The adoption and utilisation of information systems in farming at Limpopo province Vhembe district

by

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submitted in accordance with the requirements for
the degree of

MASTER OF SCIENCE

in the subject

INFORMATION TECHNOLOGY MANAGEMENT

at the

UNIVERSITY OF SOUTH AFRICA

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(November 2024)

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ACKNOWLEDGEMENT

- First of all, I would like to show my sincerest appreciation to everybody who was of great help and involved in the completion of this research study.

- First and foremost, I would like to express my deepest appreciation to my supervisor, Prof. Mkhize, who helped me in every step of this study, provided me valuable suggestions, and encouraged me all the time.

- I would also like to express my sincere appreciation to my fellow brothers of Zwashu Boys whom I found the strength to push on from their encouragement. The gratitude goes to friends and families for their support in their work.

- I would especially like to express gratitude to my cousin because he aided me in times of difficulty and helped me complete this research work. I wanted to express my gratitude for having faith in me and for supporting me throughout this journey.

- Finally, I would like to thank my wife for her love that never runs out, her patience, and for always being my source of strength. You and your support have been my guiding strength throughout my academic achievement and no words can express my gratitude for you.

- In conclusion, heartfelt appreciation goes to all the small-scale farmers from the Vhembe district who agreed to participate in this study. You are much appreciated for agreeing to tell me your stories and help me develop this research.

ABSTRACT

The goal of this research was to evaluate the level of information systems adoption and utilisation among small-scale farmers in the Vhembe district of Limpopo province, South Africa. Since agriculture is among the most crucial economic activities in the region, this research sought to evaluate attitudes of small-scale farmers, the contribution of extension officers, and factors that affect the implementation of technology in information systems for farming.

The study relied on a positivist research paradigm and was conducted through a quantitative cross-sectional survey approach in which 306 farmers were interviewed using structured questionnaires. The Kaiser-Meyer-Olkin (KMO) level of 0.917 and Cronbach's values of 0.779-0.945 proved the reliability and internal consistency of the instrument. Exploratory factor analysis revealed five key factors influencing technology adoption: Extension Officers' involvement and support for the adoption and usage of information systems, perceived attitude towards information systems, perceived barriers to adoption of information systems, and the perceived usual source of agricultural information.

The results showed a gender gap with the participants being 63.7% male and 36.3% female. Other notable factors included higher education as an influential factor, with 40.2% participant small-scale farmers possessing a degree showing a tendency to adopt information systems and a greater likelihood having bachelor level or better degree. Support from extension officers was also critical in affecting both the perception and real adoption of information systems.

The findings of this study, therefore, support the need to utilize the extension officers, foster positive attitudes, and disseminate relevant information to increase the uptake of information systems in agriculture. These views are in support of the Diffusion of Innovation Theory where more effort needs to be applied towards increasing the perceived relative advantage and lack of trialability of information systems among the small-scale farmers.

KEY TERMS: Information Systems, Small-scale farmers, Attitude, Extension officers, Agriculture, Vhembe district, Adoption, Utilisation, Barriers, Limpopo province, Factor analysis

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LIST OF ACRONYMS

DOI	- Diffusion of Innovation
EFA	- Exploratory Factor Analysis
FMIS	- Farm Management Information Systems
CFA	- Confirmatory Factor Analysis
GIS	- Geographic Information System
GPS	- Global Positioning System
GSM	- System of Mobile Telecommunication
ICAR	- Indian Council of Agricultural Research
ICT	- Information and Communication Technology
IOT	- Internet of Things
IRM	- Imazapyr-Resistant Maize
IT	- Information Technology
KMO	- Kaiser-Meyer-Olkin
M2M	- Machine to Machine
NGOs	- Non-Governmental Organizations
SLT	- Social Learning Theory
SMS	- Short Message Service
SPSS	- Statistical Package for Social Sciences
TAM	- Technology Acceptance Model
TV	- Television
UNISA	- University of South Africa
WAP	- Wireless Application Protocol

CHAPTER 1: BACKGROUND OF THE STUDY

1.1 Introduction and Background

Among other factors, sustainable growth in South Africa depends mostly on livestock and crop agriculture because more than one-third of the country's citizens reside in rural areas. South Africa has a dual agricultural economy comprising of a highly developed commercial farming industry as well as subsistence small-scale sector operated in rural areas such as the Vhembe district, where the majority of the rural population relies on subsistence farming as their primary source of income (Simelane, Lall, and Kogeda, 2019). The Vhembe district has crop farmers who cultivate several different food crops such as fruits and vegetables and the area is known for its agricultural potential (Maponya, 2021).

Agriculture has potential to contribute to all three aspects of rural development: food security, reduced poverty levels, and enhanced nutrition security (Mwangi and Kariuki, 2015). The farming industry is complicated in that it requires a variety of inputs and elements, including the price of the land, labour costs, high-end equipment, pricey tools, fertilizers, pesticides, irrigation, among others (Paraforos et al., 2016). Furthermore, in most farms, farmers rarely record agricultural activities systematically and analytically, and when recorded, the data are fragmented, dispersed, and challenging to utilize. Modern agricultural practices depend on the usage of information systems, which helps with effective management, decision-making, and productivity growth. Understanding the adoption and impact of information systems is of utmost relevance including in the context of the Vhembe district in the province of Limpopo, where agriculture contributes significantly to the local economy and provides for the needs of small-scale farmers.

According to Maponya (2021), one of the primary economic drivers in the northern Vhembe area is agriculture, which in turn contributes to the entire province and country. Income levels of small-scale farmers can rise, food expenditures would depreciate, and agricultural output would increase if the small-scale crop sector in developing countries were to grow and develop (Salami, Kamara, and Brixiova, 2017). For example, Fadeyi, Ariyawardana, and Aziz (2022) provide evidence that small-scale farmers in Africa who use new technology have raised farm productivity, earnings,

and employment rates, while also reducing poverty and improving nutritional status. Because small-scale farming provides 80% of the income for Africans, this is very crucial. Furthermore, the authors determined that small-scale agriculture plays a crucial role in boosting the economy, creating jobs, and enhancing food security. However low productivity in Africa's small-scale agriculture is related to a restricted application of technology.

Information, according to Awili, White, and Kimotho (2016), is one of the most important resources needed in the agricultural sector, to increase output. Since information suggests a transformative shift in one's perspective, particularly in the farming sector, it is crucial for communal survival (Akinola, 2017). In Sub-Saharan Africa, information technologies are used to transmit and transform data generated from agricultural activities, to foster interconnection and reveal hitherto undiscovered avenues for support of occupation (Musungwini, 2018).

Many information and communication technology (ICT) tool have been created, tested, and released globally, with differing degrees of success (Okeke, Nwoye, and Kadiri, 2020). Certain tools were created primarily to assist farmers in improving their standard of living, either by lowering the risk factors associated with crop and animal production or by increasing agricultural productivity and income creation. The Department of Agriculture, Forestry and Fisheries (2016) states that information systems like radio, television (TV), and mobile phones are crucial in forming farmers' perceptions of new agricultural knowledge worldwide, particularly regarding small-scale productivity. Small-scale agriculture in developing countries in Sub-Saharan Africa is important because it contribute to improved livelihoods and nutritional security (Oteh et al. 2021).

According to Sopuru (2015), information systems are groups of components that work together to gather, store, and process data to deliver knowledge, information, and digital goods. Furthermore, the need for agricultural products has increased along with the population, making it critical for players in the industry to have access to real-time information. Therefore, information system should enable exchange of data with services offered to compute for precision agriculture and handle different types of formats that are standard and proprietary (Nikkila, Seilonen, and Koskinen, 2010). As human population increase across the world, developing nations are turning to the information systems industry to help with agriculture to fulfill the growing demand for food

(Mdoda, Christian, and Agbugba, 2023). Access to information systems including by populations in developing nations is not complicated given that it is provided by the mass media or mobile phones, among other gadgets. These are particularly useful for providing information on food and agricultural commodity prices, which helps to ensure that prices move in tandem across market-places efficiently. Precision farming, machine learning, IoT, mobile-based systems, GIS-based applications, and other emerging technologies are welcomed additions seen as crucial in the agriculture sector in South Africa.

Born et al. (2021) purport that, although some are merging, a wide range of digital technologies about data management, field management, decision support, input and market access, institutional resources, and loan application are accessible in South Africa. A robust power and communication infrastructure, according to Porciello et al. (2022), enables these digital technologies, allowing 67% of rural residents to have access to electricity, 56% to the internet, 100% of people to possess a mobile phone, and 80% of people to own a smartphone. However, according to writers like Porciello et al. (2022), published literatures have rarely discussed the use of digital technologies by small-scale farmers in South Africa. Furthermore, concerning considering the low extension-farmer ratio, most digital technology research in small-scale agriculture has concentrated on consulting and extension services (Porciello et al., 2022). The 2.5 million small-scale households in South Africa face several challenges, including limited access to basic services, low capacity and information exchange, dependence on rain-fed crops, significant inefficiencies in accessing value chains, and climate change. Some of these difficulties can be mitigated through adoption of digital technologies.

Small-scale farmers have a lot of potential to gain from utilizing information systems in their operations. In sections of this paper unfolds, it is revealed that using information systems in farming activities can benefit small-scale farmers in various ways. One of these is through connecting users to localised agricultural information that ought to be updated regularly including but not limited to weather forecasts, markets, and approaches to crop and pest management. As pointed out by Waje et al. (2024), To enhance the small-scale agricultural production and market access, the agricultural information and knowledge flow will need to be enhanced. Furthermore, availability of updates and appropriate information plays a crucial role in helping the farmers to embrace the

modern technologies, make rational decisions and raise the produce. Consequently, it would enhance the rural livelihoods, quality, and yield, while benefiting economies.

Agriculture-related organisations use the extension to help farmers increase agricultural output by giving them access to pertinent and up-to-date information (Simelane, Lall, and Kogeda, 2019). In particular, agricultural extension officers give farmers advice, support their strategic planning, and encourage positive agricultural advancements (Simpson and Calitz, 2014). Consequently, organisations in agricultural extension are under tremendous pressure to educate farmers and disseminate the most contemporary agricultural innovations through several teaching methods of one, group, and mass extension interactions (Rehman et al., 2011).

Utilising information systems enables extension officers to provide farmers with information that is current and accurate, which boost their advising services, and provide customized recommendations catered to farming circumstances. The agricultural extension officers are critical in the improvement of the productivity and the sustainability of the small-scale farming in South Africa. They can act as a gateway between the rural farmers and the rest of the agricultural innovation system by giving access to important resources, training in technical professions, and up-to-date knowledge regarding agriculture, as noted by Mbatha (2023). Prosperity seen in the agriculture sector is largely credited to the critical role that extension services play in connecting farmers and rural communities with agricultural research in information and technology (Mabe and Oladele, 2012). By contrast, extension services provided by governments without the aid of research and technology, has not been successful in providing farmers and rural communities with the knowledge and tools necessary to achieve food security and sustainable development.

Among characteristics of farmers, personality, experience, age, education, and goals, are considered when picking information technology (IT) since they play a crucial part in the farm information system (Alvarez and Nuthall, 2006). Due largely to the fact that these components are so specialized, farmers can draw from plenty of IT and system possibilities. The usage of social networks, which are groups of people linked in some or most ways because of familial or other traditional social responsibilities, also aid spread information and technology (Weyessa, 2017). Of noteworthy is, in order for farmers to improve agricultural productivity through adopting new

technologies, the information that they rely on, ought to be credible. Perhaps, the role of social networks is highly important in this process.

Despite the potential of integration of digital technology in enhancing farming practices, small-scale farmers face finds it difficult to use it (Smidt and Jokonya, 2022). Small-scale farmers' perspectives on their agricultural practices and productivity as well as their knowledge of those processes have an impact on how they reason and view their choices (Kidane and Zwane, 2022). According to Naik et al. (2020), farmers who adopt a positive attitude toward ICT tend to increase agricultural productivity and improve their socioeconomic circumstances. The purpose of this research was to offer knowledge regarding the use of information systems by farmers in the Vhembe district of the province of Limpopo, South Africa. The study aimed to provide some real-world lessons that may be useful in facilitating the implementation of information systems and in enhancing agriculture in the area by exploring its adoption, benefits, challenges, and the roles and responsibilities of the relevant stakeholders.

