Figure 4.6 shows the results of several ICT technologies used to access farming information. The findings show that many respondents (47.33%) relied on mobile application and phones (42%) as their primary ICT channels for accessing farming information. Only 4.67% of the respondents accessed farming information via the radio, while 1.33% used television and 0.6% accessed farming information via desktop computers. This finding concurs with findings of a study by Gaikwad, Mudholkar and Prabhu (2018) which established that mobile phones were used by 88% of farmers in accessing farming information, whereas laptops and desktop computers were used by only a small percentage of farmers.

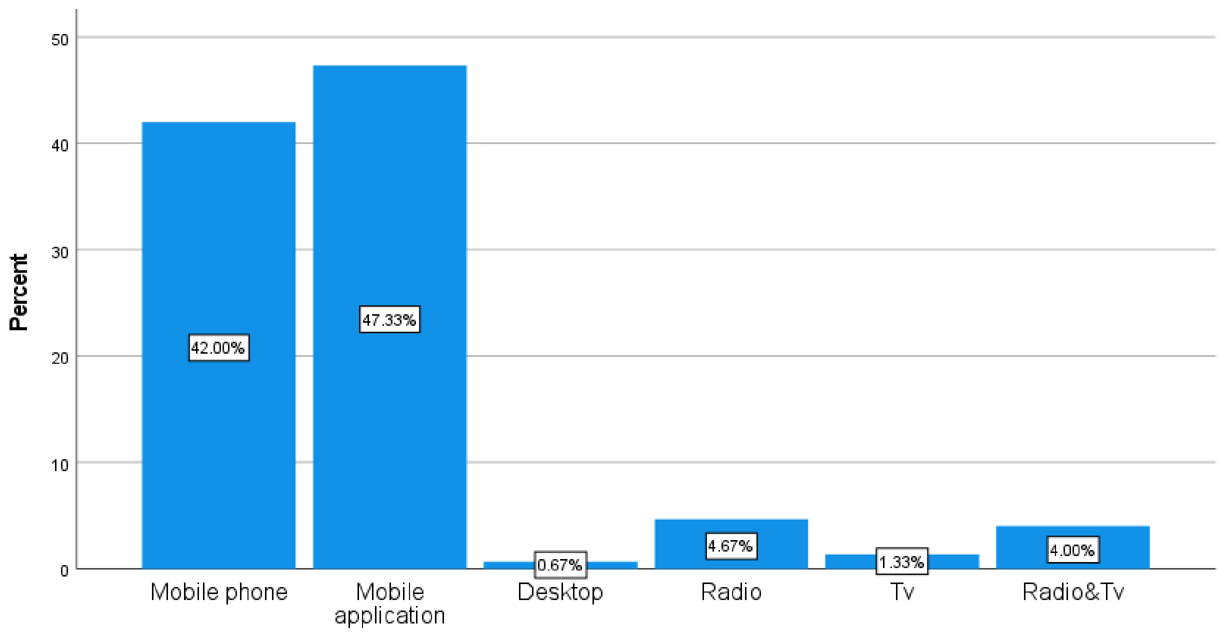


Figure 4.6: Various types of ICTs

4.2.4 Years in using ICTs for accessing farming information.

Figure 4.7 shows the results of the years of experience that the respondents have been using various ICTs to access farming information. Most of the respondents, 41.33% have been using ICTs for more than 4 years, while 22% had between 2 and 3 years. The respondents (20.67%) have been using ICTs in accessing farming information for less than one year, while 16% were using ICTs for greater than 1 year and less than 2 years.

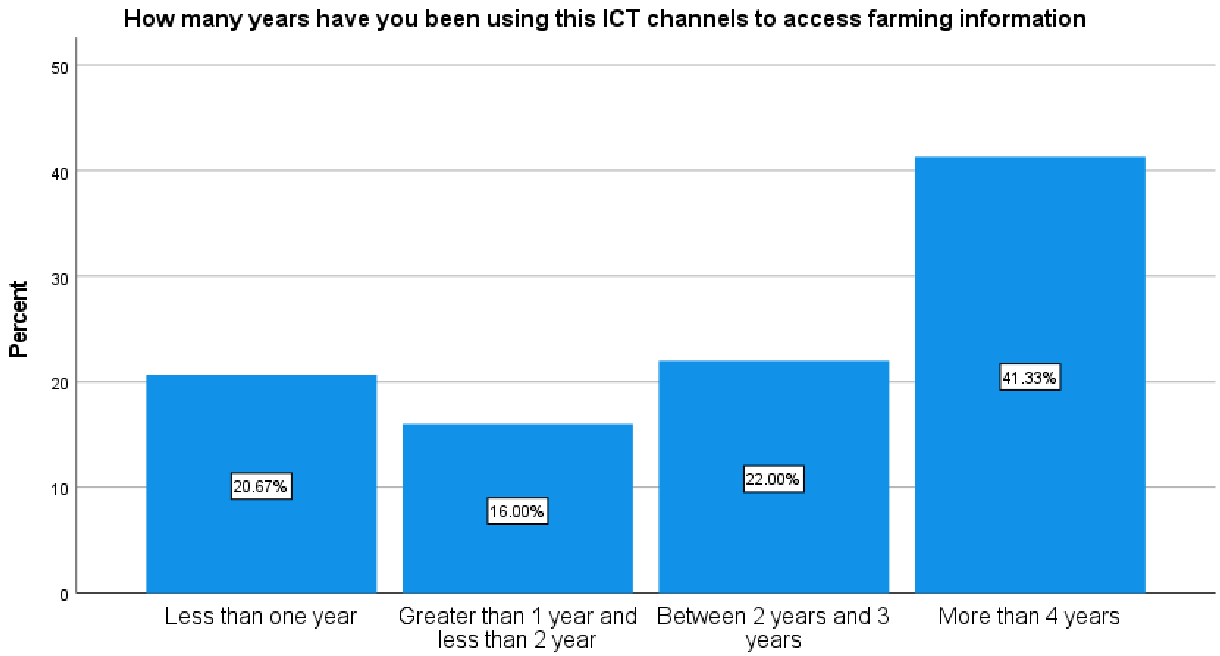


Figure 4.7: Years in using ICTs for accessing farming information.

4.2.5 Types of farming information

Figure 4.8 shows various types of farming information that were accessed by the respondents. The mostly accessed farming information through ICTs were weather condition (42%), followed by fertilizer (15.3%), farming methods (13.33%), pesticides and market price (11.33%). The lowest accessed farming information was soil type and its suitability for farming (5.33%) and farming news (1.33%). The findings of this study concur with findings of a study done by Ramavhale (2020) which established that weather forecast 69% was the most important farming information accessed by small-scale farmers.

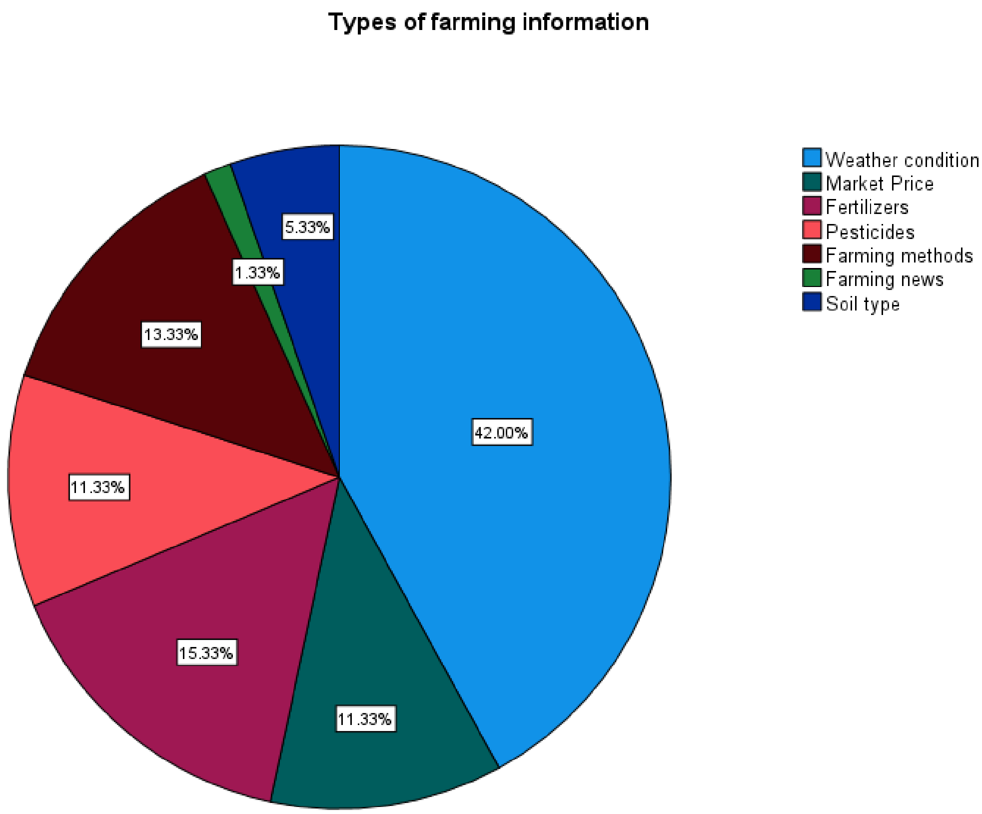


Figure 4.8: Types of farming information

4.2.6 Challenges experienced while accessing mobile application.

Figure 4.9 shows the challenges that the respondents experienced when using mobile application to access farming information. In this study, the main challenges were lack of knowledge (70%), language barrier and lack of knowledge (19.33%), followed by language barrier (8%). Training on how to use ICT (0.67%), signal problems (0.67%) and network problem (0.67%) were recorded as challenges with the lowest percentages. A study by Panda, Modak, Devi, Das, Pal and Nain (2019) found that most rural-based farmers in developing countries struggled to use ICT technologies due to limited internet access, lack of training and skill development and unreliable internet connectivity.

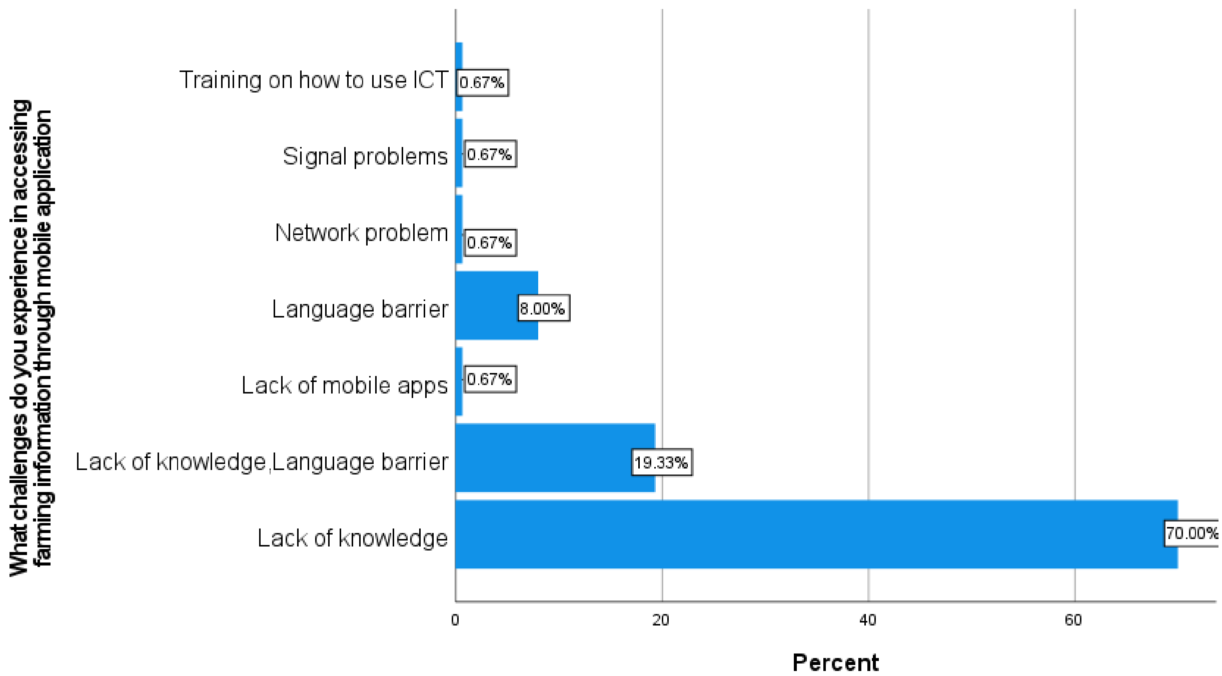


Figure 4.9: Challenges experienced through mobile application.