1.2 Problem Statement

The economy of Limpopo province, South Africa is largely based on agriculture, mining, and tourism, especially the rural districts, including Vhembe where agriculture is a major source of livelihood to most people (Maponya, 2021). In South Africa, farming at the small-scale and large-scale sectors withstands a wide range of conditions. While the latter sector is highly developed, the former is marginalized. However, productivity in the small-scale farming sector can be increased through adopting initiatives that have been proven effective in other countries. One such initiative is the application of lower than recommended rates of agricultural inputs along technical efficiency (Muzekenyi, Zuwarimwe, and Kilonzo, 2021). According to Kidane and Zwane (2022), the way that small-scale farmers think and perceive their choices is influenced by their attitudes and knowledge about their agricultural techniques and production. Information systems play a very big role in farming, delivering and providing information to stakeholders in agriculture. There is an increase in the demand of agricultural products, caused by the rise in human population and in order to meet it, farmers need proper management of agriculture information access, however, small-scale farmers have poor attitudes towards using information systems.

According to Ayim et al. (2022), although ICTs have been demonstrated to have a transformative effect on agricultural extension and decision-making, they are only effective in providing quality and access to information flows to farmers, extension officers, and other stakeholders. Exchange of information between extension officers and farmers is hindered by, among other factors, expenses, which are associated with transportation given the remoteness of farmlands. As a result, not all intended beneficiaries get covered by extension services, and the huge expenses mean that information and/or resources are not provided or delivered timely. Although there is a wealth of information regarding the use of ICT by extension officers in South Africa (Smidt and Jokonya, 2022), less is known regarding the use of ICT by farmers, particularly those in the Vhembe district. Recent reviews emphasize the need for integrated digital platforms that connect farmers with coordinators, researchers, and markets to improve agricultural decision-making and productivity (Ayim et al., 2022). It is strongly advised that in order to develop contact via information technology between farmers, coordinators, agricultural professionals, research centre, and the community to improve information systems in agriculture (Vidanapathirana, 2012). Access to relevant and timely information empowers the judgment process of farmers to respond to emerging conditions in an effective way, be adaptive, and increase agricultural productivity (Bessah et al., 2021). The advancement of agricultural processing, production, marketing, and trading depends critically on the effective and efficient delivery of information and technology services facilities. For the small-scale farming population in rural areas receiving information is crucial as it support agricultural output.

Among negative effects of small-scale farmers not using information systems includes: Poor product marketing and less exposure to the market price as marketing of farm produce is done better online and farmers can access prices from the fresh produce markets for comparison before they send their products, poor communication/connection with the clients/customers as the technology is needed to communicate with the customers, sending quotations, invoices and other business documents, Inefficient farm monitoring and evaluation in which currently the commercial farmers use technology to monitor most of the farm activities, Poor orchard management (inaccurate application of chemicals such as fertilizers, herbicides and pesticides as well as irrigation water) as most of the irrigation is now done using sophisticated technology which make sure that the right

amount of water and fertilizers are applied to the plants in which this helps to save water and prevent soil pollution, and increased time to do farm activities cause technology save time of the farmers since most of the work can be done on a very short space of time as compared to traditional farming where things are done manually.

Although agriculture make a significant contribution to the economy of the Limpopo province, particularly that in the Vhembe district, there exist gaps in research on the extent and level of information systems adoption and usage by the small-scale farmers. Even though studies have reported on the use of ICT by extension officers in South Africa, there is scarcity of information on how these technologies are taken up and utilized by farmers, especially those in the Vhembe district. This study seeks to contribute to this gap by offering a high level of description of information system adoption among the small-scale farmers in the Vhembe district. Little is known about information systems, the perception and attitude of small-scale farmers, and how these factors affect decision-making by farmers on the use of the systems. However, despite published evidence emphasizing that attitudes and knowledge importantly influence farmer decision-making and farm operations, there is still relatively scarce quantitative information on how these factors elaborate the information systems used in the farming-related practices in the Vhembe district. Additionally, there is a research gap in understanding how extension officers facilitated, or did not, the use of information systems by small-scale farmers. Information transfer through extension services is paramount important, however, there is limited understanding of how agricultural extension services can utilise information systems to positively contribute to improved agricultural productivity.

1.3 Purpose of the study

The overall goal of the study was to evaluate the status of adoption of information system and its use among small-scale farmers in the Vhembe district of the Limpopo province. This entails an assessment of the level of utilisation of modern information systems in the farming practices of these farmers. Furthermore, the study intends to explore how small-scale farmers view these information systems and how they impact their choice to embrace such technology.

Also, the study describes the work of extension officers, how they can encourage and facilitate the adoption of information systems by small-scale farmers. In addition, the research aimed to explore and analyse factors which hinder the use of information systems and therefore the adoption and implementation of the same. The research was intended to generate findings that may inform intervention strategies that would increase the rates of effective information systems application in enhancing agricultural output and productivity in the Vhembe district.

1.4 Objectives of the study

The main objectives of the study were to:

1. Assess the extent to which small-scale farmers in the province of Limpopo's Vhembe district utilize and adopt information systems for farming.
2. Examine the perceptions that small-scale farmers have on information systems and how these perceptions influence the adoption of such technology in their farming activities.
3. Explore the role of extension officers in promoting the adoption and utilisation of information systems among small-scale farmers in the district.
4. Examine the access to information systems and barriers affecting their adoption and utilisation among small-scale farmers in the district.

1.5 Research question

This study poses the following question:

- What is the current level utilisation of information systems among small-scale farmers in the Vhembe district of Limpopo province, and how do attitudes of farmers, the influence of extension officers, access and use of agricultural information, and factors impact the adoption and utilisation of information systems in farming practices?

The following questions would assist to answer the above question:

1. What is the level of information system adoption and utilisation by small-scale farmers in Vhembe district?

2. Does the attitude towards information systems affect the decision of small-scale farmers in the use of such technology in farming?
3. How do extension officers influence small-scale farmers in adopting and utilising information systems in their farming practices?
4. How does the access to information on agriculture and barriers relate to the use of information systems among small-scale farmers in Vhembe district?

1.6 Delimitation of the study

The following boundaries and limitations were determined:

- The data collected for this study can be contextualised within the Vhembe district in Limpopo province, South Africa and the results may not be generalisable to other districts or countries. Even though the region was selected because of its connection with contemporary agricultural practices and ease of accessibility for researchers, agricultural processes and technologies developed and implemented differ from one part of the world to another depending on geographical, cultural, and socio-economic discrepancies.

- The research specifically targeted small-scale farmers and other related personnel practicing farming within the identified area. This narrow focus may limit the range of input from persons who are not involved in farming or from farming within different areas which might have different approaches to farming and the problems associated with farming.

- Sampling data collection and analysis were done within a given time frame. This could be a limitation in the sense that it does not fully explain the dynamic of change and development related to information systems adoption and use over time by small-scale farmers in the Vhembe district. This is especially because the farming, and technologies employed may vary over time and the study results may not be uniformly representative of future events or changes.

- The survey and the data collection were mainly in English; thus, the results may not represent the total population since some respondents might not understand English or could not

translate the questions. This language constraint could lead to a bias of the respondents in that those with higher education levels or those with exposure to the English language would be in the sample while disregarding those with little or no knowledge of English.

- Key variables included the functions of extension officers, farmers appreciation of information systems, factors influencing the adoption of extension services, and farmers preferred method of information acquisition in agriculture. Of course, the use of this focused framework enables a more profound investigation into these characteristics; however, the availability of other potentially significant variables or factors that could affect the information systems adoption among small-scale farmers has not been examined or included in this research.

The aforementioned boundaries and limitations should be taken into consideration when generalizing the study results to other settings or when formulating policy implications. It underscores the importance of future studies in adopting larger geographical units, diverse languages, extended periods, and various factors that affect the adoption of information systems in agriculture.

1.7 Significance of the proposed study

The proposed study on the adoption of an information system among small-scale farmers in the Vhembe district is crucial for academic and real-world advancements in agronomy. It is imperative to ascertain the level and factors that affect the adoption of information systems in a bid to enhance agricultural productivity and food security in the region. The general standard of living for rural poor people is improved by ICT interventions, which also result in major agricultural investments for the development of rural households (Kamthania, 2016). So far, the use of ICT is a key component of agricultural extension and is considered as a crucial method for providing farmers with knowledge and information in a changing environment (Dhaka and Chayal, 2010). Additionally, the authors emphasized that efficient use of ICT has the potential to improve rural areas by facilitating the timely and cost-effective acquisition of information in the most user-friendly, accessible, and convenient formats.

It is reported in studies that the level of ICT literacy among rural farmers, especially in developing countries is low and this becomes a major restriction as far as meeting the information needs of rural farmers is concerned (Mbagwu, Benson and Onuoha, 2018). The most emphasized challenge that discourages farmers from using ICT is the fear of embracing new technology due to a lack of knowledge (Subashini and Fernando, 2018). Therefore, the research seeks to evaluate factors that influence the use of technology in the farming sector to achieve the goal of integrating current information techniques into conventional agriculture. This knowledge is crucial for policymakers, extension officers, and agricultural stakeholders to design and implement appropriate strategies that can lead to better delivery of specific information, which can lead to better decision-making as well as high yield for farmers involved in crop production.

1.8 Research report outline

Chapter 1: Research purpose

- Gives a proper understanding and explanation of this research study. The research issues under study include the problem statement, purpose, objectives, research question, and sub-questions after which the importance of this study. The qualitative nature of the study is explained, and the potential limitations and delimitations of the study are discussed. The literature review reveals deficiencies in published information and a justification for conducting the research is presented.

Chapter 2: Literature Review

- This chapter identify information systems adoption and utilisation, attitudes towards using information systems, and the role of extension officers from prior literature of the different studies.

Chapter 3: Research Methodology

- Presents the research techniques deployed in this undertaking. This chapter describes the research design used in this study and explains why the specific methods were adopted.

Explaining data sources. Thus, the methods of data collection, reliability, validity analysis and data presentation are also reported, and the ethical concerns are also considered.

Chapter 4: Data Collection and Presentation

- This section includes the findings and discussion of the collected data and how it serves the field of study. The findings of the study are presented in line with the objectives.

Chapter 5: Finding Summary

- Present the investigation outcomes regarding the research questions and objectives of the study. This is then followed by the conclusion that has been made after analyzing the findings and giving suggestions on how the research could be repeated.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

Adopting IT in farming by small-scale farmers is essential largely because it improve the productivity and effectiveness of farmers. The use of information systems by small-scale farmers in rural areas can be hampered by several issues, such as limited availability of information, lack of contemporary equipment, and scarce resources. Furthermore, these systems require a higher level of education and greater language proficiency (Sopuru, 2015). Conducting research that assess the extent to which information systems are used and the factors that influence it can contribute results that can help policymakers and stakeholders design relevant strategies to enhance it.

This section on review of published literature seeks to establish the extent to which information systems are adopted and factors that affect its adoption by small-scale farmers in the Vhembe area of Limpopo province. Refocusing on the technological, institutional, and individual factors that influence the adoption of information systems, the review considers relevant literature on the topic. The following aspects can be implemented by policymakers and stakeholders to enhance the use of information systems among small-scale farmers in the Vhembe area of the Limpopo province: There is therefore the need for policies to embrace these aspects that would enhance the development of the rural communities.

The purpose of reviewing literature in this study is to show theories that are relevant, factors that influence the adoption of information systems by small-scale farmers, adoption of information systems among small-scale farmers, attitude towards information systems by small-scale farmers, the role of extension services in promoting the adoption of information systems among small-scale farmers, access and the use of agricultural information by small-scale farmers, and barriers to adoption of information systems among small-scale farmers.

2.2 Theoretical Framework

Davis created the Technology Acceptance Model (TAM) in 1989 to examine how users accept and employ new technology. It identifies important elements such as perceived utility and perceived usability, that affect the willingness of people to adopt technology. The choice of technology is an idiosyncratic process that is typically driven by the farmer's attributes, such as personality, experience, age, education, and aspirations (Alvarez and Nuthall, 2006). Furthermore, the farmer is typically an integral component of the farm information system. Due to the highly individualised nature of these elements, farmers may choose different technology and system configurations.

Farmers can learn from other farmers and by trial, learn from people within their social network and that is what makes the Bandura's Social Learning Theory (SLT) of 1977 a great focus on social knowledge. Unfortunately, while knowledge is rarely a balanced or free good in credit-starved developing or emerging economies, mainstream economics assumes that it is (Sopuru, 2015). Indeed, this is partly because many of the older forms of information retrieval, such as traveling, radio, and newspapers, are costly. Therefore, knowledge asymmetry may greatly reduce the prospect of adopting agricultural technology in poor nations (Sopuru, 2015). In agriculture, information asymmetries must also be addressed to level the playing field for all parties.

This study used the Diffusion of Innovation (DOI) Theory proposed by Rogers (1962) to assess the sampling factors that affect the adoption and use of information systems in the small-scale farming population in Limpopo's Vhembe district. According to the DOI theory that Rogers first proposed in 1962, the persuasion stage of the adoption process is characterised by knowledge and various socioeconomic factors like family structure and community groups; as a result, a knowledge-based community influences a positive attitude towards technology innovations. The theory of DOI in its broad perspective can be viewed as the attitude and the mechanism of stages of innovativeness in adopting any product, service, or policy (Lundblad, 2003). The adoption of innovations is good for any sector and core for attaining sustainable development.

According to Rogers (2003), adoption of an innovation is influenced by five characteristics: the assessment criteria of the innovation qualities would include: relative advantage over competing technologies, compatibility with organisational practices and knowledge base, implementation feasibility, measure of its/or the concept's capability to be tested, and the relative observability of the process within the company and of competitors. They state that both prospective adopters of innovations and the perceived rate of adoption of such innovations experience these five characteristics.

The perceived relative advantage is defined as the extent to which a user feels that adopting an innovation would enhance their experience compared to the present technology. Compatibility deals with the extent to which an innovation can fit into the existing technological and social setup. Implementation feasibility refers to the perceived difficulty of understanding, applying, and utilising an innovation. One parameter that measures the testability of an innovation is the extent to which an innovation can be tested at a low and reasonable cost while at the same time not fully committing to its success. Observability is the extent to which potential adopters can visualize the benefits of an innovation. Also, Rogers (2003) classified members of a social system into five categories according to how they feel about innovations: The participants in the technology adoption process include innovators, the early majority, the late majority, laggards, and the early majority.

2.3 Factors that influence the adoption of information systems by Small-scale farmers.

Technology can be viewed as a facilitator or a means of getting information, expertise, and skills to small-scale farmers to increase agricultural productivity (Rogers, 2003). Recent research underlines that digital technology uptake in African agriculture is determined by cognitive commitment of farmers to the issues of scarce infrastructures, skilled training, and reluctance to change (Mhlanga and Ndhlovu, 2023). Information and technology are essential for productivity and financial success, depending on the commodity in which a farmer specialises, and agriculture's use of technology is not just restricted to its industrial components (Oladele, 2015).

Furthermore, most of the equipment used on farms now includes computer technology because farmers, like a large portion of society, have incorporated personal computer technologies into their farm operations (Shamshiri et al., 2024). Advanced technology is also connected to specialist farming practices and specialty crops. Many factors influence small-scale farmers' adoption of new technology (Jha, Kaechele, and Sieber, 2019). This is because, according to Salami, Kamara, and Brixiova (2017), small-scale farmers must learn how to apply new technologies and processes as well as integrate them into already existing systems. The traits of small-scale farmers that influence technology adoption have been the subject of numerous studies on the subject. Age, gender, education, and farming experience are some of these.

Gender in Northern Ghana has a substantial impact on small-scale farmers' adoption of new agricultural technologies, according to a study by Michalscheck et al. (2018). For example, when deciding which technologies to embrace, men and women have distinct preferences. Male small-scale farmers were found to adopt new technology quicker compared to female small-scale farmers (Murage et al., 2015). According to Treinen and van der Elstraeten (2018), in general, women have a significant impact on agricultural output development and revenue generation worldwide. ICTs present an immense opportunity for women since instead of them having to have direct contact with their peers to get the necessary information, they can get this from a computer or even a mobile phone. New technology and information also remain a problem as rural women remain confined to their homes and remain lacking in basic information which hinders them from making proper and informed decisions as per their requirements in production (Nazari and Hassan, 2011).

According to Okello et al. (2019), there is a correlation between the advancing age of small-scale farmers and their reduced enthusiasm for emerging technologies. Adoption of new technologies by older small-scale farmers is influenced by various factors, including perceived ease of use, relative cost, and perceived benefits of using the technology (Wesseler et al., 2017). Moreover, Kinyangi (2014) noted that in addition to adopting new technology slowly, older small-scale farmers in Kenya sometimes shunned it altogether. It is important to note that age plays an essential role in what relates to ideas and the rate at which people embrace new technologies. Opari farmers preferred to get technological information from older persons because the latter were seen as wiser than the former, as observed by Mignouna et al. (2011) and Kariyasa and Dewi (2013). On the

other hand, it has been discovered that age does not have a direct and positive link with technology adoption. However, research show that the younger generation of farmers are more open to embracing new technologies and showing more interest in them, according to Subashini and Fernando (2018), although elderly farmers over the age of 45 still choose the traditional method of exchanging information.

Education is one of the primary determinants influencing farmers' decision-making concerning the risks associated with new technologies and modern information resources. The rate at which small-scale farmers adopt technology was positively correlated with their educational attainment (Oyinbo et al., 2019). The recent studies in South Africa prove the idea a higher level of education of small-scale farmers predisposes them to use digital technologies because of the more effective access to information, better digital literacy, and a likelihood of being less afraid of using the ICT tools (Bontsa et al., 2024, and Smidt and Jokonya 2022). According to Cassie et al. (2015), small-scale farmers who were deemed educated having completed formal or informal education adopted new technologies quicker relative to their counterparts who were not educated. Research by Okunlola, Oludare, and Akinwalere (2011) on perceptions of fish farmers on modern technology, for instance, proved that the level of knowledge had a direct positive influence on the extent of the acceptance of the technology. This is so because the level of education influences the attitude and ideas of the respondents by making them more receptive, courteous, and able to balance the gains of the new technology. Sekabira, Bonabana, and Asingwire (2012) found out that women were more involved in small-scale farming than males because they were the main providers of food for the family as well as being more responsive to ICT.

Another consideration that determines the rate of adoption of a given technology is the level of knowledge that users have. Technology adoption is made easier since it allows farmers to learn about its existence and efficient utilisation. The extended knowledge of farming practices of the experienced farmers of Limpopo leads to the advancement of land management and food security by the application of improved agro-technologies suitable to local circumstances, which is rather instructive of the farming experience in raising awareness of technology and its implementations (Feil et al., 2024). Adoption rates of new technology were found to be poor in areas where agricultural expertise is limited and there is a lack of knowledge about the technology to be adopted

(Araya and Mohammed, 2014). This reveals the fact that farmers will only adopt technology they are aware of or one they have been brought to their attention. The level of uncertainty that surrounds the performance of a technology may yet reduce given access to information reduces it, evaluating a technology takes an objective turn rather than a subjective one the more so given that (Bonabana-Wabbi, 2002). This means not all farmers will embrace a particular technology because they were able to learn about it.

The knowledge and positive attitude of farmers play a great role in the promotion of sustainable practices, such as in-field rainwater harvesting (Dzvene et al., 2022). Furthermore, the review noted that several factors of institutional, economic, technological, and anthropocentric nature defined the manner of using agricultural technology. In particular, their review revealed that the actual implementation of factors that influence the acquisition of agricultural technologies were not universal rates that in some way have a bearing on any given level of technology that is being introduced to farmers. It is therefore important to identify the factors that promote or hinder the adoption of agricultural technology so that appropriate frameworks for technology-based programs to correct the challenges of food production in developing nations can be launched.

2.4 Adoption of information systems among small-scale farmers

Information systems play a crucial role in agriculture to enhance productivity and sustainability by using information that can guide decision-making and communication (Munyai, Ogola, and Modise, 2021). To complete certain tasks, communicate with multiple players, and inform them in diverse organisational or societal contexts, information systems utilize a variety of IT, including computers, mobile applications, cloud computing, and the Internet of Things (IOT) that are rapidly spreading to farm operations to improve farming efficiency and collaboration (Ayim et al., 2022). Information systems play a very big role in farming delivering and providing information to stakeholders in agriculture. The need for agricultural products is rising as the population increases and the proper management of agriculture information access has become paramount (Angell et al., 1991).

According to Saiz-Rubio and Rovira-Más (2020), farmers that choose to adopt some form of technology demonstrate significant benefits, including reduced labour and labour expenses, greater production or cost reductions with little additional work, and the production of high-quality food using more ecologically friendly methods. In addition, according to a study done by Saidu et al. (2017), the potential advantages of ICT include the ability to network agricultural activities globally, conduct research, and plan economic growth for self-sufficiency. Other advantages include the improvement of market activity, the interchange of pertinent information, and profit. ICT adoption in agricultural growth was still hindered by a lack of fundamental ICT skills, a lack of political will, an insufficient and unstable power supply, a bad internet infrastructure, a lack of staff to manage the infrastructure, language barriers, and knowledge of linguistic harmonisation.

However, bringing these benefits to the farm would depend on the desire by the farmers to accept new technologies in their fields as well as the potential for scale economies at each farm, as profit margin rises with farm size. In Turkey, Demiryurek et al. (2008) on their study compared and analysed current information systems used by Dairy Cattle Breeder's Associations members and non-members. They found that among functions of the information system was to generate farming information; however, the agricultural information system was in a position of not enable agricultural research to be used in the modern farming sector.

A study conducted by Thapar (2014) suggests that in order to enhance farmers' engagement in ICT-related programs, the first step is to raise awareness of the many services offered by ICT among rural residents. The personnel and officers dealing directly with the farmers should have enough training in the usage of ICT modules. To address issues and close the rapidly widening digital divide between rural and urban areas, ICT can significantly contribute to the transformation of rural areas.

Small-scale farmers in developing countries are often faced with problems like access to adequate agricultural information and this reduces their production and income. This problem can be solved using information systems since farmers can obtain relevant information on this matter upon which appropriate decisions could be made. According to Damba et al. (2020), growing agricultural production is seen as an important step toward addressing food insecurity and poverty in developing

Africa, especially small-scale farmers. Furthermore, the adoption and use of technology is one such route to increasing agricultural productivity and the way more advanced agricultural technologies are disseminated is a significant limiting factor for technological adoption and utilisation.

Venkatesh (2000) discovered that a person's general ideas about computers were the most significant predictors of their perception of the system's perceived usability. Their results on the study suggest that to improve user acceptance and usage, there is a need to place more emphasis on individual differences than has typically been the case in information systems and human-computer interaction research, which has tended to overemphasize system-related perceptions and design elements. In addition, since a farmer partake in farm information systems, the choice of appropriate IT is usually an individual decision depending on their personality, such as his or her attitude, experience, age, level of education and personal goals (Alvarez and Nuthall, 2006). Stakeholders may opt for various IT systems since all of them are unique or because they want to have an IT system that can be distinctly different from that of any other farmer. Different forms of information systems are adopted by small-scale farmers such as weather alerts through mobile applications, and applications for market prices together with management software for crop and financial management. It means these systems assist in enhancing decision-making and organisational flow.

2.4.1 Types of information systems adopted by small-scale farmers.

Saiz-Rubio and Rovira-Mas (2020) allude to the fact that the agriculture business experience changes through adopting new technology is something that can elicit a lot of enthusiasm as this major primary sector in the economy has the potential to reach another level of farm productivity and profitability. Saiz-Rubio and Rovira-Mas (2020) continue and highlights that precision agriculture is the third wave in the process of the modern agriculture revolution where inputs (what is needed) are put wherever they are needed. The first two waves of this revolution mechanisation and the green revolution with its genetic modification were, respectively, mechanisation and the green revolution. Currently, there is an improvement in farm knowledge systems due to the availability of more data informing it. Further, Zhang and Kovacs (2012) defined Precision agriculture as using geospatial techniques and sensors (like; GPS, remote sensing, GIS, etc.) to control the change in the field and manage the field differently. It is now more frequently employed high-

resolution satellite photography to examine these fluctuations for crop and soil conditions. Moreover, geospatial techniques and sensors has the potential to assist small-scale farmers in making better decisions about how to allocate their inputs, saving production costs, or boosting outputs, and, potentially, improving profitability (Batte, and Arnholt, 2003). However, there is little information available regarding how farmers employ Precision agriculture technology to enhance managerial decision-making or the relative size of benefits and costs of Precision agriculture technologies on specific farms.