4.3 REGRESSION ANALYSIS

This section presents regression analysis of the study to establish the effect of predictor variables on the dependent variables (behavioral intention toward ICT for sustainable farming (BI_ICT4SF) and use behavior of ICT for sustainable farming (UB_ICT4SF)).

4.3.1 Model summary for BI_ICT4SF1

Table 4.1: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate

1	.774[a]	.599	.582	.533

a. Predictors: (Constant), TI, PE, SV, PV, FC, EE

The Table 4.1 presents the R and R square values. The R value represents the simple correlation (0.774), which indicates a high degree of correlation (strong positive relationship). The R square value indicates how much of the total variation in the dependent variable (BI_ICT4SF1), can be explained by the independent variables (PE, EE, FC, PV, SV and TI). Table 4.1 indicates that 59.9% of total variation in behavioral intention toward ICT for sustainable farming (BI_ICT4SF1) is explained by TI, PE, SV, FC and EE.

4.3.2 ANOVA for BI_ICT4SF1

Table 4.2: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	60.696	6	10.116	35.598	.000[b]
	Residual	40.637	143	.284		
	Total	101.333	149			

a. Dependent Variable: BI_ICT4SF1

b. Predictors: (Constant), TI, PE, SV, PV, FC, EE

The Table 4.2 presents the ANOVA results for the dependent variable (BI_ICT4SF1), which demonstrates how well the regression equation fits the data (i.e., predicts the dependent variable) (Kumari & Yadav, 2018). It indicates that the regression model predicts the dependent variable significantly well as demonstrated by highly significant value of 0.000. Table 4.2 indicates that the independent variables were statistically significant in predicting the dependent variable, with an F-ratio value of 35.59.

4.3.3 Coefficients for BI_ICT4SF1

Table 4.3: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	.358	.438		.816	.416
	PE	.376	.116	.242	3.235	.002
	EE	.057	.116	.039	.493	.623
	FC	.356	.071	.341	5.017	.000
	PV	-.252	.054	-.291	-4.688	.000
	SV	-.231	.099	-.143	-2.333	.021
	TI	.388	.122	.221	3.192	.002

a. Dependent Variable: BI_ICT4SF1

The coefficients values are used in testing the hypotheses of this study. Table 4.3 provides information to predict dependent variable (BI_ICT4SF1) from independent variable (TI, PE, SV, PV, FC, and EE), as well as to determine whether independent variable (TI, PE, SV, PV, FC, and EE) contribute statistically significantly to the model. The standardized coefficients (i.e. sig column) is used to determine the statistical significant. If the significance level is greater than 0.05, the independent variable is not statistically significant, whereas values less than 0.05 are statistically significant. The regression equation is presented as: BI_ICT4SF1 = 0.376*PE + 0.356*FC - 0.252*PV - 0.231*SV + 0.388*TI.

4.3.4 Model summary for BI-ICT4SF2

Table 4.4: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.708[a]	.501	.480	.617

a. Predictors: (Constant), TI, PE, SV, PV, FC, EE

The model summary (Table 4.4) provides the R, R square, adjusted square and std. error of the estimate. The R value represents the simple correlation (0.708), which indicates a high degree of correlation (strong positive relationship). The R square value indicates how much of the total variation in the dependent variable (BI_ICT4SF2), can be explained by the independent variables (TI, PE, SV, PV and EE). Table 4.4 indicates that 50.1% of total variation in behavioral intention toward ICT for sustainable farming (BI-ICT4SF2) is explained by TI, PE, SV, FC and EE, which is moderate.

4.3.5 ANOVA for BI-ICT4SF2

Table 4.5: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	54.820	6	9.137	23.967	.000[b]
	Residual	54.514	143	.381		
	Total	109.333	149			

a. Dependent Variable: BI_ICT4SF2

b. Predictors: (Constant), TI, PE, SV, PV, FC, EE

The Table 4.5 presents ANOVA results for the dependent variable (BI_ICT4SF2) which report how well the regression equation fits the data (i.e., predicts the dependent variable). It indicates that the regression model predicts the dependent variable significantly well, i.e. P = 0.000. Table 4.5 indicates that the independent variables were statistically significant in predicting the dependent variable, with an F-ratio value of 23.967.

4.3.6 Coefficients for BI_ICT4SF2

Table 4.6: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	.200	.508		.395	.694
	PE	.406	.135	.251	3.017	.003
	EE	.195	.135	.127	1.451	.149
	FC	.297	.082	.274	3.617	.000
	PV	-.194	.062	-.216	-3.117	.002
	SV	-.261	.115	-.155	-2.274	.024
	TI	.316	.141	.173	2.246	.026

a. Dependent Variable: BI_ICT4SF2

The Coefficients table (Table 4.6) provides information to predict dependent variable (BI_ICT4SF2) from independent variable (TI, PE, SV, PV, FC, and EE), as well as to determine whether independent variable (TI, PE, SV, PV, FC, and EE) contribute statistically significantly to the model. Table 4.6 shows that construct variables, PE, FC, PV, SV and TI were statistically significant. Thus, the regression equation is presented as: BI_ICT4SF2 = 0.406*PE + 0.297*FC - 0.194*PV - 0.261*SV + 0.316*TI.

4.3.7 Model summary for BI_ICT4SF3

Table 4.7: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.780[a]	.608	.591	.539

a. Predictors: (Constant), TI, PE, SV, PV, FC, EE

Table 4.7 presents the model summary for the dependent variable BI_ICT4SF3. The R value (0.780), indicates a high degree of correlation (strong positive relationship). Table 4.7 indicates that 60.8% of total variation in behavioral intention toward ICT for sustainable farming (BI_ICT4SF3) is explained by TI, PE, SV, FC and EE, which is high.

4.3.8 ANOVA for BI_ICT4SF3

Table 4.8: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	64.346	6	10.724	36.930	.000[b]
	Residual	41.527	143	.290		
	Total	105.873	149			

a. Dependent Variable: BI_ICT4SF3

b. Predictors: (Constant), TI, PE, SV, PV, FC, EE

Table 4.8 presents ANOVA results for the dependent variable BI_ICT4SF3. Table 4.8 indicates that the independent variables were statistically significant in predicting the dependent variable, with F-ratio value of 36.930 and p = 0.000 which is a good fit for the data.

4.3.9 Coefficients for BI_ICT4SF3

Table 4.9: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	T	Sig.
1	(Constant)	.500	.443		1.129	.261
	PE	.259	.117	.163	2.209	.029
	EE	.120	.117	.079	1.025	.307
	FC	.313	.072	.293	4.356	.000
	PV	-.287	.054	-.325	-5.286	.000
	SV	-.234	.100	-.142	-2.338	.021
	TI	.505	.123	.282	4.114	.000

a. Dependent Variable: BI_ICT4SF3

Table 4.9 presents the Coefficients values that predicts the dependent variable (BI_ICT4SF3) to the results also determine whether the independent variable (TI, PE, SV, PV, FC, and EE) contribute statistically significantly to the model. Variable TI, PE, SV, PV and FC were statistically significant in explaining the dependent variable (BI_ICT4SF3). The regression equation is presented as: BI_ICT4SF3 = 0.259*PE + 0.313*FC - 0.287*PV - 0.233*SV + 0.505*TI.

4.3.10 Model summary for UB_ICT4SF1

Table 4.10: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.847[a]	.718	.712	.46847
a. Predictors: (Constant), BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1				

The model summary (Table 4.10) shows an R value of 0.847, which indicates a high degree of correlation (strong positive relationship). The R square value indicates how much of the total variation in the dependent variable (UB_ICT4SF1), can be explained by the independent variables (BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1). Table 4.10 indicates that 71.8% of total variation in behavioral intention toward ICT for sustainable farming (UB_ICT4SF1) is explained by BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1, which is high.

4.3.11 ANOVA for UB_ICT4SF1

Table 4.11: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	81.451	3	27.150	123.711	.000[b]
	Residual	32.042	146	.219		
	Total	113.493	149			
a. Dependent Variable: UB_ICT4SF1						
b. Predictors: (Constant), BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1						

Table 4.11 indicates that the independent variables were statistically significant in predicting the dependent variable with an F-ratio value of 123.711, statistically significant, i.e. p =0.000 which is a good fit for the data.

4.3.12 Coefficients for UB_ICT4SF1

Table 4.12: Coefficients

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.081	.100		.815	.417
	BI_ICT4SF1	.171	.098	.161	1.740	.084
	BI_ICT4SF2	.165	.087	.162	1.896	.060
	BI_ICT4SF3	.579	.107	.559	5.395	.000
a. Dependent Variable: UB_ICT4SF1						

Table 4.12 shows that only the variable BI_ICT4SF3 was statistically significant with a p = 0.000. The regression equation is presented as: UB_ICT4SF1= 0.579*BI_ICT4SF3.

4.3.13 Model summary for UB_ICT4SF2

Table 4.13: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.803[a]	.645	.638	.53005

a. Predictors: (Constant), BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1							

Table 4.13 provides the R, R Square, adjusted square and std. error of the estimate. The R value represents the simple correlation (0.803), which indicates a high degree of correlation (strong positive relationship). The R square value indicates how much of the total variation in the dependent variable (UB_ICT4SF2), can be explained by the independent variables (BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1). Table 4.13 indicates that 64.5% of total variation in behavioral intention toward ICT for sustainable farming (UB_ICT4SF2) is explained by BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1, which is high.

4.3.14 ANOVA for UB_ICT4SF2

Table 4.14: ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	74.482	3	24.827	88.369	.000[b]
	Residual	41.018	146	.281		
	Total	115.500	149			
a. Dependent Variable: UB_ICT4SF2						
b. Predictors: (Constant), BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1						

Table 4.14 presents ANOVA results indicating that the independent variables were statistically significant in predicting the dependent variable, i.e. F-ratio is 88.369 and p = 0.000 which is a good fit for the data.

4.3.15 Coefficients for UB_ICT4SF2

Table 4.15: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.249	.113		2.210	.029
	BI_ICT4SF1	-.020	.111	-.019	-.184	.854
	BI_ICT4SF2	.248	.099	.241	2.513	.013
	BI_ICT4SF3	.633	.121	.606	5.211	.000
a. Dependent Variable: UB_ICT4SF2						

Table 4.15 presents the coefficients values that predicts the dependent variable (UB_ICT4SF2) from independent variable (BI_ICT4SF3, BI_ICT4SF2 and BI_ICT4SF1). The results establish whether the independent variables (BI_ICT4SF3, BI_ICT4SF2 and BI_ICT4SF1) contribute statistically significantly in explaining the model. The standardized coefficients on the sig column is used to determine the statistical significant. If the significance level is greater than 0.05, the independent variable is not statistically significant but if is less than 0.05 the independent variable is statistically significant. The regression equation is presented as: UB_ICT4SF2= 0.248*BI_ICT4SF + 0.633* BI_ICT4SF3.

4.3.16 Model summary for UB_ICT4SF3

Table 4.16: Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.615[a]	.379	.366	.98395
a. Predictors: (Constant), BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1				

Table 4.16 shows an R value of 0.615 which indicates a high degree of correlation (strong positive relationship). Table 4.13 indicates that 37.9% of total variation in behavioral intention toward ICT for sustainable farming (UB_ICT4SF3) is explained by BI_ICT4SF3, BI_ICT4SF2, and BI_ICT4SF1, which demonstrate a low correlation (Karch & Van Ravenzwaaij, 2020).

4.3.17 ANOVA for UB_ICT4SF3

Table 4.17: ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	86.150	3	28.717	29.661	.000[b]
	Residual	141.350	146	.968		
	Total	227.500	149			
a. Dependent Variable: UB_ICT4SF3						
b. Predictors: (Constant), BI_ICT4SF3, BI_ICT4SF2, BI_ICT4SF1						

Table 4.17 presents ANOVA results for the UB_ICT4SF3 dependent variable. It indicates that the independent variables were statistically significant in predicting the dependent variable, i.e. with an F-ratio value of 29.661 which is statistically significant, i.e. p = 0.000 which is a good fit for the data.