According to Fountas et al. (2015), Farm Management Information Systems (FMIS) aid in the management of agricultural productivity. They are highly developed and intricate systems. Their goal is to meet the growing need for lower production costs, adherence to agricultural laws, and maintenance of high standards for product quality and safety. A few of the crucial FMIS components that are made accessible to farmers at a reasonable price include dedicated user interfaces, automated data processing features, expert knowledge and user preferences, standardized data transfer, scalability, and specific designs aimed toward farmers.

The IOT can influence future computers and communications systems that are dependent on advancement in several vital sectors such as nanotechnology and wireless sensors as stated by Zhao et al. (2010). In addition, industrial parts and typical objects will become intelligent parts and possess functionalities through integrated information processing tools. Additionally, they might acquire digital identities that can be accessed remotely, have sensors for monitoring environmental changes, or even become networked and tagged down to dust particles. One application of IOT technology in agriculture for automation is the measuring and control system for greenhouse production environments that gives Real-time indications for the critical temperature, humidity, and soil gathered in the agriculture production process and sent via wireless networks using an M2M (machine to machine) support platform (Zhao et al., 2010; Saiz-Rubio and Rovira-Más, 2020; Muangprathub et al., 2019). Moreover, for the terminal to master the information and direct production, real-time data of the agricultural production environment must be obtained utilising the WAP (wireless application protocol), SMS (short messaging service), and web patterns.

2.5 Attitude towards information systems by small-scale farmers

In the view of Singh et al. (2018), the attitude that small-scale farmers hold on the technology has a great influence on technical change adoption. This has to do with the dispositions or mental state of the small-scale farmers towards their decisions concerning their belief systems regarding their farming practices and productivity (Kidane and Zwane, 2022). However, the attitudes of small-scale farmers are positively and significantly impacted by their experience. According to Agnese and Othman (2021), the attitudes of small-scale farmers toward the usage of digital applications for monitoring are positively correlated with the markers of commitment, trust, resources, time, and recognition. Moreover, the stake of small-scale farmers as well as the farmer trainers in using or approving digital applications is also linked with the connection to the land as well as the traditional practices and cultural values.

Senyolo et al. (2021) observed that while examining the climate-smart agriculture such as drought tolerant seed varieties in Limpopo province, perceived benefits, ease of use and fit of the technology were the key drivers of adoption of climate-smart technologies in small-scale farmers. They argue that the small-scale farmers feel more motivated to utilize agricultural technologies when they consider that such technologies are relevant and compatible with their social economic and environmental situation and when the tech is found useful and useful to their livelihoods. The perception the farmers have for the technologies influences the decision to adopt the technology and this perception is unique since farmers can explain first-hand how functional the technologies are.

In South Africa, age, education, and gender are powerful determinants of the Agricultural technology adoption by small-scale farmers (Senyolo et al., 2021). Lack of knowledge and attitude are the main barriers to technology adoption in rural farming communities, which are constrained by complicated and interconnected obstacles at the national, regional, and international levels that are influenced by sociocultural and environmental factors (Aldosari et al., 2017; Lwoga and Chigona, 2019). Farmers' contacts and interactions with other farmers regarding innovation can positively impact their attitudes and perceptions, especially when contacts and interactions are frequent (Burbi and Rose, 2016).

2.6 The role of extension services in promoting the adoption of information systems among small-scale farmers.

Small-scale farmers are more likely to adopt new technology when extension officials provide services about its advantages (Udimal et al., 2017). Evidence of this was shown by Adejuwon (2019) and Oyinbo et al. (2019) who showed that adoption of new technologies by small-scale farmers was positively impacted by the availability of extension services. In the study, participant small-scale farmers were assisted in learning about new technology and their advantages by extension officers. This accelerated the pace at which small-scale farmers adopted new technologies. Distances between the owners of technology, that is, the researchers, and the users are bridged by extension officers. This reduces the costs of the exchange that are likely to occur when passing information about the new technology to a relatively larger and diverse group of farmers (Genius et al., 2013). In their study, Genius et al. (2013) argue that extension officers have a list of farmers, with whom they seek to work in a way to transform the rest of the farmers in their respective areas of operation or jurisdiction.

The other key determinant in the usage of technology, which has also been realized, is the availability of extension services. Farmers get enlightened by extension officers on the existence, value, and benefits associated with the adopted technologies. These officers help in implementing the technology developed by the research team since they act as a bridge between the technology creators and the end-users. This assists in reducing the amount of information costs entailed in informing a large and varied populace of farmers about the availability of a new technology (Genius et al., 2010). In the main, extension officers deal with a limited number of farmers whom they consider to be their colleagues by one direct or one indirect chance of contributing to all farmers in their corresponding zones.

The agriculture sector is undergoing significant development, which has impacted the agricultural communications sector. For example, Oladele (2015) showed that extension officers in the North-West province in South Africa had a high perception of the ICT effect on agricultural information access. There is a big opportunity for extension officers because there is more information but possibly less understanding than ever before in agriculture. Agricultural prosperity has been largely attributed to the critical role that extension services have played in connecting farmers and

rural communities with agricultural research in information and technology (Mabe and Oladele, 2012). Additionally, extension services offered by governments of developing countries have not been efficient in delivering knowledge and technologies that can empower farmers and farming communities to be food secure and be able to have sustainable development. This is compounded by the inability of extension officers to properly adopt ICTs in pushing new agricultural technology, enhancing the dissemination of information on inputs, finances, and marketing among others, and bridging the digital divide in the rural regions.

Indeed, given that new technologies ought to be delivered to farming communities from research laboratories, the extension mode of technology transfer must be well-coordinated and efficient (Singh, 2016). The process of technology transfer does not have to occur one-time because of the ever-evolving concepts in the field of technology (Chauhan, 2010). In order to provide benefits to farmers timeously, there must be an on-going stream of information about new technology available in the right packages. Thapar (2014) opines that for farmers and rural people to be convinced to embrace any new practices or technologies, effective communication channels are mandatory for the adoption of new technologies. Moreover, the first way of enhancing farmers' participation in ICT-related programs is to consider the concept of improving the perception of rural citizens on the various services within ICT.

The study conducted by ccc Due to a lack of an effective extension model, less than one-third of the innovations developed by the Indian Agricultural Universities and ICAR laboratories were implemented in farmers' fields. With the technical manpower and financial resources available in India, direct interaction between agricultural professionals and all necessary farmer clients cannot be formed effectively.

In a study conducted by Vidanapathirana (2012), the mentioned services that provide agricultural information and knowledge are required to brief their clients who are involved in agricultural activities about new technologies. The significance of research and advisory services is that they offer and serve their clients with unprejudiced, more factual, and exact technical and managerial information as well as recommendations based on the requirements of their customers. Farmers often adapt new technologies in agriculture at a slow pace due to poor connection between research

and extension services, and often research does not address farmers' needs directly. Low agricultural production in many nations has been linked, among other things, to weak links between researchers, extension officers, and farmers as well as to inefficient technology transfer methods, such as information packing, communication channels, and techniques. Therefore, the agricultural sector should establish information systems that integrate farmers, agricultural educators, researchers, extensionists, and farmers.

2.7 Access and the use of agricultural information by small-scale farmers

Information is power and it is a strategic tool that can help anyone who wants to achieve any target or goal he or she may set in life. It remains important to everybody and everything in society and this view also holds to date. Information is one of the most valuable entities required in any civilisation process; hence acquiring and utilising it is a fundamental and meaningful activity. Information is a useful resource that is employed by the user in different ways. In the opinion of Haliso and Ajayi (2014) today, ICT is valuable in that it eases the process of searching and distribution of information while turning them into digital processes. In addition, the Global System of Mobile Telecommunication (GSM) empowers consumers and market players to search for published and exchange adapted agricultural information on marketing and production via e-mail, short message service (SMS), and the Internet. Yet as in the previous point, even where they are aware, they may lack the tools to employ mobile phones or internet connection which has a positive direct and indirect effect on their production.

Small-scale farmers need information from the moment they have a concept until the final user of a product. According to Salau, Saingbe, and Garba (2014), agricultural information encompasses knowledge of the industry's fundamental concepts as well as novel concepts, ideas, and technological advancements that will help the industry advance and raise people's standards of living. That means that every idea, every trend, every stage requires facts to be made a reality. Information can be made available to farmers based on their individual or group information requirements because they have different information requirements depending on their category (Haliso and Ajayi, 2014; Nicholase-Ere, 2017). From the foregoing, it could be argued that farmers need several forms of information.

Small-scale farmers require quantitative data to help them plan for their activities, select their inputs as well as determine where and when to market their produce. Lwoga, Stilwell, and Ngulube (2011) opined that increasing information and knowledge dissemination, and absorption in the agricultural sector, into the sector, and within is crucial in increasing the production of small-scale agricultural producers and linking increased production to rewarding markets. Therefore, standards of living in the national economy, food sovereignty, and rural income would be enhanced.

According to the study conducted by Elly and Epafra Silayo (2013), the most important information needed by farmers in Tanzania farmers concern crop and animal production, markets, financial options, and processing. Furthermore, the study reveals that there is a big disparity in the two wards' information requirements for "information on crop and livestock husbandry" as well as "information on value addition". Due to the relevance of the context and content, farmers frequently rely on traditional, interpersonal methods of communication, and access to non-agricultural (other) information is made possible by modern communication technologies.

According to the findings of the study conducted by Lwoga, Stilwell, and Ngulube (2011), local people (neighbors, friends, and family) were by far the best sources of information for farmers, followed by public extension agencies, and in some places, farmers' associations, village meetings, co-operative unions, agricultural input providers, and NGOs were significant sources of agricultural expertise. In addition, since media and dictionaries were scarce with low literacy levels, other print materials excluding books were rare. The very useful technologies and technologies that exist at the community’s disposal include high technologies like the internet and e-mail were comprehensively used at a low rate apart from radio and cell phones. The results indicate that farmers likely prefer face-to-face communication over written material and more modern ICTs like the internet and e-mail as well as radio and cellphones. However, a study conducted to determine how well rural residents could get information and how well it satiated their information demands by Apata and Ogunrewo (2010) discovered that only 20% of the material on channels such as (Radio, Farmer's associations, groupings, and cooperatives, etc.) satisfies peoples' information needs.

Agricultural informational dissemination comprises different ways that include extension services, online platforms, and farmer networks that help in reaching the farmers with information necessary

for their farming practices. Nonetheless, there are still barriers that farmers face in acquiring and applying agricultural information such as weak access to technology, language barriers, and differences in Technology access and skills gaps in the farming communities. These barriers point to the fact that there is more that needs to be done to ensure that both the dissemination of information for use in agriculture and its subsequent use, occur in a variety of contexts.

2.7.1 Information Dissemination Methods

To raise their productivity and income, Small-scale farmers need to be enlightened about modern agricultural practices. Farmer-to-farmer interactions, extension officers, print media (newspapers, magazines, newsletters, flyers, brochures, and posters), as well as electronic media (radio, TV, film, slides, and film strips), have all been utilized extensively to transmit information to farmers (Okwu, Kuku, and Aba, 2007). The study conducted by Vidanapathirana (2012) on the use of agricultural information systems in rural communities and agriculture explored some restricting factors and apparent restrictions on the sharing of agricultural information and are listed below:

Broadcasting media: Poor reception and coverage are frequent issues in underdeveloped nations. The messages disseminated during the present study fail to consider the information needs of rural people. Despite often relevancy of the information, it is not disseminated at the right time, thus failing to affect the target population. In a study done by Okwu, Kuku, and Aba (2007) in trying to establish the specific periods that the respondents preferred agricultural information programs to be presented, they were made to state that they preferred the shows to be aired in the morning and in the afternoon when they are busy with their farms and cannot watch TV but listen to the radio.

Print media: The ability to transmit messages using leaflets and newsletters among farmers who cannot read is quite limited. The survey carried out by Rehman et al. (2011) also disclosed that farmers obtain their information from the print media in the foremost. Besides, factors such as quality of information, newness, farmers' interest, timely publishing of the newspapers, easy avail-

ability of the print media to the farmers, relevance of information, farmers' literacy level, comprehensiveness, and cost of the print media were among the numerous aspects that influenced their efficiency.

Technical language: Small-scale farmers cannot understand the language that is used to convey information. The findings by Okwu, Kuku, and Aba (2007), indicate that the broadcast in English is more frequent than in the native languages that the farmers could understand.

Existing extension programs: Some of these initiatives have no proper planning and are conducted without the proper consultation of the farmers, whose thinking processes are to be changed. Such agricultural information packages cannot help altering the farmers attitude or even sustain the farmers' focus. Khan and Akram (2012) reported that it is unproductive for extension professionals to disseminate knowledge and information to small-scale farmers in their existing ways. In addition, extension personnel must be retrained to improve their capacity to provide farmers with information and to guarantee extension workers are aware and capable of working with them, extension programs for rural regions should be created (Umar et al., 2021).

Visits to a farm or home were the most effective technique for disseminating agricultural information, followed by field days, demonstration plots, office calls, workshops, and discussions, farmers training sessions, and local agriculture fairs (Khan and Akram, 2012) for farmers opinions of the tactics employed by extension personnel to disseminate new agricultural technologies. In a study conducted in the central region of Khyber Pakhtunkhwa Pakistan by Khatam, Sher, and Ashraf (2013) showed that most farmers were aware of the strategies employed by extension personnel to spread information about agricultural technologies, such as farm visits, demonstrations, and house visits. In another study, Haliso and Ajayi (2014) revealed that Lagos was not only a city that was in the dark regarding methods of information dissemination through internet and telephone technologies that are in vogue in other parts of the world, but it also did not make use of modern techniques of information dissemination through internet and telephone technologies. In addition, to further encourage the production and marketing of farmers, there is a need to assist in the establishment and management of information centres by utilising existing libraries.

2.7.2 Challenges to accessing and using agricultural information.

Rural areas can be described by geographical features such as remote settings or a small coverage area (Nkebukwa, 2018). Other things being equal, the restrictions hamper one's ability to share and receive critical information and to communicate in general. Lwoga, Stilwell, and Ngulube (2011) list the following as the main factors that make it difficult for rural communities to effectively and efficiently access and use pertinent information: lack of access, poor and ineffective techniques for searching information, high cost of information, the absence of other people and ineffective time for acquiring the information. As indicated by Glendenning, Babu, and Asenso-Okyere (2010), farming in India is confronted with diverse challenges, and there is a need to acquire knowledge on ways of dealing with challenges. Issues arising from access to land and water, degradation and exploitation by climate change, and changes in diet preferences are some of the challenges pointed out. Farmers now have the potential to earn more money due to the recent global increase in food prices and inflation, but there is a shortage of knowledge to help them take advantage of this opportunity.

Findings of a study conducted by Ndimbwa, Mwantimwa, and Ndumbaro (2021) suggest that in the analysed locations, outdated and erroneous agricultural expertise and information were provided to small-scale farmers. Lack of education, lack of libraries and information centres, shortage of extension officers, low income, and illiteracy were the factors that restricted the access to and use of current and accurate agricultural information and knowledge. Radio and TV programmes related to agriculture were not up to the mark the packaging of the information and using of a general language other than agricultural terms by the extension officers were also factors. It has long been an issue to have insufficient knowledge and information to encourage creation. As a result, small-scale farmers rely mostly on informal networks of information and knowledge transfer, including those created by other farmers, kin, friends, and neighbors. These routes of interpersonal communication can occasionally be faulty, inaccurate, or impractical. Unexpectedly, it was discovered that the tasks carried out by extension officers were inadequate.

2.8 Barriers to the adoption of information systems among small-scale farmers

Consequently, Nmadu, Aiyelitsoya, and Sallawu (2013) observed that language, indigence, and illiteracy ranked among primary challenges that hampered small-scale farmers in Nigeria from embracing digital technology to acquire marketing information. In a study conducted among small-scale farmers in Kenya, it was established that they were restricted by inadequate access to information, lack of infrastructure, low illiteracy levels, unsuitable information services, and a shortage of technical skills (Odini, 2014). Indeed, the major challenges that I have identified appear to stem from technology. Tummers, Kassahun, and Tekinerdogan (2019) asserted that issues with interoperability to system integrate farming management systems and their parts hinder the "substitutability" of the apps and platforms and thus limit their usefulness and chances of future implementation of such technology (Kruize et al., 2016). Some of the important criteria stated by farmers include the ability to either accommodate new software or incorporate old software. The lack of any standards for data exchange means that data standards are directly linked with the issue of interoperability problems.

The above study enumerated several factors that limit the deployment of digital technologies in small-scale agriculture, which are not within the farmers' control. Due to their meager incomes, small-scale farmers often find it difficult, if not impossible, to buy digital technology on their own. As a result, the productivity and economic sustainability of digital technology are constrained. This means that government and other agricultural sector development organisations' involvement is necessary for digital technology to be successfully applied in small-scale agriculture (Smidt and Jokonya, 2022).

According to Musa, Githeko, and El-Siddig (2013), several issues with Sudan's agricultural information system had an impact on other information and knowledge systems in the nation. Overall, an organisation's resources may not be sufficient to meet the nation's ICT needs. This is made worse by the lack of coordination in the management and distribution of information. As a result, the system develops several flaws and has problems including the full omission of some agricultural knowledge, fragmentation of information resources, inadequate services, and expensive duplication of information resources and services.

Most rural areas in developing countries are outside the range of mobile signals due to poor infrastructure and inadequate electrical connections, which disadvantages underprivileged people (Treinen and Van der Elstraeten, 2018). The challenges are occasioned by the fact that many developing nations endure weak or no ICT infrastructure; hence, it becomes virtually impossible to give the information needs of the rural-based farmers via internet-based information systems. Since it is difficult to link up the foregoing rural farmers with ICT instruments such as internet service providers, reliable internet, etc., it is not easy to extend Internet information services to the farmers (Mbagwu, Benson, and Onuoha, 2018).

Overall, there is a negative relationship between the type of technology use and success, the higher the complication level of the technology the lower the chances of success (Shi and Yan, 2016). This is the easiest thing small-scale farmers do, they decide either to never adopt a particular technology or adopt it later when it is extremely hard to do so for a business establishment. From the following findings, it can be concluded that rural farmers from various developing countries lack adequate technological competency that is essential in meeting the required information needs (Mbagwu, Benson, and Onuoha, 2018). Besides, the partial barrier to the success of information systems practice in small-scale farming is the apprehension of farmers to embrace change due to a lack of knowledge.

2.9 Summary

Small-scale farmers require information systems more than before because the resources assist them in accessing current and relevant agriculture information. According to this literature analysis, several information systems that small-scale farmers often employ have been highlighted and they are FMIS and precision agriculture. These technologies could enhance the productivity and the financial returns of small-scale farming businesses. policymakers and other stakeholders should thus focus their efforts on influencing small-scale farmers to adopt information systems.

Information systems can help organisations, such as small-scale farmers, increase productivity, revenue, and food security. However, there are several reasons why information system adoption

is still limited in many developing nations, this includes inadequate infrastructure, low literacy levels, restricted technology, and limited information system acceptance. This means that agricultural information is crucial for small-scale farmers as they require knowledge to make appropriate decisions. Information systems are often sophisticated, and their execution may be offset through their acquisition, hence minimizing their potential impact. The time taken to seek information has been significantly impacted by inadequate facilities in rural areas. Removing barriers to IT in small-scale farming has proved difficult due to a lack of information on how to enhance improved telecommunication services in rural areas.

The research, therefore, asserts that small-scale farmers require agricultural information to enable them to make good decisions about their farming practices. The information is obtained from different sources and certain factors affect small-scale farmers decision-making. Since farmers are required to make sound decisions and improve their farming practices, they need accurate and reliable information. Enhancing the agricultural extension services and other official channels can assist small-scale farmers improve their performance by providing them with correct and reliable information. Farmers access information via print, broadcast, and technical language media, in addition to extension programs. In this case, these initiatives have been depicted to support the adoption of contemporary farming methods among small-scale farmers.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

The purpose of this chapter is to describe the research methodology employed to establish the extent to which information systems were adopted and used in farming activities among small-scale farmers in the Vhembe district of Limpopo province, South Africa. It includes the research approach, methods for data collection, methods of selecting samples, and methods for data analysis. It aims at presenting a clear systematic framework for explaining the effects of information systems on agricultural processes and the perceptions of farmers regarding such technologies as well as the duties of the extension officers in enhancing the utilisation of the information systems. This chapter makes the findings of the study credible, dependable, and suitable for small-scale farming in the context of the Vhembe district by outlining the research methods in detail.

3.2 Research design

The study will use the quantitative cross-sectional survey as its methodological approach. The selection of a cross-sectional survey design for this study on information systems among small-scale farmers in the Vhembe district was driven by several considerations that make it particularly suitable compared to other research designs. Cross-sectional surveys are advantageous because they provide a snapshot of a population at a single point in time, making them efficient for capturing a wide range of data from a large sample of respondents concurrently. This approach allows for the collection of demographic information alongside specific responses to research questions, thereby providing a comprehensive overview of the status and attitudes regarding information systems usage among small-scale farmers in the Vhembe district.

The research design and positivist paradigm of research qualify the research as part of quantitative research, and it is under the cross-sectional survey design. The positivist paradigm presupposes the view of the objective reality accessible to measurement on the basis of empirical observations and statistical description (Zyphur and Pierides, 2020). This philosophical approach will support using structured research tools (questionnaires), as they allow collecting measurable data that will help the researcher find trends, test theories, and conclude them with generalisations about the population of the study (Creswell and Creswell, 2018).

Moreover, the rapid data collection process inherent in cross-sectional surveys facilitates timely insights into the subject matter, which is crucial for understanding dynamic phenomena such as technology adoption and agricultural practices. It is noteworthy that several methods can be termed ‘’quantitative research’’ if these are aimed at systematically studying quantitative or statistical characteristics of social realities (Watson, 2015). As a result, measurement is a key feature of quantitative research, and this type of study posits that the subject under consideration is measurable.

In contrast, longitudinal designs, which involve studying the same group of individuals over an extended period, were not chosen due to practical considerations. Longitudinal studies require significant resources and time commitment to track changes and developments over time. They would not be as feasible for this study given the potentially transient nature of technology adoption and the logistical challenges of maintaining contact with small-scale farmers in a rural setting like the Vhembe district. Additionally, while qualitative methods such as in-depth interviews or focus groups provide rich, contextual insights, they may not capture the breadth of data needed to establish statistically significant trends and patterns across a larger population. Therefore, the cross-sectional survey design was selected to efficiently gather quantitative data that can provide a broad understanding of the current landscape of information systems use among small-scale farmers in the Vhembe district, facilitating informed policy recommendations and interventions.

3.3 Population and Sample

3.3.1 Population

The target population of this study comprised all small-scale farmers operating in different regions within the Vhembe district of the Limpopo province, South Africa. The term “population” refers to the whole number of individuals, occurrences, or objects in which a given researcher seems to have an interest in studying (Sekaran and Bougie, 2019). The comparative studies used in agriculture indicate that the behavioral patterns of rural population may be similar so that they can facilitate easier generalization of the results (Tshabalala and Sidique, 2020).

This group consisted of farmers who practiced both subsistence and small-scale commercial farming that was the backbone of the district's agriculture. The participant farmers often used traditional agriculture methods, have poor access to modern tools and techniques in farming, and were largely dependent on farming activities for their sustenance. Given this target group, the study was intended to provide a broad picture of the status of information systems adoption and use within the district. To achieve this, the research involved sampling farmers from different localities within the Vhembe district to avoid a biased sample that would likely cover only one aspect of small-scale farming in this region.

3.3.2 Sample

Sampling involves identifying the right individuals, items, or events to represent the entire population (Sekaran and Bougie, 2019). About the existing theories, sampling can be applied to generalize about a certain group or make conclusions regarding such a group. There are commonly two major types of sampling methods used: probability sampling whereby every member of the population is subject to a definite probability of being selected, and non-probability sampling where a sample is chosen based on subjective assessment other than randomization (Bhardwaj, 2019).