4.3.18 Coefficients for UB_ICT4SF3

Table 4.18: Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.902	.209		28.223	.000
	BI_ICT4SF1	-.132	.206	-.088	-.639	.524
	BI_ICT4SF2	-.273	.183	-.189	-1.491	.138
	BI_ICT4SF3	-.538	.225	-.367	-2.387	.018
a. Dependent Variable: UB_ICT4SF3						

The Coefficients table (Table 4.18) shows that all the two-independent variables (BI_ICT4SF2; β = - .088 and p = 0.524 and BI_ICT4SF1; β = -.189 and p = 0.138) were not statistically significant in explaining the dependent variable (UB_ICT4SF3). The regression equation is presented as: UB_ICT4SF3= 0.018*BI_ICT4SF3.

Table 4.19 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate

1	.700[a]	.491	.469	.636
a. Predictors: (Constant), TI, PE, SV, PV, FC, EE				

The model summary (Table 4.19) shows an R square value of 0.700, indicating how much of the total variation in the dependent variable (UB_ICT4SF1), can be explained by the independent variables (TI, PE, SV, PV and EE). Table 4.19 indicates that 49.1% of total variation in behavioral intention toward ICT for sustainable farming (UB_ICT4SF1) is explained by TI, PE, SV, FC and EE, which shows a low correlation.

Table 4.20 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	55.672	6	9.279	22.948	.000[b]
	Residual	57.821	143	.404		
	Total	113.493	149			
a. Dependent Variable: UB_ICT4SF1						
b. Predictors: (Constant), TI, PE, SV, PV, FC, EE						

The ANOVA results for the dependent variable: UB_ICT4SF1 (Table 4.20) reports how well the regression equation fits the data (i.e., predicts the dependent variable). It indicates that the regression model predicts the dependent variable significantly well as demonstrated by an F-ratio of 22.948 and p = 0.000; thus a good fit for the data.

Table 4.21 Coefficients

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	T	Sig.
1	(Constant)	.682	.523		1.305	.194
	PE	.155	.139	.094	1.118	.265
	EE	.170	.139	.108	1.227	.222
	FC	.348	.085	.314	4.104	.000
	PV	-.281	.064	-.308	-4.391	.000
	SV	-.239	.118	-.139	-2.022	.045
	TI	.389	.145	.209	2.682	.008
a. Dependent Variable: UB_ICT4SF1						

Table 4.21 shows the results for the dependent variable (UB_ICT4SF1) against its predictor variables, i.e. (TI, PE, SV, PV, FC, and EE). Only FC, PV, SV and TI were statistically significant in explaining UB_ICT4SF1. Thus, the regression equation is presented as: UB_ICT4SF1 = 0.348*FC - 0.281*PV - 0.239*SV + 0.389*TI.

Table 4.22 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.699[a]	.488	.467	.643
a. Predictors: (Constant), TI, PE, SV, PV, FC, EE				

The model summary (Table 4.22) shows an R square value 0.699, which indicates a high degree of correlation (strong positive relationship). Furthermore, Table 4.22 indicates that 48.8% of total variation in behavioral intention toward ICT for sustainable farming (UB_ICT4SF2) is explained by TI, PE, SV, FC and EE, which is low.

Table 4.23 ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	56.398	6	9.400	22.743	.000[b]
	Residual	59.102	143	.413		
	Total	115.500	149			

a. Dependent Variable: UB_ICT4SF2

b. Predictors: (Constant), TI, PE, SV, PV, FC, EE

The ANOVA results for the dependent variable (UB_ICT4SF2) indicates that the independent variable were statistically significantly in predicting the dependent variable, with an F-ratio value of 22.743 and p = 0.000 which is a good fit for the data.

Table 4.24 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	.026	.529		.049	.961
	PE	.068	.140	.041	.488	.626
	EE	.280	.140	.177	2.001	.047
	FC	.214	.086	.192	2.504	.013
	PV	-.243	.065	-.263	-3.750	.000
	SV	.074	.120	.043	.623	.534
	TI	.452	.147	.241	3.086	.002
a. Dependent Variable: UB_ICT4SF2						

Table 4.24 provides information on the dependent variable (UB_ICT4SF2). EE, FC, PV and TI were statistically significant in explaining the dependent variable: UB_ICT4SF2. The regression equation is presented as: UB_ICT4SF2 = 0.280*EE + 0.214*FC - 0.243*PV + .452*TI.

Table 4.25 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.603[a]	.363	.336	1.007
a. Predictors: (Constant), TI, PE, SV, PV, FC, EE				

Table 4.25 provides the model summary, i.e. R, R square, adjusted square and std. error of the estimate. The R value 0.603 was obtained and indicates a high degree of correlation (strong

positive relationship). Table 4.25 indicates that 36.3% of total variation in behavioral intention toward ICT for sustainable farming (UB_ICT4SF3) is explained by TI, PE, SV, FC and EE, which is very low.

Table 4.26 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	82.629	6	13.771	13.594	.000[b]
	Residual	144.871	143	1.013		
	Total	227.500	149			
a. Dependent Variable: UB_ICT4SF3						
b. Predictors: (Constant), TI, PE, SV, PV, FC, EE						

Table 4.26 presents the ANOVA value for the dependent variable UB_ICT4SF3. Table 4.26 indicates that the independent variables were statistically significant in predicting the dependent variable, with an F-ratio value of 13.594 and p = 0.000 which is a good fit for the data.

Table 4.27 Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
		B	Std. Error	Beta		
1	(Constant)	2.736	.828		3.306	.001
	PE	-.484	.219	-.208	-2.206	.029

	EE	-.075	.219	-.034	-.341	.734
	FC	.018	.134	.011	.134	.893
	PV	.649	.101	.502	6.403	.000
	SV	-.068	.187	-.028	-.362	.718
	TI	.165	.229	.063	.718	.474
a. Dependent Variable: UB_ICT4SF3						

The Coefficients table (Table 4.27) for the UB_ICT4SF3 dependent variable. PE and PV contribute statistically significantly to the model. The regression equation is presented as: UB_ICT4SF3 = 2.736 - 0.484*PE + 0.649*PV.

4.4 Hypotheses Testing

4.4.1 Hypotheses 1

Based on the proposed conceptual model for this study (Figure 2.15), the following hypotheses were formulated:

$H1_0$: *Performance Expectancy (PE) does not have influence on behavioral intention toward ICT for Sustainable Farming (BI-ICT4SF).*

$H1_A$: *Performance Expectancy (PE) has influence on (BI-ICT4SF).*

Table 4.28: Performance Expectancy

Independent variables	B	R	R-square	P
PE1	0.376	0.774	0.599	0.002
PE2	0.406	0.708	0.501	0.003
PE3	0.259	0.780	0.608	0.029

The hypothesis tested the relationship between PE and BI-ICT4SF. The results show that all p-values were less than 0.05. The data indicates that Performance Expectancy (PE) has influence on (BI-ICT4SF). Therefore, the $H1_A$ is accepted and $H1_0$ rejected.

4.4.2 Hypotheses 2

$H2_0$: Effort Expectancy (EE) does not have influence on (BI-ICT4SF).

$H2_A$: Effort Expectancy (EE) has influence on (BI-ICT4SF).

Table 4.29: Effort Expectancy

Independent variables	B	R	R-square	P
EE1	0.057	0.774	0.599	0.623
EE2	0.195	0.708	0.501	0.149
EE3	0.120	0.780	0.608	0.307

Hypothesis H2 tested the relationship between EE and BI-ICT4SF. The results show that p-values were all greater than 0.05. The data indicates that Effort Expectancy (EE) does not have influence on (BI-ICT4SF). Therefore**,** the null hypothesis ($H2_0$) was accepted, while the alternative hypothesis ($H2_A$) was rejected.

4.4.3 Hypotheses 3

$H3_0$: Facilitating Condition (FC) does not have influence on (BI-ICT4SF).

$H3_A$: Facilitating Condition (FC) has influence on (BI-ICT4SF).

Table 4.30: Facilitating Condition

Independent variables	B	R	R-square	P
FC1	0.356	0.774	0.599	0.000
FC2	0.297	0.708	0.501	0.000
FC3	0.313	0.780	0.608	0.000

The relationship between FC and BI-ICT4SF was tested by the H3 null hypothesis. The results show that all p-values were less than 0.05. The data indicates that Facilitating Condition (FC) has influence on (BI-ICT4SF). Therefore, the null hypothesis ($H3_0$) was rejected, while the alternative hypothesis ($H3_A$) was accepted.

4.4.4 Hypotheses 4

$H4_0$: Price Value (PV) does not have influence on (BI-ICT4SF).

$H4_A$: Price Value (PV) has influence on (BI-ICT4SF).

Table 4.31: Price Value

Independent variables	B	R	R-square	P
PV1	-0.252	0.774	0.599	0.000
PV2	-0.194	0.708	0.501	0.002
PV3	-0.287	0.780	0.608	0.000

Hypothesis H4 tested the relationship between PV and BI-ICT4SF. The results show that all p-values were less than 0.05. The data indicates that Price Value (PV) has influence on (BI-ICT4SF).

Therefore, the null hypothesis ($H4_0$) was rejected, while the alternative hypothesis ($H4_A$) was accepted.

4.4.5 Hypotheses 5

$H5_0$: Socio-cultural value (SC) does not have influence on (BI-ICT4SF).

$H5_A$: Socio-cultural value (SC) has influence on (BI-ICT4SF).

Table 4.32: Socio-cultural value

Independent variables	B	R	R-square	P
SV1	-0.231	0.774	0.599	0.021
SV2	-0.261	0.708	0.501	0.024
SV3	-0.234	0.780	0.608	0.021

Hypothesis H5 tested the relationship between SV and BI-ICT4SF. The results show that all p-values were less than 0.05. The data indicates that Socio-cultural value (SC) has influence on (BI-ICT4SF).

Therefore, the null hypothesis ($H5_0$) was rejected, while the alternative hypothesis ($H5_A$) was accepted.

4.4.6 Hypotheses 6

$H6_0$: Technical Information (TI) does not have influence on (BI-ICT4SF).

$H6_A$: Technical Information (TI) has influence on (BI-ICT4SF).

Table 4.33: Technical Information

Independent variables	B	R	R-square	P
TI1	0.388	0.774	0.599	0.002
TI2	0.316	0.708	0.501	0.026
TI3	0.505	0.780	0.608	0.000

The null hypothesis H6 tested the relationship between TI and BI-ICT4SF. The results show that all p-values were less than 0.05. This indicates that Technical Information (TI) has influence on (BI-ICT4SF).

Therefore, the null hypothesis ($H6_0$) was rejected, while the alternative hypothesis ($H6_A$) was accepted.

4.4.7 Hypotheses 7

H7$_0$: Behavioral Intention toward ICT for sustainable farming (BI-ICT4SF) does not have influence on Use Behavior of ICT for sustainable farming (UB-ICT4SF).

H7$_A$: Behavioral Intention toward ICT for sustainable farming (BI-ICT4SF) has influence on Use Behavior of ICT for sustainable farming (UB-ICT4SF).

Table 4.34: Behavioral Intention toward ICT for sustainable farming

Independent variables	B	R	R-square	P
BI_ICT4SF1	0.579	0.847[a]	0.718	0.000
BI_ICT4SF2	0.248	0.803[a]	0.645	0.013
BI_ICT4SF3	0.633	0.803[a]	0.645	0.000

The null hypothesis H7 tested the relationship between BI-ICT4SF and UB-ICT4SF. Based on the analysed results from UB_ICT4SF1 to UB_ICT4SF3. The results show that all p-values were less than 0.05. The data indicates that Behavioral Intention toward ICT for sustainable farming (BI-ICT4SF) has influence on Use Behavior of ICT for sustainable farming (UB-ICT4SF) in the context or rural farmers in the Limpopo Province.

Therefore, the null hypothesis (H7$_0$) was rejected, while the alternative hypothesis (H7$_A$) was accepted.