In probability sampling, the probability of selecting each element of the population is known and usually equal, but in non-probability sampling, there is no way of knowing the probability that any element of the population will be selected: this is unknown, and the probability cannot be calculated (Wiśniowski et al., 2020). A total of 306 small-scale farmers responded to this study through a survey aimed at providing information on several factors regarding agricultural information systems and sub-implementation and services. The purpose of this sample size was to gain representativeness within the population of interest so that generalized findings could be made.

The Small-scale farmers were identified using the agricultural database and community registration list existing in the Vhembe district in Limpopo province. From this list, a random sampling method was applied to avoid bias since each farmer was allocated an equal probability of being selected. This approach reduced bias and ensured that the study offered a relative of the existing

attitudes and practices towards the adoption of information systems amongst small-scale farmers in the Vhembe district in Limpopo province.

3.4 Pilot Study

To ensure the internal validity of the study, a pilot test was conducted before administering the main survey to establish the reliability and validity of research instruments and procedures. The pilot study in the current research was conducted on a smaller group comprised of 30 small-scale farmers from different areas within the Vhembe district. The main goal of this pilot was to high-light and solve important concerns that might be arising from the survey questions themselves, the processes of data gathering, and the overall sustainability of the given research study.

The feedback gathered from the pilot participants was analysed to improve the survey questions, such as question clarity and appropriate response choice. For example, some concerns such as lack of clarity in some questions were pointed out and eliminated after receiving feedback during the pilot testing to make the final survey more comprehensible to the participants in the main study. Furthermore, the pilot study was carried out with the objectives of establishing the efficiency and effectiveness of the survey in terms of the amount of time it would take to administer the survey and the various processes that must be followed when gathering the data. Some changes were made to facilitate the gathering of the data, these were in line with what was learned in the pilot study to ensure that the main study was done in the most efficient manner possible. The outcomes of the identified pilot study were used in adjusting the main survey considering validity and reliability, which ensured the validity of the presented study results.

3.5 Data collection

Primary and secondary sources can provide data. Primary data, according to Sekaran and Bougie (2019), are the initial facts that the researcher has personally learned about the variables that are relevant to the study's particular goal. As opposed to primary data, secondary data is information gathered for objectives unrelated to the issue. The primary source of quantitative data for this study is a survey questionnaire that will be given to small-scale farmers in the Vhembe district of the province of Limpopo.

After the pilot study had been conducted, relevant adjustments can be made. As a result of this exercise, data collection for the main study was conducted on a sample size of 306 respondents selected from small-scale farmers in the Vhembe district. The questionnaire was developed into two parts: a demographic section, and Likert scale questions intended to assess farmers' attitudes, the extent of execution of agricultural information systems, and access to agricultural information.

The questionnaires were allocated through various means to ensure that a mixed group of representative small-scale farmers within the Vhembe district municipality was covered. There were options given to participants to fill in the hard and electronic copies through email and various social media links. In most cases, questionnaires were administered directly face-to-face basis where possible and online in those instances where there was no direct access to the participant readily possible.

Before responding to the questionnaires, the objectives of the study were clearly explained to each of the small-scale farmers, including aspects of voluntariness and anonymity of the response, that each respondent appended a signed consent form to the questionnaire was, in principle, an ethical requirement that guaranteed willingness to participate in the study before respondents completed the survey instrument. Assistance was made available throughout the data collection period to individuals who may need help in completing the survey so that it was inclusive and procured data accurately.

The survey was completed within the estimated timeframe, and the assistance of a researcher was available to respondents where necessary to complete the questionnaire. This rigorous data collection exercise was executed in pursuit of ensuring the reliability and validity of the research findings through the compilation of appropriate datasets that would truthfully depict views and experiences on agricultural information systems by small-scale farmers within the Vhembe district.

3.6 Inclusion and exclusion criteria

The inclusion criteria were aimed at specific demographic indicators that are significant given the objectives of the work. In this case, farmers should be considered because they are above 18 years old and legally considered adults capable of giving informed consent. The minimum age requirement establishes the legal capacity for individuals to reason and decide whether they want to participate in the study.

Moreover, the limitation of subjects to only small-scale farmers is another deliberate and relevant sampling bias. These reasons include the fact that it is postulated that small-scale farmers are different from large-scale or commercial farmers in terms of the challenges they encounter, their requirements as well as their experiences using information systems for farming. Due to the focus on a specific group of farmers in the Vhembe district of the Limpopo province, the study may provide more relevant data that is relevant to this subset of farmers which can lead to specific recommendations which may require specific actions to be taken in this regard.

3.7 Data Analysis

The general process of identifying relevant information in data and making necessary calculations and estimates about the data is called data analysis (Ibrahim, 2015). The procedure is used to manage the large quantities of acquired data in a bid to have meaning from the data. This stage of the analysis of the quantitative data, according to Marshall and Rossman (2014), may be described as the following: The most difficult, the most complicated, the most perplexing, the most enjoyable, and the most creative.

Data analysis for this study was completed using Statistical Package for Social Sciences (SPSS) version 29.0. To analyse the demographic and Likert data of the respondents and their answers to the survey questions, the research used descriptive statistics, correlation, and regression. Basic quantitative analysis including frequency distributions, relative frequency distributions, means, and standard deviations will be used to present the sample information. Exploratory factor analysis (EFA) on the use of information systems in farming within the Vhembe district of Limpopo province was conducted. The reason for selecting the EFA approach to analyse the use of information

systems in farming within the Vhembe district is that it is a simple way of identifying underlying factors or dimensions in a dataset. The method is useful in exploring complex relationships amongst the variables when there are no apriori hypotheses about the structure of these relationships.

The Kaiser's criterion is used; the eigenvalues greater than one are considered important, and the cut-off loading value is set equal to 0.40. The method of analysis adopted here is the maximum likelihood estimation, which is considered efficient in estimating the parameters and nonlinearities in the data. Furthermore, to take into consideration anticipated theoretical associations among the variables, the oblique rotation method of ProMax is chosen. ProMax improves the credibility of the analysis because it permits factors to co-vary, which makes extracting relevant factors easier. SPSS and the selected statistical methods of descriptive statistics and EFA with ProMax rotation were chosen for rigorous analysis of the survey data with valuable insights to be offered about factors influencing the adoption and utilisation of information systems among small-scale farmers in the Vhembe district. These suit very well with the objectives of the study, which seek complex relationships and descriptions of underlying factors contributing to the effective implementation of agricultural information systems in this region.

3.8 Reliability and Validity

To increase the reliability and validity of the study, various methodological precautions were taken at every stage of the investigation. Sekaran and Bougie (2019) stated that when establishing the reliability of a measure it establishes the lack/absence of bias of the measure, which in essence ensures consistent instrument or internal consistency validity can therefore be described as the extent to which an instrument is a measure of what it is Idea or intended to be. These are the use of standardized measurement instruments, proper data collection techniques, and following proper steps in analysis and applying the right test like factor analysis. Furthermore, attempts were made to minimize the possibility of sample bias and to generalize the results to the rest of the small-scale farmers in the Vhembe district.

Relevant statistical techniques, and of prime interest factor analysis, were central in establishing the measurement constructs used in this study. This provided the means to confirm that the underlying dimensions in the data would establish the theoretical framework in line with empirical observation. This not only strengthened the validity of the study through an assurance of the effectiveness of its instruments but also captured the target constructs in carrying out the inference or generalisation of findings beyond the sample under study.

Furthermore, in order to secure the reliability of the survey instrument, the internal consistency was checked on Cronbachs alpha coefficient. This statistical indicator determines the extent to which a collection of items is grouped together as well as the reliability of the scale. The reliability of results were good with Cronbach alpha being 0.779 to 0.945. In particular, the highest reliability was returned in the construct of Adoption and Utilisation of Information Systems (alpha = 0.945), followed by attitude towards Information systems (alpha = 0.943), and influence and support of extension officers (alpha = 0.909). These values are much above the generally embraced value of 0.70, and this validates that all items in each construct reliably measure the same concept.

3.9 Ethical Consideration

Ethical concerns are critical, and it is customary to adhere to the University of South Africa (UNISA) procedures for ethical approval for this study. Ethics, according to Kahari (2010), is a code of conduct that defines how a certain person or a specific group should behave when interacting with interview subjects, employers, other researchers, and respondents. This helped to ensure that the rights, self-determination, and welfare of the agricultural community were not violated during the study.

The approval from the UNISA ethical committee supports the research and justifies the participants' treatment as well as their anonymity as well as their consent. The research was subjected to rigorous ethical scrutiny to ensure there were no adverse impacts and adherence to ethical principles. For the study in the Vhembe district of the Limpopo province, it was important to obtain participants' informed consent. Every volunteer was provided with a statement of the purpose and

design of the research, the possible harms and advantages, and any other information necessary for informed consent.

Protective measures were therefore taken to ensure the confidentiality of information regarding the participants. First, data collected from the participants were anonymized through unique codes and not by any form of personal identifiers; this step prevent one from identifying a person from the data. Next, every electronic data is stored on secure, passworded servers, with the physical documents kept in locked cabinets, accessible only to the members of the research team who have authorized access. The procedures regarding confidentiality were explained in the informed consent forms and emphasized that the information provided would not be shared with unauthorized parties. It was clearly stated that all data reported would be in aggregate form, meaning that the responses would not be traceable back to the subject. These precautions were important in building trust and integrity throughout the process by ensuring confidentiality and privacy for both parties concerned in the study.

3.10 Summary

This study adopted a cross-sectional survey design to assess the level of adoption and use of Information Systems among small-scale farmers in Vhembe district in Limpopo province. There were 306 small-scale farming households in the study, selected using a simple random sampling method. Before administering the survey questions for the main study, a pilot study involving 30 farmers was conducted to evaluate the structure and reliability/viability of the survey instrument, which required some modifications.

The second data collection procedure was to complete the revised survey in person to achieve a high response rate. The statistical analysis was done on SPSS software with a version of 29.0 including descriptive analysis and EFA using maximum likelihood with ProMax rotation factor analysis to test for the factors that influenced the use of technology. To ensure that research was ethical; ethical approval was sought from UNISA, the participant's consent was sought, and their identities were concealed.

CHAPTER 4: SUMMARY OF RESULTS

4.1 Introduction

This chapter presents the analysis of the responses from 306 participants, focusing on three main areas, demographic attributes, factor analysis, and the extent of application and use of information systems. This paper presents an overview of the sample population, and the main variables used in this study's assessment.

First, the demographic data of the respondents are examined. This section expands on different characteristics including age, gender, education level, and work experience. This is important because these demographics give context to the subsequent analyses and help to highlight patterns or trends that might affect the use of information systems in small-scale farming. In this study demographic analysis revealed a predominant representation of male participants comprising 63.7% of the total sample (195) respondents whereas female participants constituted 36.3% (111) respondents

After that, the chapter provides a detailed factor analysis. This statistical tool is used to examine the association between two or more variables and to decrease the data by forming factors. The study identifies five factors influencing information systems adoption among small-scale farmers. Each factor is a different perspective of the respondents about information systems, their impact, support, and role of extension officers, attitude, barriers, and source of agricultural information. Apart from confirming the constructs employed in the study, the factor analysis identifies the dimensions that are most influential in capturing the variation in responses.