4.5 Correlation matrix

Table 4.35 Correlation matrix

	PE	EE	FC	PV	SV	TI	BI_ICT4SF1	BI_ICT4SF2	BI_ICT4SF3	UB_ICT4SF1	UB_ICT4SF2	UB_ICT4SF3
PE	1.00	0.52	0.43	-0.33	0.30	0.34	0.53	0.50	0.47	0.42	0.44	-0.32
EE	0.52	1.00	0.40	-0.31	0.34	0.28	0.46	0.48	0.48	0.43	0.46	-0.27
FC	0.43	0.40	1.00	-0.21	0.31	0.41	0.56	0.48	0.53	0.47	0.44	-0.19
PV	-0.33	-0.31	-0.21	1.00	-0.23	-0.36	-0.50	-0.41	-0.55	-0.48	-0.47	0.56
SV	0.30	0.34	0.31	-0.23	1.00	0.28	0.23	0.19	0.25	0.23	0.35	-0.19
TI	0.34	0.28	0.41	-0.36	0.28	1.00	0.53	0.46	0.52	0.46	0.48	-0.20
BI_ICT4SF1	0.53	0.46	0.56	-0.50	0.23	0.53	1.00	0.80	0.87	0.78	0.70	-0.56
BI_ICT4SF2	0.50	0.48	0.48	-0.41	0.19	0.46	0.80	1.00	0.85	0.77	0.74	-0.57
BI_ICT4SF3	0.47	0.48	0.53	-0.55	0.25	0.52	0.87	0.85	1.00	0.84	0.79	-0.60
UB_ICT4SF1	0.42	0.43	0.47	-0.48	0.23	0.46	0.78	0.77	0.84	1.00	0.85	-0.64
UB_ICT4SF2	0.44	0.46	0.44	-0.47	0.35	0.48	0.70	0.74	0.79	0.85	1.00	-0.65
UB_ICT4SF3	-0.32	-0.27	-0.19	0.56	-0.19	-0.20	-0.56	-0.57	-0.60	-0.64	-0.65	1.00

The correlation Table 4.35 presents the association between variables (Kafle, 2019). In this study, correlation between PE and EE was (0.52) which is moderately and positively correlated. The correlation between PE and UB_ICT4SF3 was (-0.32) weak negative correlation, which implies that high levels of PE are associated with low level of UB_ICT4SF3. The correlation between EE and BI_ICT4SF1 was (0.46) which is weak positive. FC and UB_ICT4SF2 is a weak positive correlation which implies that high level of FC is associated with high level of UB_ICT4SF2. PV and FC value was (-0.21) which is very weakly and negatively correlated. The correlation between SV and PE was (0.30), which implies weak positive correlation. TI and UB_ICT4SF3 was (0.52) which implies moderate positive correlation. BI_ICT4SF1 and UB_ICT4SF2 was (0.70), demonstrating a strong positive correlation. The correlation between BI_ICT4SF2 and TI was weak positive, which implies that an increase in BI_ICT4SF2 was associated with an increase in TI. The correlation between UB_ICT4SF3 and BI_ICT4SF3 was (-0.60), thus, showing a moderate and negative correlation.

4.6 Chapter summary

The chapter focused on the analysis and interpretation of data. Data was collected using questionnaires. Seventy-five questionnaires were distributed to Tshakhuma small-scale farmers while another seventy-five questionnaires were distributed to Matangari small-scale farmers. Quantitative data were coded using the IBM SPSS version 28. Hypotheses were tested using regression analysis. The next chapter (5), presents the qualitative data analysis.

CHAPTER FIVE: THEMATIC ANALYSIS

5. Introduction

This chapter presents the interview results. Face-to-face semi-structured interviews were conducted to collect data. The findings thematically analyzed and presented. The themes were derived from the interview questions.

5. 1 Themes for the study

Thematic analysis involves the selection of codes and formulation of themes for analyzing qualitative (interview) data (Kiger & Varpio, 2020). In this section, the themes and sub-themes for the study are outlined (see Table 5.1).

Table 5.1 Themes and Sub-themes

Theme	**Sub-themes**
Theme 1: ICTs	1.1 Platform used to access farming information 1.2 ICT training 1.3 Farming information accessed through ICTs
Theme 2: Benefits of ICT	1.4 Improving sustainable farming
Theme 3: Challenges of ICT	1.5 Challenges in agricultural sector

The next section discusses theme 1: ICTs, which consist of three sub-themes; *platform used to access farming information, ICT training and farming information accessed through ICT.*

5.2 ICT channels

There are various types of ICTs that are used by small scale farmers when accessing farming information. The findings of this study revealed that most respondents have used smartphone to access farming information. The findings of the study by Fosu and Van Greunen, (2020) revealed that all farmers have used mobile phone to access farming information. The findings are expressed by the respondents' comments below:

"I believe smartphone is the best ICT channel that allows farmers to access latest farming information 24/7. I have used smartphone to access daily weather report." (Respondent 1).

"Using smartphone I was able to download Agri Assistant app which helped me to access latest agricultural news and pest & disease control." (Respondent 2).

"I find it very useful to access farming information through smartphone because I can download any farming app that I want. The good thing about accessing farming information through mobile app is that, farming information on app is continuously updated and accessible 24/7." (Respondent 3).

Nowadays, smartphone is no longer used for social media only, but also used as a digital device for accessing farming information (Chhachhar, Qureshi, Khushk & Maher, 2014). Farmers are increasingly using smartphones as both a source of information and a tool to obtain information on farming to make better decision (Dharanipriya & Karthikeyan, 2019). These sentiments are supported by the respondents' comments below:

"I prefer to use smartphone compared to other ICTs because I am a person who spend a lot of time in my farm, so I do not have time to sit down and watch farming programmes on television. I have used smartphone to access farming information." (Respondent 4).

"I have used smartphone because I wanted to access daily farming information through Rolfe's agri app. I did not want to access farming information through radio and TV, because the farming information programmes on radio and TV are not broadcasted every day." (Respondent 5).

"With the use of smartphone, I am able to access latest farming information through the mobile app. The mobile app that I use send me daily notification about the weather report, so this helps me to plan my daily farming activities." (Respondent 6).

"I access farming information through smartphone because if I am experiencing any problem on my crops, I use my smartphone to check for solution from google and farming mobile app." (Respondent 8).

The radio is more accessible than smartphone, being less expensive to purchase and maintain, requiring no electricity other than batteries, while the best thing about watching TV is that you can see images that are expressly designed to provide farming information (Braimok, 2017). Furthermore, farmers now have a new option of watching various farming shows on several channels (Chhachhar, Qureshi, Khushk & Ahmed, 2014). In line with this, respondent 7 indicated that:

"I access farming information through radio and TV because radio and TV broadcast farming programs in my home language, which made it simple for me to understand."

5.2.1 Platform used to access farming information

This study found that small scale farmers used mobile apps, radio, TV and internet as their major platforms for accessing farming information. This study is in-line with Eskia (2019) who found that famers uses mobile phone, radio, TV and internet as their ICT sources of information. The results of this study revealed that most of the respondents use mobile app in accessing farming information.

The internet is a powerful platform for encouraging and facilitating exchange of information for farmers (Mbagwu, Benson & Onuoha, 2017). Respondents' perceptions and lived experience regarding the use of internet as an ICT source of farming information were indicated below:

"I believe that I will be able to find an answer to any query I pose on the internet. I access my farming information through internet because it enables me to access latest farming information." (Respondent 1).

Mobile phones have become a new compact and inexpensive resource for obtaining various types of farming information on marketing strategies (Chhachhar & Hassan, 2013). Similar sentiments were expressed by the respondents during interviews as indicated below:

"I think the use of mobile app in accessing farming information helps farmers to be always updated about any news which is related to the farming. I have used Agri Assistant app to access latest agricultural news, daily weather report, soil type and pest & disease control." (Respondent 2).

"I find it very useful to access farming information through Agtag mobile app because the farming information on app is continuously updated and accessible 24/7." (Respondent 3).

"Using OneSoil scouting mobile app, I find it very easy to check the five days' weather report and to know the amount of fertilizer to use on my crops." (Respondent 4).

Respondent 5 emphasized that mobile apps provide timely and updated information on the amount of fertilizer to use on their crops as indicated below:

"I prefer smartphone in accessing farming information than radio and TV. With the use of Rolfe's agri app I have managed to access latest information about fertilizer, fungicides, seed treatment, insecticides and soil conditioners."

"Through the use of smartphone, I find it easy to access farming information on google by checking latest pest & disease control, learn more about the soil type and access seven days' weather report." (Respondent 6).

Radio and television were found to be the most effective means of scientific information dissemination to most of farmers, as they quickly transfer latest farming methods to both literate and illiterate farmers in remote places (Vijayakumar, 2017). Comment from respondents with regards to use of radio and TV as source of farming information include the following:

"I think accessing farming information through radio & TV is better compared to other ICT channels. I listen to farming programmes on radio and watch farming programmes on TV." (Respondent 7).

Respondent 8 indicated that:

"I find it very useful to access fertilizer information through fertilizer blend calculator app. I have managed to calculate amount of fertilizer to use on my crops."

5.2.2 ICT training

Government provides ICT training for small-scale farmers across South Africa (Mbatha & Masuku, 2018). Findings of this study concurs with findings of Mamun-ur-Rashid (2020) who established that 11.7% of respondents received ICT training, while 88.3 % did not. These findings are supported by the following comments from the respondents:

"I was one of the few privileged farmers to attended ICT training provided by the local government. During ICT training I have learned on how to use smartphone in accessing farming information through google." (Respondent 1).

Respondent 8 emphasized on having attended government funded ICT training as follows:

"I have attended ICT training from the government and learnt how to use ICT in accessing farming information. I have also learnt how to use latest technologies like drone, which is used to spray chemical on crops."

The findings of this study revealed that most of the respondents did not attend ICT training. This can be supported by the following comments from the respondents:

"I did not attend the ICT training, because I have experience in using mobile app to access latest farming information." (Respondent 2).

"I did not attend the ICT training, because I know how to use ICT in accessing farming information and I also know the latest technologies which are used in farming." (Respondent 3).

Respondent 4 indicated that:

"I believe the people who are supposed to attend the ICT training from the local government are those who do not have experience in using ICT in accessing farming information. I did not attend any ICT training, because I know how to use mobile app in accessing farming information and I have experience in using latest technologies which are used in farming like drone."

Respondent 5 emphasized that people who are supposed to attend ICT training are those that do not have experience on how to use ICTs:

"I think ICT training is meant for those farmers without experience in using ICT in accessing farming information."

Respondent 6 indicated that:

"I did not attend any ICT training from the local government. I have a friend who taught me how to access farming information through mobile app."

Respondent 7 indicated that:

"I believe ICT training is meant to help farmers on how to use ICT. I did not attend any ICT training because I have experience in using ICT in accessing farming information."

5.2.3 Farming information accessed through ICT channels

Small-scale farmers accessed various types of farming information through ICTs to achieve good harvest. The use of ICTs to disseminate information about seeds, cultivars and their sources, as well as information on other farm-production, has a lot of potential (Kiambi, 2018). Farmers may benefit from real-time weather predictions and early warning information to avoid disaster and support them in making informed decisions on climate change adaption (Hussain, 2015). Comments from the respondents with regards to accessing real-time weather forecasts include:

"I believe that checking weather helps the farmers to plan for the day-to-day activities. I have accessed 7 days weather report through my smartphone." (Respondent 1).

"I have accessed weather report through the Agri assistant mobile app. checking daily weather report helps me to know when to plant or harvest." (Respondent 2).

"Checking a weather report helps to plan a day-to-day activity. I have accessed daily weather report through my smartphone, this helps me to avoid spraying chemical in my crops during rainy days." (Respondent 6).

The findings of a study by Kiptum (2016) suggest that most of the participants (54.9%) stated that soil improvement is the type of farming information they would want to obtain to enhance their production. These findings were supported by respondent 3 who indicated the following:

"I think it is very much important to know the soil type before planting crops, it helps to produce fresh crops. I have checked the soil type through the mobile app."

The findings of a study by Kiptum (2016) indicated that the types of farming information accessed by farmers are pest management, use of fertilizer, soil improvement, market price, insecticide and weather. These findings were supported by respondents as indicated below:

"I believe fertilizer helps the crops to grow faster. I have accessed information about the various types of fertilizer which are used for sweet potato through the mobile app." (Respondent 4).

"Crops they need to be maintained at all the times. I have accessed the type of fungicides to be used on my crops through the mobile app." (Respondent 5).

"Fungicides helps to destroy fungus on crops. I have accessed information about fungicides through listening to radio and watching on television." (Respondent 7).

"I have accessed the type of fertilizer to use on my crop through the mobile app. I keep on checking the latest type of fertilizer so that I can be able to maintain my crops." (Respondent 8).

The following section will discuss theme 2: Benefits of ICT, which consist of one sub-theme; *Use of ICT in improving sustainable farming.*

5.3 Benefits of ICT

The use of ICTs benefited most farmers in accessing farming information. According to the farmers, the most notable benefit of ICTs was that it enhanced their farming by cutting total costs and increasing their income (Braimok, 2017). The findings of this study revealed that majority of small-scale farmers have benefited from using ICT in accessing latest farming information. Farmers' knowledge and information are the most significant aspects in making agricultural decisions about marketing, financing and production, smartphone have played a key role in this regard (Chhachhar & Memon, 2019). The comments from the respondents are indicated below:

"Using smartphone helps me to access latest weather report. Using ICT, I have gained the knowledge on the type of seed that I have to use when planting sweet potato, type of fertilizer that I have to use on my crops and amount of water that I have to use on my crops." (Respondent 1).

"The use of ICT keeps me informed about the weather and latest agricultural news. It helps me to determine the soil type, pest & disease control." (Respondent 2).

"Using the mobile app has enables me to stay up to date on soil type and amount of water to use on my crops at all times." (Respondent 3).

Farmers indicated that using ICTs, particularly radio and television, enabled them to acquire accurate information like weather forecasts and more spontaneous information on farming techniques in the field (Braimok, 2017). The findings are expressed by the respondents' comments below:

"The use of ICT makes it easier for me to keep track of seven days' weather forecast, this helps me to plan my day-to-day farming activities. It helps me to know the type of fertilizer to use on my crops." (Respondent 4).

"Using ICT has benefited me on maintaining my crops, it helps me to be updated on the type of fungicides and pesticides to use on my crops." (Respondent 5).

"I believe the use of ICTs in accessing farming information helps the farmers to maintain their crops because they access latest farming information like weather forecast. The use of ICT helps me to check the weather for the whole week." (Respondent 6).

"It helps me to check the weather report, know the type of fertilizer to use on my crops so that they can grow fast. It also helps me to be aware of the type of pesticides to use on my crops so that they can grow in good health." (Respondent 7).

"The use of ICT helps me to maintain my crops." (Respondent 8).

5.3.1 Use of ICT in improving sustainable farming

Farmers' access to market information, production inputs and market dynamics can all be improved with ICT, which has an impact on the quality and quantity of their output (Gaol & Gustira, 2020). The finding of this study revealed that farmers could improve their soil quality with the help of the ICT channels and sustain their crops. The use of mobile apps has benefited farmers in water management. This was supported by respondents' comments as indicated below:

"With the use of smartphone, I have gained experience of knowing amount of water to use on my crops, this helps my crops to grow faster." (Respondent 1).

"The use of mobile app helps me to maintain soil quality. It also helps me to know my soil type and type of fertilizer to use on my soil type. Knowing my soil type and type of fertilizer helps me to produce bigger sweet potato." (Respondent 2).

"The use of mobile app helps me to know my soil type and amount of water to use on my crops, this helps me to produce more sweet potato." (Respondent 3).

"Using ICT helps me to maintain my crops, know the type of fertilizer to use on my crops, this has helps me to produce fresh sweet potato." (Respondent 4).

The proper use of ICTs will benefit in enhancing farmers' access to information to improve agricultural productivity (Charles, Kyazze & Sseguya, 2015). Comments from the respondents regarding improving agricultural productivity indicated below:

"I believe knowing the soil type helps farmers to know the type of seed and fertilizer to use. Knowing the type of fertilizer, fungicides, seed treatment and insecticides has helped me to maintain my crops." (Respondent 5).

"The use of ICT helps me to maintain my soil quality and this helps me to produce fresh sweet potato." (Respondent 6).

"I believe accessing farming information through ICT channels helps me to maintain my crops." (Respondent 7).

"Knowing how much fertilizer to use on my crops helps me to maintain my crops at all times and produce more sweet potato." (Respondent 8).

The following section will discuss theme 3: Challenges of ICT, which consist of one sub-theme; *Challenges in agricultural sector*.

5.4 Challenges of ICT

The findings of this study revealed that respondents experienced challenges while accessing farming information through various ICTs. The results show that two respondents had a battery problem, three had lack of knowledge, while the other three experienced loss of signal whilst using ICT channels. Findings of this study concurs with findings of a study done by Lwesya and Kibambila (2017) which established that poor signals were one of the challenge farmers experienced. The findings of Ramavhale (2020) indicated that over 20% of small-scale farmers consider issues like low network access, especially in rural locations, to be negligible in their usage of ICT. These findings are supported by the following respondents' comments:

"There are advantages and disadvantages of using ICT in accessing farming information. I have experienced the loss of signal while using my smartphone in accessing farming information." (Respondent 1).

"Loss of signal is the problem that I have experienced while using radio and tv in accessing farming information, I think this is because where I am staying there are lot of mountain." (Respondent 7).

The findings of a study by Braimok (2017) established that mobile phone posed a problem of requiring frequent charging. These findings are expressed by the respondents' comments below:

"I believe when you are using smartphone for long time in accessing farming information, it makes the battery of phone to flat, and always charging a phone it can cause battery problem. My smartphone has a battery problem because I spend a lot of time checking for farming information like latest updates on types of fertilizer, pesticides to use on my crops." (Respondent 2).

"The use of smartphone to access farming information cause the battery to discharge more quickly, and the more I charge my smartphone the worse the situation becomes." (Respondent 6).

Most rural small scale farmers' ICT literacy is terribly poor, particularly in Africa they are uneducated and lack the abilities to use computer (Mbagwu, Benson & Onuoha, 2017). These sentiments were voiced by several interviewees:

"I think farmers who have experience in accessing latest update on farming information, they produce fresh and healthy sweet potato. My problem is that I lack knowledge on how to use mobile apps." (Respondent 3).

"I am experiencing the network problem while accessing farming information through mobile app, this problem sometimes makes me not to be able to access latest updates in farming." (Respondent 4).

"The problem I am experiencing while using mobile app in accessing farming information is that, I do not have enough knowledge on how to use the app." (Respondent 5).

"Is not everything that I know from the fertilizer blend calculator mobile app, this app it requires someone who have enough knowledge on how to use it, because if you do not have enough knowledge on how to use it, you may end up using more fertilizer in your crops." (Respondent 8).

5.4.1 Challenges in agricultural sector

Small-scale farmers in rural areas are still facing challenges in agricultural sector. A study by Mpandeli and Maponya (2014) revealed that small-scale farmers in Tshakhuma, Radali and Tshiombo face a variety of challenges, including insufficient access to productive resources, high costs of inputs, access to markets and transportation costs, all of which impede sustainable agriculture in the Vhembe district.

A study by Mutero, Munapo and Seaketso (2016) revealed that over 66 percent of farmers said that they funded farming enterprises with personal funds whereas 48 percent said they used both personal funds and government funds. Furthermore, the small-scale farmers from Tshakhuma, Radali and Tshiombo stated the high price of inputs (seeds, fertilizer and pesticides) as their major challenge (Mpandeli & Maponya, 2014). Similar sentiments were expressed by the respondents indicated below:

"I believe every small-scale farmer must use fertilizer and pesticides on their crops, because fertilizer enables the crops to grow faster, while pesticides helps to destroy insects in crops. I cannot afford to buy fertilizer and pesticides and I do not have any farming funds which assist me to maintain my crops." Respondent 1.

"Farming requires someone with money because there are lot of things that are required like seeds, fertilizer etc. I do not have access to any farming funds and this affect my farming activities because things like fertilizer are expensive and I cannot afford to buy fertilizer. " Respondent 2.

"There are different types of sweet potato seeds, some of the seeds are expensive while others are affordable. The more the seed price is high the more farmers can produce fresh sweet potato and the less the seed price, the less chance of producing fresh sweet potato. I cannot afford to buy the

expensive seed. I use the seed, which is not expensive, so the challenge is that sometimes if I can use it without adding fertilizer, it produces few sweet potato crops." Respondent 3.

Small-scale farmers are finding it challenging to compete in the current market environment, as they encounter significant physical barriers to market access (Baloyi, 2010). A study by Mutero (2016) revealed that 79 percent of small-scale farmers declared to purchase their goods at the farm gate, whereas 41 percent claimed to market through wholesalers and ten percent reported to sell to fruits and vegetable markets.

"I do not have access to market places, so I sell my sweet potato at home." Respondent 4.

The lack of availability to technology by small-scale farmers has a severe impact on their capacity to reach marketplaces locally, nationally and globally (Baloyi, 2010). Respondent 5 indicated that:

"I do not have access to sell my produce to big companies, so I sell my products near the road."

A study by Mutero, Munapo and Seaketso (2016) revealed that roughly 57% of respondents said their produce was picked up by customers, 28% said their produce did not require transportation, about 12% of small-scale farmers said they used paid transportation, while 4% said they used their personal vehicle. In line with this, the following respondents indicated that:

"I leave my produce under the table in my market because I do not have a transport to transport my produce." Respondent 6.

"I do not want to leave my produce in my market place, so I do not have any other plan of where I can put my produce. I have hired a boy to assist me with transportation, so every day he transports my produce from home to market then after work from marketplace to home. Transportation is a problem and is expensive." Respondent 7.

"I use my personal car every day to transport my produce from home to market, the challenge is the petrol money. Sometimes I use a wheelbarrow to transport my produce from home to market, but the problem is the distance." Respondent 8.

5.5 Chapter summary

The chapter focused on the qualitative data analysis. Data was collected using interviews. Four small-scale sweet potato farmers from Tshakhuma were interviewed, while four small-scale sweet potato farmers from Matangari village were also interviewed. Qualitative data was analyzed using thematic analysis. Themes and sub-themes were discussed.

The first theme that was discussed in this chapter is ICT channel. The respondents have used various types of ICT channels to access farming information. The mostly used ICT channel was smartphone, followed by radio and television. This theme had three sub-themes i.e., platform used to access farming information, ICT training and farming information accessed through ICT channels. The findings of the study show that most of the respondents relied on mobile app as their source of farming information. The results show that few respondents have attended ICT training while majority of respondents did not.

The second theme that was discussed is benefits of ICT, which highlighted the respondents' benefits on the use of ICTs. This theme had one sub-theme which is the use of ICT in improving sustainable farming. The third theme which was discussed is the challenges of ICT. The next chapter presents the conclusion of the study.

Chapter 6: Conclusion and Recommendation

6.1 Introduction

This chapter provides a summary of the research study, limitations of the study, the recommendations of the study and suggestions for the future research.

6.2 Aim of the study

As outlined in chapter 1, the aim of this study was to investigate the effects of factors affecting small-scale sweet potatoes farmers' behavioral intention and actual use behavior of ICTs for sustainable farming with an aim of proposing a framework for guiding these farmers to improve their farming practices in the Vhembe Rural District of Limpopo Province in South Africa. Seven hypotheses were formulated to accomplish the aim of the study. These factors are discussed next, in-line with findings of this study.

6.2.1 Performance expectancy

The study found that performance expectancy has a positive influence on behavioral intention toward ICT for sustainable farming. The study revealed that most of respondents indicated that the use of ICTs in accessing farming information enabled them to improve their sustainable farming. This finding is in line with findings of a study done by Henze and Ulrichs (2016) which indicated that agricultural apps enabled farmers to improve their productivity. A study by Angello (2017) indicated that small-scale farmers have benefited from various types of ICTs in accessing farming information and enhancing their farming production. Furthermore, a study done by Shemfe (2019) suggests that small-scale farmers use ICT since it improved their access to farming information and assisted them in making better decisions during transactions.

6.2.2 Effort expectancy

This study found that effort expectancy has a negative influence on behavioral intention toward ICT for sustainable farming. The findings of the study showed that most of respondents indicated that the use of farming mobile app in accessing farming information is not easy.