Finally, the chapter focuses on the extent of information systems adoption and utilisation among the respondents. Small-scale farmers with a bachelor's degree or higher were found to be more likely to adopt and use information systems than other small-scale farmers with lower education levels. This section analyses to what extent and how participants are using information systems in farming. They provide knowledge of the degree of information systems implementation in the sector today and the degree of use of information systems by the different stakeholders in the

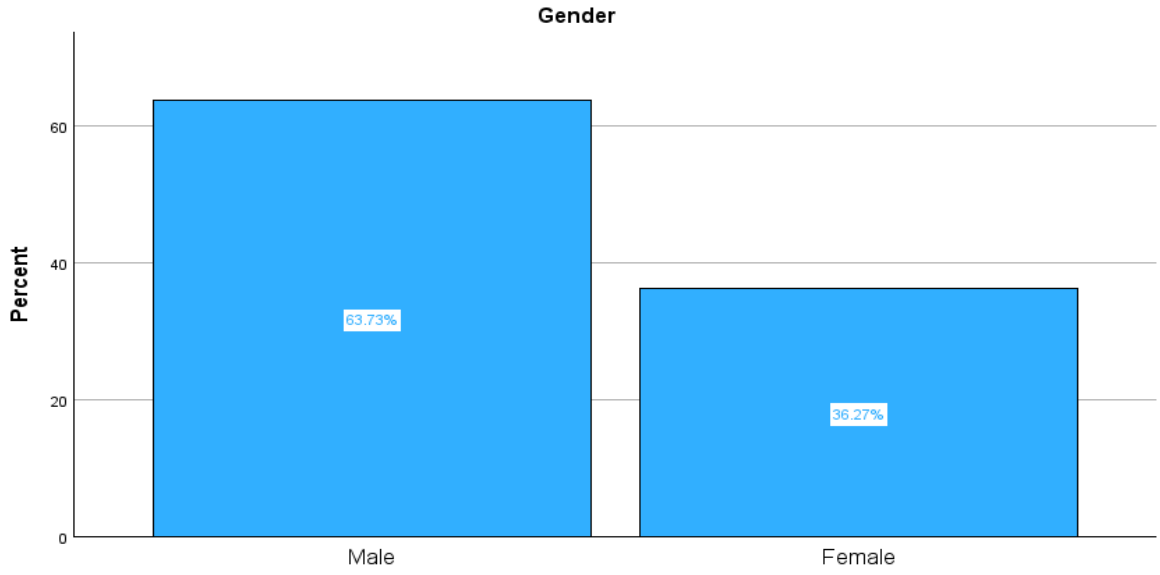
sample. This knowledge is crucial to defining gaps, challenges, and opportunities for IT in agriculture application enhancement.

4.2 Demographics

4.2.1 Gender

The gender distribution of the responses to "The adoption and utilisation of information systems in farming at Limpopo province Vhembe district". in Figure 1 shows that the male participants were the most dominant compared to female participants. Of the 306 participants, 63.7% of the sample population, 195 reported being male. On the other hand, 111 respondents, or about 36%. 3% of the total, identified as female.

Figure 1: Gender of Respondents



The fact that most of the participants were males imply that men may have been more involved in farming-related issues and information systems in this area. This may affect the outcome of the study in the sense that the male small-scale farmers may have had different perceptions, usage, and attitudes towards the use of information systems than the female farmers. For example, male small-scale farmers may indicate a higher usage and awareness of information systems if they have better chances of acquiring such technologies. According to Sekabira, Bonabana, and Asingwire,

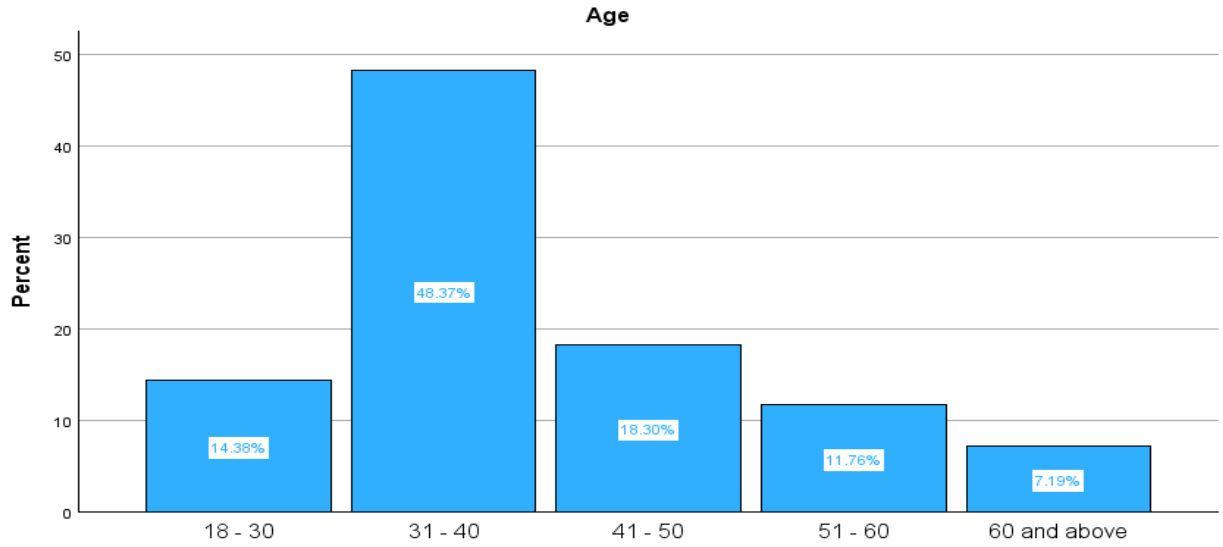
(2012), women are often portrayed as more involved in small-scale farming because they are primarily charged with stewardship of ensuring that food is secure in the home, and they are supposedly more devoted to ICTs.

Similar works of other researchers such as Treinen and van der Elstraeten (2018) point out that women have more involvement in the innovation of agriculture and income generation all over the world. However, it was noticed from the survey results that men are more likely to have responded compared to women in this study area. On the other hand, the smaller number of female participants could be suggestive of challenges that limit women in accessing information systems in farming. Such factors might include the inability to access technology, lower education/training levels, or socio-cultural factors that hinder women from engaging in certain forms of farming.

4.2.2 Age

The small-scale farmers' age distribution observed when the questionnaires were administered, gives the demographic profile of the farming community in the study area, Vhembe district in Limpopo province. This means that the data analysis revealed patterns within different age groups, which provides a comprehensive understanding of the role of age in this select population of farmers.

Figure 2: Age of Respondents



The result of the survey in Figure 2 revealed that a greater percentage of the respondent small-scale farmers (48.4%) were within the age bracket of 31 - 40 years. Subashini and Fernando (2018) stated regarding the sharing of information that the conventional approach is still preferred by small-scale farmers aged over 45 years and are reluctant to accept new technology, however, the younger generation show more interest on it. From the data presented here, it is evident that most of the participant small-scale farmers in the area were at an economically active age, a clear indication that they were key employees who couldn't foster local income-generating ventures in agricultural activity. Furthermore, the survey also proves that the representation varies from one age group to another. 18.3% of respondents were aged between 41 - 50 years, and 11.8% are between the age of 51 - 60. Moreover, only 7.2% of participants were small-scale farmers of 60 years and above. These older age groups remain part of the farming community although their representations are lower than the younger age groups. They proved invaluable in bringing experience and knowledge to techniques used in farming.

Conversely, a young age group which encompasses people between 18 - 30 years experienced a representation of 14.4% of the sampled respondents. This observation draws attention to some of the possibilities of older small-scale farmers turning down alternatives that may reduce their commitment to a farm, thus pointing to the fact that more needs to be done to ensure that they encourage the youth to start and continue farming. An effort should be made to achieve and expand the youth's participation in agriculture as this would assist in making farming progressive and sustainable. This is done through campaigns that encourage young people to consider farming as a business and ensure that those who wish to farm receive knowledge and tools that may have a positive impact on their farming and make it easier for them to engage in farming. In my view, the youth should be encouraged to participate in agriculture practices more so because they are flexible and can easily adopt new technologies that can help in the improvement of outputs.

4.2.3 Level of Education

The educational background of the respondents in survey research projects such as "The adoption and utilisation of information systems in farming at Limpopo province Vhembe district" should begin with an analysis of the level of education of the small-scale farming community being surveyed.

Figure 3: Respondents level of education.

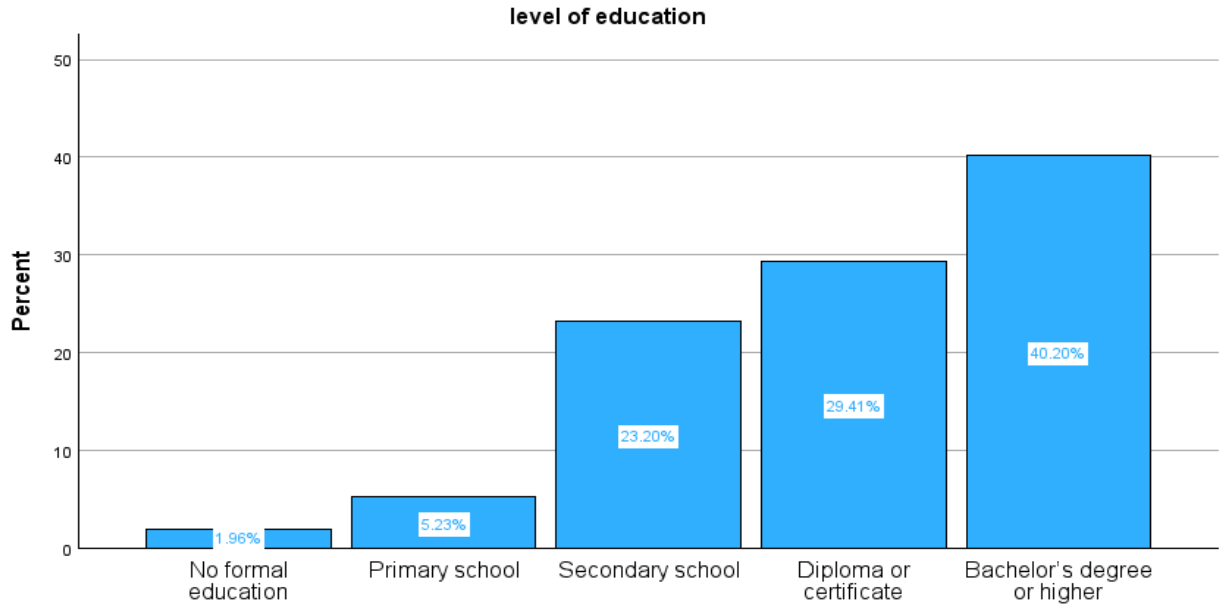


Figure 3 shows that the respondents' diverse educational backgrounds make it evident that they belong to various educational categories in varying degrees Notably, a sizable fraction of participants, comprising 40.2% of the sample, hold a bachelor's degree or higher. The recent studies in South Africa prove the idea a higher level of education of small-scale farmers predisposes them to use digital technologies because of the more effective access to information, better digital literacy, and a likelihood of being less afraid of using the ICT tools (Bontsa et al., 2024; and Smidt and Jokonya 2022). This finding highlights the notable representation of individuals with advanced education within the small-scale farming sector and may point to a trend toward higher educational attainment among farmers in the region.

The educational distribution among the respondents points to several possible factors that may affect the adoption of information systems in small-scale farming. Small-scale farmers with education levels of bachelor's degree and above are more likely to adopt new technologies as well as adopt innovative methods of farming. This could lead to more efficient and productive farming methods; this is because an educated farmer will be able to understand and implement advanced methods in farming as well as technology. It can also lead to better decision-making in their decisions on farming activities since they can access and use a wider variety of information sources.

There are also significant percentages found in the survey regarding the other categories of education. About 29.4% of people who finished their studies had a diploma or certificate to prove it which indicates that indeed a significant population had a technical or vocational education. This group is most likely to have been hands-on skills and knowledge that could be utilized in enhancing farming practices. Moreover, 5.2% of the participants had only a primary school education while 23.2% percent had attended secondary school education. 2.0% of the population reported having never attended college at all. This disparity in education level among the small-scale farmers may impact them differently in terms of their capacity to adopt and benefit from the information systems. The less educated may struggle to comprehend and employ sophisticated technologies, which could reduce their engagement in the digital transformation of agricultural practices.

4.2.4 Number of Experience

Information regarding the number of years that the participants in the study "The adoption and utilisation of information systems in farming at Limpopo province Vhembe district" were able to come up with can be obtained by inspecting the years of tenure and experience the small-scale farming community put forward.