Some of respondents indicated that using farming mobile app in accessing latest farming information requires prior experience. This finding concurs with findings of a study done by Henze and Ulrichs (2016) which found that some of mobile apps users still require official exposure and training. Findings of a study done by Misaki, Apiola, Gaiani and Tedre (2018) suggest that the use of mobile phone in accessing farming information requires someone with high level of education and someone who understand foreign language like English. Furthermore, a study done by Hamad, Eltahir, Ali and Hamdan (2018) indicated accessing farming information through mobile phone requires someone who understands English. These findings concur with findings of this study, in which the majority of respondents stated that for most rural-based farmers, some form of training in using mobile apps is required for the effective use of such technologies for sustainable farming.

6.2.3 Facilitating condition

Facilitating condition had a positive significant influence on behavioral intention toward ICT for sustainable farming. The findings of the study revealed that some of respondents indicated that ICT training from government has enabled them to know how to use ICT channels in accessing farming information. This finding concurs with findings of a study done by Chauke (2016) which suggest that 54.55% of respondents agreed to have received some form of training in farming.

6.2.4 Price Value

Price value had a positive significant influence on behavioral intention toward ICT for sustainable farming. The study found that most of the respondents had access to ICTs. This finding is in-line with Shemfe (2019) who found that most of farmers had access to television, radio and mobile phone. Furthermore, a study by Sennuga, Conway and Sennuga (2020) indicated that most of respondents had access to mobile phone, radio and TV.

6.2.5 Socio-cultural value

The study found that socio-cultural value has a positive significant influence on behavioral intention toward ICT for sustainable farming. The findings of the study indicated that some respondents rely on mobile apps to access the latest farming information. Most respondents believed that farming information accessed through mobile apps enabled them to sustain their crops. The findings of a study by Shubhangi, Mane and Kulkarni (2019) concur with findings of this study; it established that farmers use mobile apps to access various information that aid with farm management, control and monitoring.

6.2.6 Technical information

The study found that technical information has a positive significant influence on behavioral intention toward ICT for sustainable farming. This finding concurs with findings of a study done by Mwakaje (2010) which suggests that the use of ICTs has positive effects on market access. Similarly, a study done by Sennuga, Conway and Sennuga (2020) indicated that access to ICT had a positive influence on the respondents' crop yields.

6.2.7 Behavioral intention toward ICT for sustainable farming

Behavioral intention toward ICT for sustainable farming had a positive significant influence on use behavior of ICT for sustainable farming. The study found that respondents had a positive attitude toward the use of ICTs in accessing farming information. This finding is in-line with a study by Nikhil (2019) which found that the majority of respondents (88.33%) had a positive attitude towards the use of ICT. Furthermore, findings of the study done by Lokeswari (2016) found that farmers had a positive attitude towards ICT.

6.3 Research Questions Revisited

6.3.1 How do small-scale farmers use ICTs in accessing farming information in Vhembe District?

In line with this research question, this study found that most of respondents use mobile phone to access latest farming information through mobile applications, while others use mobile phone to access information through Google. This research question was answered by the findings and concurs with findings of a study done by Makaula (2021) which established that small-scale farmers use mobile phone to access farming information and to communicate with customers and agricultural advisors. Few respondents access farming information through listening to radio, while others access farming information through watching farming programs on TV. This finding concurs with findings of a study done by Mburu (2013) which found that farmers use radio and TV to access farming information.

6.3.2 What are the challenges and benefits of using ICTs in small-scale sweet potatoes farming?

The findings of this study found that small scale farmers experienced many challenges, among others including the lack of knowledge, internet connectivity and network problems and language barriers. Most of respondents relied on mobile application to access farming information; however, they indicated that the lack of knowledge hinders them from accessing farming information through various types of mobile app, because most of them rely only on specific app like weather apps and agriculture assistant apps. Furthermore, respondents indicated that language barrier makes it difficult for them to understand some of the concepts in mobile apps. One of the challenges that small-scale sweet potato farmers face while accessing farming information through mobile apps is poor network problem/connectivity, while others indicated that network problems prevent them from accessing farming information through Google. Battery problem was one of the challenges that small scale farmers experienced while accessing farming information through mobile phone. Respondents indicated that the more they use their mobile phone in accessing farming information, the faster the battery died.

Few respondents who accessed farming information through radio indicated that the radio station that broadcasted the farming program occasionally lost signal, while others who depended on television indicated that television channel occasionally lost signal. Respondents who rely on radio for accessing farming information indicated that farming programs are not broadcasted every day, while others indicated that farming programs on radio are broadcasted early in the morning while they are still sleeping. The findings of this study is in line with findings of a study done by Ramavhale (2020) which found that farming programs on radio are broadcasted at unfavorable time.

Moreover, the findings of this study revealed that most of respondents rely on mobile applications in accessing latest farming information. Some of respondents indicated that some mobile apps enabled them to access farming information in one app. Few respondents show that they access farming information through television (TV) because it displays the images. Some respondents indicated that radio was their primary source of farming information because it broadcasted information in their home language. These findings concur with findings of a study done by Mburu (2013) which indicated that farmers with no formal education rely on radio when accessing farming information because farming programs were broadcasted in their home language.

6.3.3 Which ICTs are used by small-scale farmers in Vhembe District to access farming information?

The study found that most of respondents used mobile phone in accessing farming information. Respondents indicated that their mobile phones enabled them to download farming mobile apps, which helped them to access up-to-date farming information. The results showed that some of respondents rely on radio, while others rely on TV in accessing farming information. Few respondents used desktop to access farming information. This finding concurs with findings of a study done by Musa, Githeko and EI-Siddig (2013) which indicated that small-scale farmers rely on mobile phone, radio and TV as their source of farming information. A study done by Krell, Giroux, Guido, Hannah, Lopus, Caylor and Evans (2021) found that farmers often use mobile phone to access farming information. Furthermore, a study done by Mishra, Yadav, Dubey, Kumar and Mishra (2020) found that respondents have used mobile phone, radio and TV to access latest farming information.

6.3.4 What is the utilization levels of ICTs for sustainable farming by small-scale sweet potato farmers?

The findings of this study indicated that most of the respondents have used ICTs for more than four years in accessing farming information, while others indicated that they have been using ICTs for two to three years. The results indicated that some respondents have used ICTs for less than one year in accessing farming information. Few respondents indicated that they have used ICTs in accessing farming information for more than one year and less than two years. This finding concurs with findings of a study done by Khan, Qijie, Ali, Shahbaz and Shah (2019) which indicated that most of respondents have used mobile phone for more than 3 years. Furthermore, a study by Sobalaje and Adigun (2013) found that 38% of respondents have used ICTs for 1 to 2 years in accessing farming information, while 32% indicated that they have been using ICT for roughly 3 to 5 years in accessing farming information.

6.3.5 How can small-scale sweet potatoes farmers in Vhembe Rural District best use ICTs for sustainable farming?

This study found that most of the respondents rely on their mobile phone to access latest farming information. This finding concurs with findings of a study done by Misaki, Apiola, Gaiani and Tedre (2018) which indicated that the utilization of mobile phone in the crop agriculture production chain allows farmers to gain access to agricultural information that helps them make better decision and enhance crop yields. The results showed that using a mobile app to access farming information enabled them to maintain the quality of their crops and soil, while others indicated that using mobile app enabled them to know the type of fertilizer and pesticides to use on their crops and this information helped them to sustain their crops. This finding agrees with findings of a study done by Ali, Jabeen, Nikhitha and India (2016) which indicated that ICT improve farming production and market access. Furthermore, a study done by Sennuga, Conway and Sennuga (2020) found that ICT had a serious influence on the farming production and productivity of small-scale farmers.

The findings of this study revealed that some of respondents rely on radio to access farming information. The respondents indicated that they prefer to access farming information through listening to radio since radio broadcasts farming programs in their home language. A study done by Folitse, Osei, Dzandu and Obeng-Koranteng (2016) indicated that radio continues to be the most cost-effective tool of raising awareness and encouraging small-scale farmers to embrace innovative farming practices for long-term development and sustainability.

Latest farming technologies can help small-scale farmers to sustain their crops. Small scale farmers can rely on latest farming technologies like soil & water sensors, weather tracking and drone. Soil sensor can assist farmers in determining the quantity of water on their crops, while a drone can assist in spraying chemicals on the crops. This finding concurs with findings of a study done by Adeyemi, Grove, Peets and Norton (2017) which indicated that the use of dielectric soil sensors can help irrigation to be more sustainable.

6.4 Summary of the study

This study aimed to investigate how small-scale sweet potato farmers use ICTs in accessing farming information like market price and others in Vhembe District, Limpopo Province of South-Africa. Literature review outlines the use of ICT in accessing farming information, challenges and benefits related to the use of ICTs. Literature review also outlines the various types of ICTs used to access farming information. Lastly, it outlines the use of Internet of Things in farming.

This study adopted a mixed methods approach. The quantitative method was in the form of structured questionnaire while qualitative was in the form of semi-structured interview questions. In this study, simple random sampling technique was used to select 150 respondents. Questionnaires were distributed to 75 respondents from Matangari village, while another 75 questionnaire were distributed to respondents from Tshakhuma village. Interviews were conducted with four respondents from Matangari villages and four respondents from Tshakhuma village. The data collected using questionnaire were analyzed using IBM SPSS version 27 software while interview data were analyzed using thematic analysis. Data collected using questionnaire were presented in the form of pie charts and graphs. Multiple regression was used to test the proposed hypotheses.

The results indicate that most of respondents were female (57.33%), the highest level of age were between the ages of 40-49 (32%). ICTs were used as a source of farming information; however, the level use of ICTs depends on the farmers' level of education. The highest educational level of the respondents was tertiary (57.33%). The results indicate that majority of respondents (71.33%)

were aware of the use of mobile application in accessing farming information. The results indicate that majority of respondents (47.33%) used mobile application to access farming information, followed by mobile phone (42%), radio (4.67%), radio & tv (4%), tv (1.33%) and desktop (0.67%). The mostly accessed farming information through ICTs were weather forecast (42%), followed by fertilizer (15.3%), farming methods (13.33%), pesticides and market price (11.33%).

The findings of the study revealed that most of respondents (70%) lack knowledge in accessing farming information through mobile application. The study found that lack of knowledge, language barrier, network problems and lack of ICT training were challenges that hinders small-scale farmers in accessing farming information through ICTs. Market access, lack of access to market price and high price of input were also challenges that small-scale sweet potato farmers experienced.

Table 6.1: Hypotheses Testing Summary

Hypothesis	**Beta and significance**			**Results**
Performance Expectancy	**Independent variables**	**B**	**P**	Performance Expectancy (PE) has influence on (BI-ICT4SF). **Accepted**
	PE1	0.376	0.002	
	PE2	0.406	0.003	
	PE3	0.259	0.029	
Effort Expectancy	**Independent variables**	**B**	**P**	The data indicates that Effort Expectancy (EE) does not have influence on (BI-ICT4SF). **Rejected**
	EE1	0.057	0.623	
	EE2	0.195	0.149	
	EE3	0.120	0.307	
Facilitating Condition	**Independent variables**	**B**	**P**	Facilitating Condition (FC) has influence on (BI-ICT4SF). **Accepted**
	FC1	0.356	0.000	
	FC2	0.297	0.000	
	FC3	0.313	0.000	

Price Value	**Independent variables**	**B**	**P**	Price Value (PV) has influence on (BI-ICT4SF). **Accepted**
	PV1	-0.252	0.000	
	PV2	-0.194	0.002	
	PV3	-0.287	0.000	
Socio-cultural value	**Independent variables**	**B**	**P**	Socio-cultural value (SC) has influence on (BI-ICT4SF). **Accepted**
	SV1	-0.231	0.021	
	SV2	-0.261	0.024	
	SV3	-0.234	0.021	
Technical Information	**Independent variables**	**B**	**P**	Technical Information (TI) has influence on (BI-ICT4SF). **Accepted**
	TI1	0.388	0.002	
	TI2	0.316	0.026	
	TI3	0.505	0.000	
Behavioral Intention toward ICT for sustainable farming	**Independent variables**	**B**	**P**	Behavioral Intention toward ICT for sustainable farming (BI-ICT4SF) has influence on Use Behavior of ICT for sustainable farming (UB-ICT4SF). **Accepted**
	BI_ICT4SF1	0.579	0.000	
	BI_ICT4SF2	0.248	0.013	
	BI_ICT4SF3	0.633	0.000	

6.5 Refined Conceptual Framework based on Findings

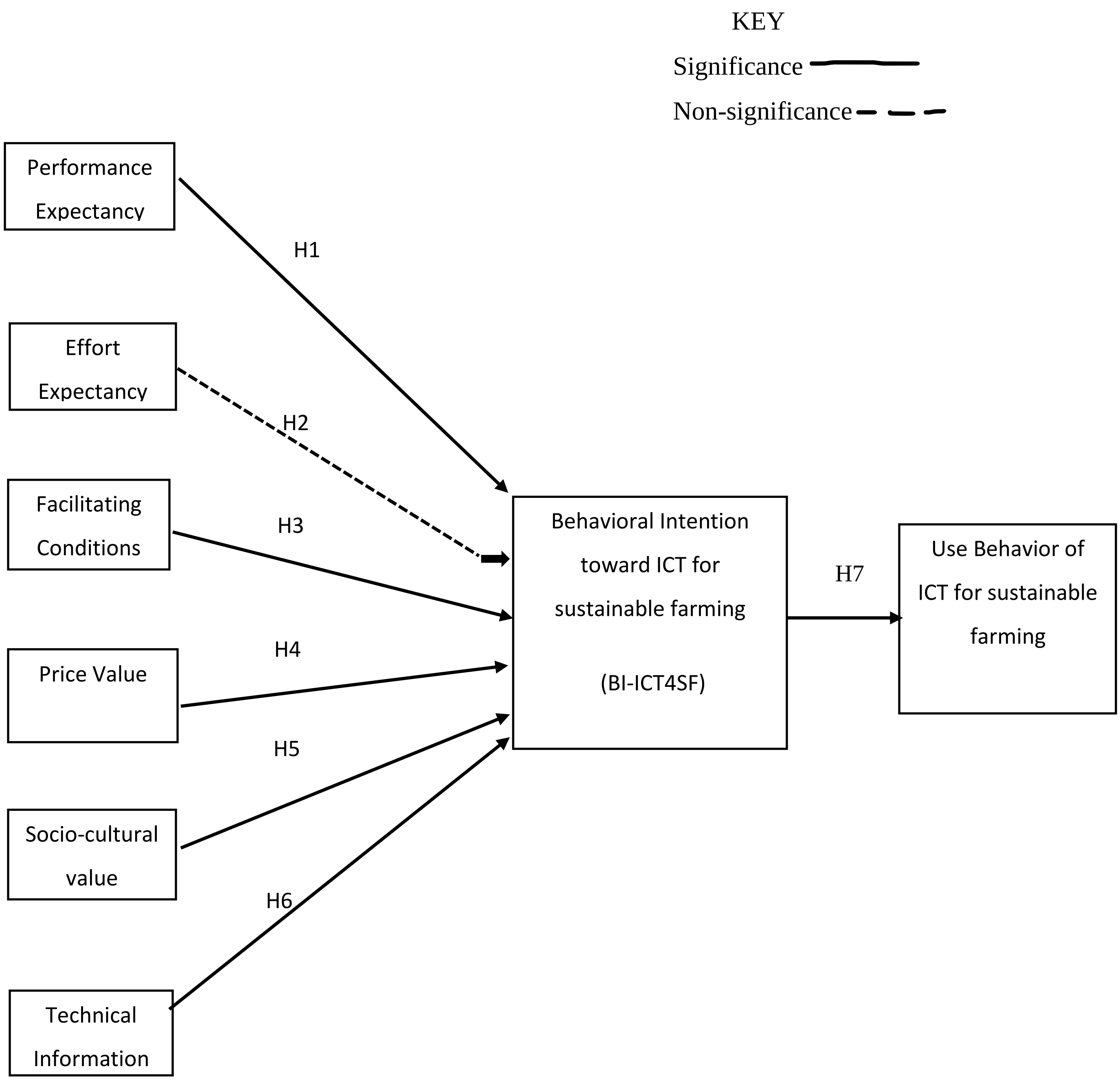


Figure 6.1: ICT for Sustainable Farming Conceptual Framework

Based on the findings of the study six hypotheses were accepted while one was rejected. Performance expectancy has a positive effect on behavior intention toward ICT for sustainable farming. Effort expectancy was rejected since it has no effect on behavior intention toward ICT for sustainable farming. Since some small-scale farmers lacked knowledge on how to use mobile applications to access farming information, effort expectancy was rejected. This finding concurs with findings of a study done by Schukat and Heise (2021) which indicated that effort expectancy (-0.057) shows no significance. Facilitating condition, price value, socio-cultural value and technical intention have a positive effect on behavior intention toward ICT for sustainable farming. Behavioral intention toward ICT for sustainable farming has a positive effect on use behavior of ICT for sustainable farming.

6.6 Limitations of the study

The scope of the study was limited to Vhembe District Municipality in two villages: Matangari and Tshakhuma. Due to covid-19 pandemic, the interviews were conducted telephonically which made it difficult to gain more information because some of the respondents did not gave me enough time to interview them.

6.7 Recommendations

Most of the small-scale farmers in rural area lack knowledge on how to use mobile apps in accessing farming information. Some small-scale farmers relied on radio and TV as their source of farming information while others relied on mobile phone in accessing only latest weather forecast and this hinders them in accessing other farming information like fertilizer and pesticides. Farming mobile applications provides latest farming information to farmers and other apps combine a variety of farming information into a single app. For success use of mobile apps in the rural area, the agricultural department needs to conduct classes that will help small-scale farmers on how to use various types of farming mobile apps in accessing latest farming information.

6.8 Future research

This research study focused on small-scale sweet potato farmers from two villages (Matangari and Tshakhuma) in Vhembe district. There is a need for further studies that investigate how small-scale farmers in rural areas across South Africa use ICT for sustainable farming. Moreover, such studies could be extended to commercial farmers as these are well established with better access to resources, media and markets.

6.9 Conclusion

The study objectives were formulated to achieve the aim of the study. The first objective was to assess the use of ICTs by small-scale sweet potatoes farmers in Vhembe District of Limpopo province in South Africa. The second objective was to identify the hindrances to the use of ICTs for information accessing by small-scale sweet potatoes farmers in Vhembe District of Limpopo province in South Africa. The third objective was to identify ICTs that are being used to access farming information by small-scale farmers in Vhembe District of Limpopo province in South Africa. The fourth objective was to establish the adoption and use levels of ICTs for sustainable farming by small-scale sweet potato farmers. The last objective was to propose an ICT framework that could be used by small-scale sweet potatoes farmers for sustainable farming in Vhembe Rural District of Limpopo province in South Africa.

From the findings of the research study, it can be concluded that small scale sweet potatoes farmers relied on ICTs to access farming information. However, the use of ICT depends on the level of education and awareness of the farmers. The results of the study showed that most of respondents had tertiary education and relied on mobile phone to access farming information, while small-scale farmers with no formal education relied on radio for farming information. The results found that most of the small-scale farmers use mobile phone to access latest farming information through mobile applications. The results also revealed that weather forecast was the most accessed farming information by small-scale sweet potato farmers. The results showed both challenges and benefits of using ICTs in accessing farming information. The main reason of using ICTs to access farming information, was that it enabled them to access most up-to-date farming information, which helped them to sustain healthy crops. The major challenges were lack of knowledge, network problem and language barrier. The results also revealed the challenges that were faced by small-scale sweet potatoes farmers include access to market, high cost of inputs and transportation costs. The findings revealed that small scale farmers used ICTs like mobile phone, radio, TV and desktop to access farming information. The results of the study showed that few respondents attended the formal ICT trainings, while the majority did not. The findings of the study showed the use level of ICTs in accessing farming information. Most of the respondents used ICTs for more than four years in accessing farming information. It can be concluded that ICTs play an important role in assisting small-scale sweet potato farmers in accessing up-to-date farming information.

The conceptual framework for this study was derived from the one proposed by Venkatesh, Thong and Xu (2012). The conceptual framework consisted of seven variables which are: performance expectancy, effort expectancy, facilitating conditions, price value, socio-cultural values, and technical information. The findings of this study showed that price value, performance expectancy, facilitating conditions, socio-cultural value and technical information are strong predictors of BI-ICT4SF; while BI-ICT4SF has a positive influence on use behavior of ICT4SF. Effort expectancy was not a significant predictor of BI-ICT4SF. Based on these findings, the proposed framework was refined and presented in Figure 6.1.

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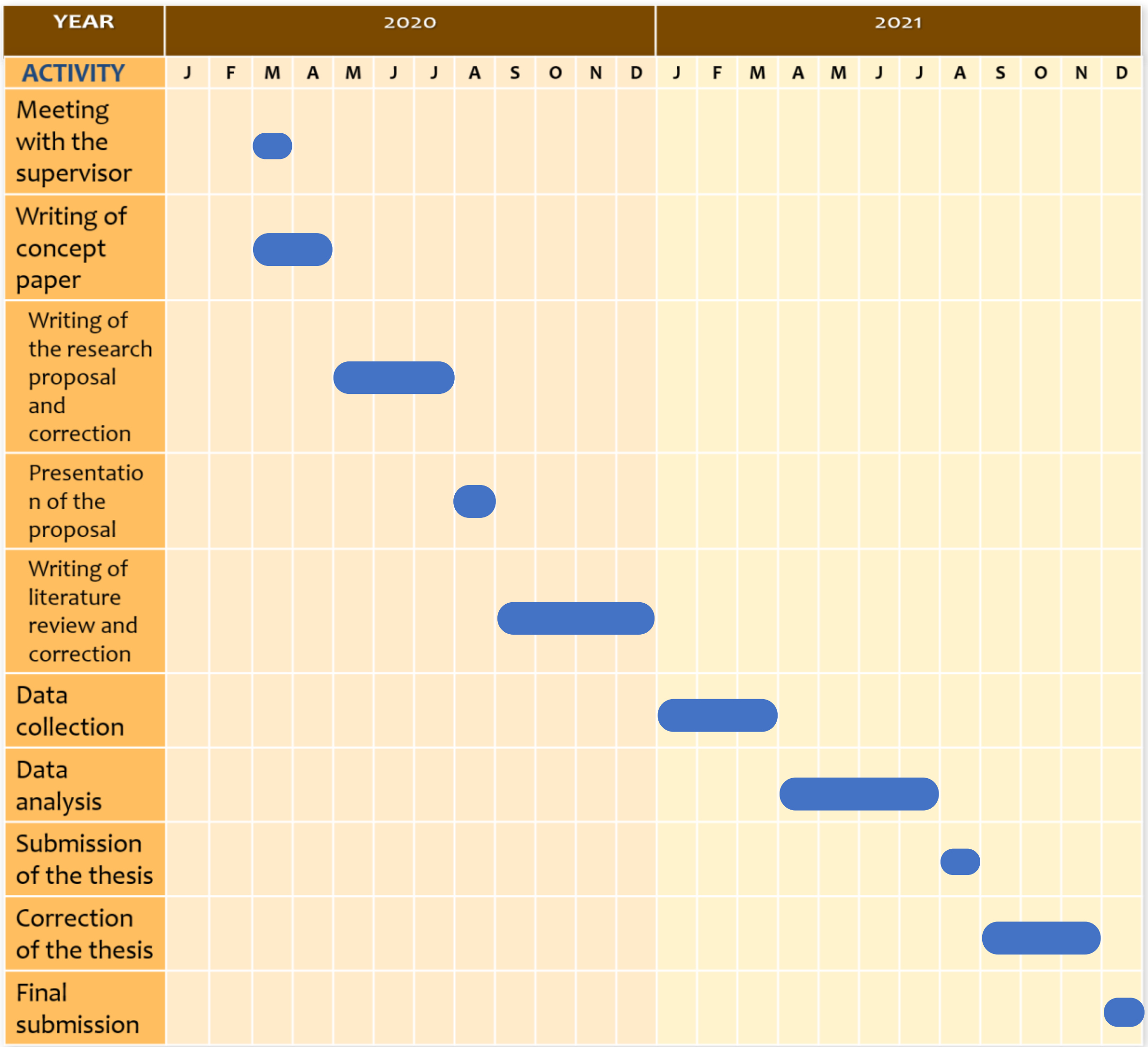
APPENDICES

Annexure A: Work Plan



Annexure B: Participant Letter of Information and Consent Letter

PARTICIPANT LETTER OF INFORMATION

My name is MATHIVHA NDUVHO SHARON, a postgraduate student doing Master of Commerce in Business Information Systems at the University of Venda in South Africa. I am

currently conducting a study entitled: “Framework for Information and Communication Technology for Sustainable Farming in South Africa: A case of Small-Scale sweet potato Farmers”. This study is aimed at coming up with a framework that could be used by small-scale sweet potatoes farmers in South Africa to improve their farming activities for sustainable livelihoods. This research reviews the concept of sustainable farming in the small-scale sweet potatoes farming sector in South Africa, the factors affecting the adoption and best ways in which such adoption and use could be enhanced. I am therefore kindly inviting you to participate in this study as a respondent.

This study is underpinned by the University of Venda ethical protocols and procedures, which states that, every participant should be issued with a consent letter that stipulates their rights to participation, withdraw at any time whenever they find themselves that they are unable to continue for some reasons. Please note that your participation is voluntary and valuable to success of this study. Also, note that this is an academic research and that there are no financial rewards for participation. The data being collected is anonymous and will be presented anonymously and treated with high degree of confidentiality. All data being collected contributes towards the right-up of the final dissertation.

If you agree to participate, please answer the research questions on the questionnaire. On average this questionnaire will take between 15-20 minutes to completion.

I thank you for your participation in this study and marking it a success.

If you have any concerns you are free to contact myself or my research supervisor on the details bellow:

Researcher name: MATHIVHA NDUVHO SHARON

Email: mathivhanduvho@gmail.com

Phone: 071 122 4216

Research Supervisor: Dr W. Munyoka

Email: Willard.munyoka@univen.ac.za

Annexure C: CONSENT LETTER

Statement of Agreement to Participate in the Research Study:

- I……………………………………………….hereby confirm that I have been informed by the researcher, MATHIVHA NDUVHO SHARON, about the nature, conduct, benefits and risks of this study - Research Ethics Clearance Number: _,

- I have also received, read and understood the above written information (Participant Letter of Information) regarding the study.

- I am aware that the results of the study, including personal details regarding my gender, age and level of education will be anonymously processed in the dissertation.

- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerized system by the researcher.

- I am free at any stage, without prejudice, withdraw my consent and participation in the study.

- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

- I understand that significant new findings developed during this research which may relate to my participation will be made available to me on request.

Full Name of Participant	Date	Time	Signature
I, …………………….	……………	…………	…………………..

MATHIVHA NDUVHO SHARON, herewith confirm that the above participant has been fully informed about the nature, conduct and risks of the above study.

Full Name of Researcher ………………………. Date………………. Signature………………

Full Name of Witness (If applicable) …………………Date……………… Signature…………

Full Name of Legal Guardian (If applicable) ………………Date…………… Signature…………

Annexure D: Interview Guide Questions

1. What is your level of education?
2. How do you access farming information?
3. Where do you access market price details?
4. What type of farming information do you access through smartphones?
5. What type of mobile applications or ICT in general do you use to access farming information?
6. Are you receiving any training / assistance from local government or any other sources on how to use ICTs to access farming information? If yes, what kind of training is provided?
7. Do you think using smartphones and mobile applications to access farming information can improve sustainability in farming?
8. In your own opinion, do you think information disseminated through these ICTs is helpful? And what do you think so?
9. What benefits has ICTs provided to your small-scale sweet potatoes farm?
10. What challenges do you encounter while trying to use ICTs for farming?

Annexure E: Research Questionnaire

This study aims to investigate the use of ICTs in accessing farming information by small-scale sweet potato farmers for sustainable farming in Vhembe Rural District, Limpopo Province.

Note: All the collected information will only be used for academic purposes. This questionnaire will take between 15 – 20 minutes of your time to complete. I kindly thank you for your participation in this study.

Please answer the following questions by putting a cross (x) within relevant answer.

SECTION A: Demographics Details

Village……………………………

1. Gender

   ○ Female

   ○ Male

2. Age

   ○ 20-29

   ○ 30-39

   ○ 40-49

   ○ 50-59

   ○ Above 50

3. Level of Education

   ○ No Education

- ○ Primary
- ○ Secondary
- ○ Tertiary
- ○ Farming training

4. What is your household income per month (in South African Rands-ZAR)?

    - ○ Below R100
    - ○ Between R100 and R500
    - ○ Between R501 and R1000
    - ○ Between R1001 and R1500
    - ○ Above R1501

SECTION B: ICT channels used in accessing farming information by small-scale sweet potato farmers.

5. Do you have any farming application in your phone?

    - ○ Yes
    - ○ No

6. Are you aware that you can use mobile application to access farming information?

    - ○ Yes
    - ○ No

7. Which of the following ICT channels do you use to access farming information?

    - ○ Mobile phone

◯ Mobile application

◯ Others (Specify……………………….)

8. What type of farming information do you access through ICT channels?

◯ Weather condition

◯ Market Price

◯ Fertilizers

◯ Pesticides

◯ Farming methods

◯ Others (Specify………………………..)

9. How many years have you been using this ICT channels to access farming information?

◯ Less than one year

◯ More than one year

10. Have you ever had any training on how to use ICT channels in accessing farming information?

◯ Yes

◯ No

If your answer to the above question is "YES", who provided the training?

Specify……………………….

11. Which language is used to disseminate farming information on the ICT channels that you use?

◯ English

◯ Tshivenda

○ Tsonga

12. How often do you access farming information through mobile application?

○ Always

○ Sometimes

SECTION C: Challenges associated with the use of ICT channels in accessing farming information.

13. What challenges do you experience in accessing farming information through mobile phone? (*You can tick more than one)*

☐ Loss of signal

☐ Battery problem

☐ Language barrier

Other (*specify*)…………………………………….

14. What challenges do you experience in accessing farming information through mobile application? (*You can tick more than one)*

☐ Lack of knowledge

☐ Language barrier

Other (*specify*)…………………………………….

SECTION D: Farmers' Behavioral intention towards ICTs for Sustainable Farming.

In this section, please indicate with a cross (x) based on the level to which you agree or disagree with each of the following statement, using the scale:

Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD)

PERFORMANCE EXPACTANCY (PE)

No	Based on your experience of using ICTs to access farming information, to what extend do you agree or disagree with the following statements? (Give response to each)	SA	A	N	D	SD
PE 1	My smartphone enables me to access agricultural information relevant to my farming activities.					
PE 2	I would find the use of mobile applications useful in my day-to-day farming activities.					
PE 3	Using the smartphones enables me to access the latest market information more quickly.					
PE 4	The use of smartphone does not improve my sweet potatoes farming performance.					
PE 5	Using mobile applications helps me overall in my agricultural activity and increases my productivity.					

EFFORT EXPECTANCY (EE)

No	Respond to the following statements on how easy it is for you to learn and use smartphones and mobile applications for farming for the first time. (Give response for each)	SA	A	N	D	SD
EE 1	I find it clear and understandable to use smartphones to access farming information					
EE 2	I find mobile applications for farming easy to use.					
EE 3	I do not require much technical expertise to effectively use my smart phone to access farming information.					
EE 4	The use of smartphone and mobile applications for farming is frustrating.					

FACILITATING CONDITIONS (FC)

No	Focusing on the assistance given to you or actions taken by your government or local municipality or any other organizations to assist you in	SA	A	N	D	SD

	accessing and using smartphones and mobile applications for farming, respond to the following statements. (Give response for each!)					
FC 1	There is adequate training on the use of smartphones and mobile applications in accessing farming information.					
FC 2	I have necessary resource, such as mobile phone with internet access, to be able to use mobile applications for accessing farming information.					
FC 3	A specific group is available for assistance with smartphone and mobile applications difficulties.					

PRICE VALUE (PV)

No	To what extent has the price value of ICT devices and services has affected your intentions to use smartphones (Give response for each!)	SA	A	N	D	SD
PV1	Internet services are unaffordable for me					
PV2	I cannot afford to have smartphone to access the internet					
PV3	I cannot afford the charges of acquiring ICT skills required for me to use mobile applications					

SOCIAL-CULTURAL VALUE (SV)

No	To what extent do you agree or disagree with the following statements regarding the effect of social-cultural value on your intention to use ICTs in farming? (Give response for each!)	SA	A	N	D	SD
SV1	I have been using radio and Tv to access farming information					
SV2	I was encouraged by training on how to use mobile applications by government department					
SV3	I would use mobile applications if I feel I have to use it without anyone's influence					

TECHNICAL INFORMATION (TI)

No	To what extent do you agree or disagree with the following statements regarding the technical information? (Give response for each!)	SA	A	N	D	SD
TI1	Availability of smartphone enables me to access latest market price					
TI2	Using mobile applications enables me to access farming information					
TI3	Mobile applications provide accurate farming information					
TI4	I find it difficult to understand the farming information on mobile applications					

BEHAVIORAL INTENTION TOWARD ICTs FOR SUSTAINABLE FARMING (BI-ICT4SF)

No	Respond to the following statements regarding your plans for using smartphones and mobile applications (Give response for each!)	SA	A	N	D	SD
BI - ICT4SF 1	I intend to use smartphone in accessing farming information in the future.					
BI - ICT4SF 2	I predict I would use mobile applications in accessing farming information in the future					
BI - ICT4SF 3	I plan to use the mobile applications in accessing farming information in the future					

USE BEHAVIOR OF ICT FOR SUSTAINABLE FARMING (UB-ICT4SF).

No	Respond to the following statements regarding your use	SA	A	N	D	SD

	behavior of smartphones and mobile applications (Give response for each!)					
UB-ICT4SF1	Using smartphone and mobile applications in accessing farming information is a good idea.					
UB-ICT4SF2	Accessing farming information through mobile applications on smartphone makes work more interesting.					
UB-ICT4SF3	I dislike the idea of accessing farming information through mobile applications.	SA	A	N	D	SD

THANK YOU FOR PARTICIPATING IN THIS SURVEY!

Annexure F: Ethics certificate

ETHICS APPROVAL CERTIFICATE

RESEARCH AND INNOVATION
OFFICE OF THE DIRECTOR

NAME OF RESEARCHER/INVESTIGATOR:

Ms NS Mathivha

STUDENT NO:
14000817

PROJECT TITLE: **Framework for information and communication technology for sustainable small-scale sweet potato farming: a case of Vhembe district in Limpopo province, south Africa.**

ETHICAL CLEARENCE NO: SMS/20/BIS/11/2503

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr W Munyoka	University of Venda	Supervisor
Mr D Tutani	University of Venda	Co - Supervisor
Ms NS Mathivha	University of Venda	Investigator – Student

Type: **Masters Research**
Risk: **Minimal risk to humans, animals or environment (Category 2)**
Approval Period: **March 2021 – March 2023**

The Research Ethics Social Sciences Committee (RESSC) hereby approves your project as indicated above.

General Conditions
While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following.

- The project leader (principal investigator) must report in the prescribed format to the REC:
  - Annually (or as otherwise requested) on the progress of the project, and upon completion of the project
  - Within 48hrs in case of any adverse event (or any matter that interrupts sound ethical principles) during the course of the project.
  - Annually a number of projects may be randomly selected for an external audit.
- The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the REC. Would there be deviated from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited.
- The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date; a new application must be made to the REC and new approval received before or on the expiry date.
- In the interest of ethical responsibility, the REC retains the right to:
  - Request access to any information or data at any time during the course or after completion of the project,
  - To ask further questions; Seek additional information; Require further modification or monitor the conduct of your research or the informed consent process.
  - withdraw or postpone approval if:
  - Any unethical principles or practices of the project are revealed or suspected.
  - It becomes apparent that any relevant information was withheld from the REC or that information has been false or misrepresented.
  - The required annual report and reporting of adverse events was not done timely and accurately,
  - New institutional rules, national legislation or international conventions deem it necessary

ISSUED BY:
UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE
Date Considered: February 2021

Name of the RESSC Chairperson of the Committee: Prof Takalani Mashau

Signature: PTMashau

UNIVERSITY OF VENDA
OFFICE OF THE DIRECTOR
RESEARCH AND INNOVATION
2021 -03- 25
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Thohoyandou 0950

University of Venda
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