Figure 4: Respondents Farming Experience

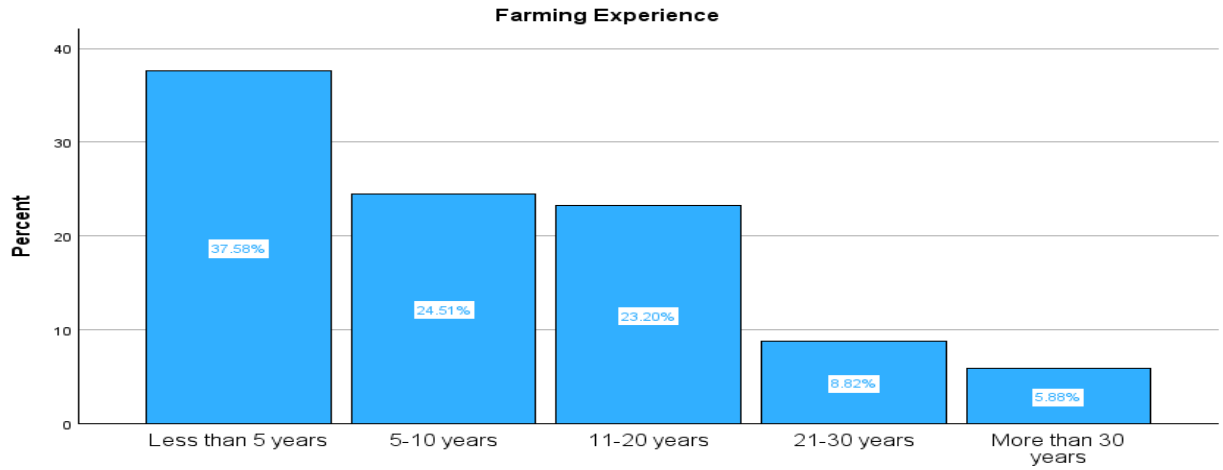


Figure 4 shows that young small-scale farmers with experience of less than 5 years of farming make up a significant proportion of the sample and contribute 37.6% of the total. This means that several people are in a new way of farming or people who have changed their career path and entered farming. In addition, using the results of the survey, participants characterized by varying levels of experience are selected. While 23.2% of respondents answered that they had been involved in the agricultural business for 11 - 20 years. 24. 5% of the respondents had been farming for 5-10 years, showing that there was a moderate number of small-scale farmers with farming experience. They probably knew about agricultural practices and might be practicing a combination of traditional and modern practices.

In addition, there is a comparatively low but still fairly large number of responders, 8.8% had been farming for a period of between 21 - 30 years. This group comprised individuals who had been very vibrant within the agriculture sector for many years, and these people possessed quite a lot of insights and valuable experience. Moreover, 5.9% of the participants said that they had been engaged in farming for more than 30 years, which suggests they were more mature and experienced people, who could share their valuable experience and real-world advice with other farmers.

This distribution of farming experience means that extension services, as well as training, need to be customized appropriately based on respondents' needs. The first training that can be provided is orientation training for the new farmers since they might not be conversant with the best practices and modern technologies necessary for farming. The second type of training can come in the

form of master training where the experienced farmers share their knowledge through their experience with other empowering techniques. Given the foregoing, the agricultural development initiative can now centre strategies on the specific needs and optimum experiences of the identified experience groups to help the farming community in the Vhembe district embrace innovation and re-awaken the traditional way of farming.

4.2 Factor Analysis

An EFA was then conducted on the adoption and utilisation of information systems in farming in the Vhembe district of the province of Limpopo. EFA was preferred to Confirmatory Factor Analysis (CFA) since the focus of the study was to examine the unidentified factor structures with no specified model. This rendered EFA more adequate to detect trends in the data particular to the small-scale farmers in the Vhembe district. The Kaiser's criterion was used whereby the eigenvalues had to be greater than one and the cut-off value was set at .40. The maximum likelihood estimation is commonly accepted as efficient for parameter estimation and capturing nonlinearity in data and this estimation method was used in the analysis. Additionally, ProMax, an oblique rotation technique, was chosen. It was anticipated that the objects under examination would exhibit conceptual relationships, so the application of an oblique rotation method was justified. ProMax improves the validity and accuracy of the analysis results by allowing factors to correlate with one another, which makes it simpler to extract more significant and interpretable factors.

Initially, maximum likelihood factor analysis with the ProMax rotation method was performed again on all 30 items and 2 items ("In my farming operations, I use information systems for planning and decision-making" and "To handle data and maintain track of records on my farm, I use information systems") were removed due to an excessively high correlation that prevents multicollinearity. Five factors were extracted after a second look at the factorability of the remaining 28 items, and the results can be explained by Kaiser-Meyer-Olkin (KMO) and Bartlett's Test of Sphericity, communalities, factor extraction, and factor pattern.

4.2.1 Kaiser-Meyer-Olkin and Bartlett's Test of Sphericity

KMO test yielded a value of 0.917 as the results are shown in Table 1. Given that a KMO value of 0.6 is usually regarded as acceptable, this value suggests a high degree of sampling adequacy for factor analysis. Factor analysis is justified because the KMO value of 0.917 indicates that a significant amount of the variance in the variables can be attributed to underlying factors. Furthermore, a chi-square value of 6601.994 and a p-value less than 0.01 indicated that Bartlett's test of sphericity was significant. This important finding confirms that the variables are sufficiently intercorrelated to move on to factor analysis by showing that the correlation matrix is not an identity matrix.

Table 1: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.917
Bartlett's Test of Sphericity	Approx. Chi-Square	6601.994
	df	378
	Sig.	<.001

4.2.1 *Communalities*

Communalities are the share of variance for each variable that can be accounted for by the factors extracted. Higher communalities mean that a greater part of the variance is being captured by common factors, so variables are more likely to have shared variance. The acceptable value for communality is generally above 0.4 though in certain situations even values as low as 0.2 might suffice provided these variables are theoretically important (Zeynivandnezhad, Rashed, and Kanooni, 2019).

In this study, communities were assessed for each variable to determine whether they belonged in the factor analysis. Table 2 lists the original and extracted communalities for each variable. All communalities were found to be above the 0.3 cutoff point, indicating that a significant portion of the variance for each variable could be explained by the factors that were extracted. These figures provide confidence that the factors found through analysis correctly represent the underlying relationships between the variables.

Table 2: Communalities

	Initial	Extraction
My farming operations today make use of information systems.	.784	.795
Information systems have helped me become more efficient in my farming operations.	.782	.797
To access agricultural data relevant to my farming methods, I regularly employ information systems.	.817	.850
Overall, Information systems are helpful for enhancing my farming practices.	.822	.825
I believe information systems can make my farming practices more productive.	.686	.672
I am interested in utilising modern information systems and other technologies in my farming operations.	.786	.789
I am motivated to adopt and employ information systems for my farming practices because of my favourable approach towards them.	.736	.730
I view information systems as useful instruments for making wise farming decisions.	.753	.771
I think information systems can keep me informed about the most recent agriculture techniques.	.755	.762
The way I feel about information systems has a beneficial impact on how I use these technologies.	.734	.739
Agricultural extension officers regularly push me to think about implementing information systems for my farming practices.	.754	.751
Agricultural extension officers provide me with advice and training on how to use information systems in my farming activities.	.798	.815
I believe that agricultural extension officers are helpful and play a significant role in encouraging farmers to use information systems.	.652	.415
The difficulties associated with adopting information systems are properly addressed by extension officers.	.770	.795
The assistance of extension officers is essential in removing obstacles to the adoption of information systems.	.646	.404

Extension officers create awareness about the advantages of using information systems in farming.	.836	.874
I rely on agricultural extension services to provide me with knowledge about farming techniques.	.376	.308
I use websites and online platforms to research agricultural practices.	.528	.521
I consult other farmers and local networks to find out knowledge about agriculture.	.465	.470
I rely on radio and television programmes about agriculture for information.	.356	.368
I use pamphlets and brochures printed on paper to get agricultural information.	.566	.608
Overall, I have no trouble getting the agricultural information I need for my farming activities.	.537	.512
The complexity of information systems affects my willingness to adopt them.	.497	.473
It is difficult for me to use information systems successfully because of my lack of technical expertise and experience.	.593	.590
The expense of obtaining and using information technology is a significant barrier for me.	.654	.725
Information systems are harder to deploy since people are unaware of their advantages.	.619	.681
I do not have reliable internet connectivity, which affects my ability to use information.	.458	.439
My decision to implement information systems is influenced by recommendations from other farmers or agricultural professionals.	.460	.386

Extraction Method: Maximum Likelihood.

4.2.2 Factor Extraction

The eigenvalues and total variance explained by the factors are shown in Table 3. In this study, the maximum likelihood method was used to extract factors. 28 factors were initially found in the dataset. However, five unique factors which all had an eigenvalue greater than 1 were kept after extraction and ProMax rotation. Combined, these five variables explained 63.80% of the variance in the total. The results surpass the recommended threshold of at least 50% variance explained by

the retained factors, which is generally the case. These six factors account for 63.80% of the common variance among the 28 variables, according to the analysis.

Table 3: Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	10.741	38.361	38.361	10.253	36.618	36.618	8.089
2	3.354	11.980	50.341	3.005	10.732	47.350	7.474
3	2.754	9.837	60.178	2.465	8.803	56.154	3.782
4	1.627	5.810	65.988	1.055	3.767	59.921	7.784
5	1.199	4.281	70.269	1.087	3.880	63.801	5.353
6	.953	3.405	73.674				
7	.798	2.849	76.522				
8	.665	2.376	78.898				
9	.640	2.286	81.184				
10	.514	1.835	83.019				
11	.504	1.800	84.819				
12	.458	1.635	86.454				
13	.448	1.599	88.053				
14	.382	1.366	89.418				
15	.339	1.211	90.629				
16	.313	1.119	91.748				
17	.277	.989	92.737				
18	.268	.957	93.694				
19	.242	.863	94.557				
20	.239	.853	95.410				
21	.222	.792	96.201				
22	.208	.744	96.945				
23	.196	.700	97.646				
24	.169	.603	98.248				
25	.155	.552	98.800				
26	.126	.450	99.251				
27	.113	.402	99.653				
28	.097	.347	100.000				

Extraction Method: Maximum Likelihood.

a. When factors are correlated, sums of squared loadings cannot be added to obtain a total variance.

4.2.3 Pattern Matrix

Table 4 below displays the pattern matrix that was created using the maximum likelihood extraction method and ProMax rotation with Kaiser normalisation. The rotation reached convergence after six iterations. Factor loadings reflect each variable's relationship to the underlying factor, including its strength and direction. The table highlights the variables with significant loadings that have the greatest impact on each of the five factors.

Table 4: Pattern Matrix[a]

	Factor				
	1	2	3	4	5
Extension officers create awareness about the advantages of using information systems in farming.	.977				
Agricultural extension officers regularly push me to think about implementing information systems for my farming practices.	.951				
The difficulties associated with adopting information systems are properly addressed by extension officers.	.942				
Agricultural extension officers provide me with advice and training on how to use information systems in my farming activities.	.915				
The assistance of extension officers is essential in removing obstacles to the adoption of information systems.	.511				

I believe that agricultural extension officers are helpful and play a significant role in encouraging farmers to use information systems.	.438		
My decision to implement information systems is influenced by recommendations from other farmers or agricultural professionals.	.414		
I rely on agricultural extension services to provide me with knowledge about farming techniques.			
I am interested in utilising modern information systems and other technologies in my farming operations.		.882	
I believe information systems can make my farming practices more productive.		.873	
I view information systems as useful instruments for making wise farming decisions.		.867	
I think information systems can keep me informed about the most recent agriculture techniques.		.840	
I am motivated to adopt and employ information systems for my farming practices because of my favourable approach towards them.		.789	
The way I feel about information systems has a beneficial impact on how I use these technologies.		.762	
The expense of obtaining and using information technology is a significant barrier for me.			.840

Information systems are harder to deploy since people are unaware of their advantages.	.802			
It is difficult for me to use information systems successfully because of my lack of technical expertise and experience.	.756			
The complexity of information systems affects my willingness to adopt them.	.668			
I do not have reliable internet connectivity, which affects my ability to use information.	.598			
To access agricultural data relevant to my farming methods, I regularly employ information systems.		.924		
Information systems have helped me become more efficient in my farming operations.		.882		
My farming operations today make use of information systems.		.860		
Overall, Information systems are helpful for enhancing my farming practices.		.806		
I use pamphlets and brochures printed on paper to get agricultural information.			.690	
I consult other farmers and local networks to find out knowledge about agriculture.			.662	
I rely on radio and television programmes about agriculture for information.			.649	

Overall, I have no trouble getting the agricultural information I need for my farming activities.	.455
I use websites and online platforms to research agricultural practices.	.413

Extraction Method: Maximum Likelihood.
Rotation Method: Promax with Kaiser Normalisation.
a. Rotation converged in 6 iterations.

Based on the provided factor pattern matrix, the following factor names are suggested:

Factor 1: Influence and Support of Extension Officers

- This factor captures the ability of the agricultural extension officers to support the adoption and use of Information Systems among small-scale farmers. Extension officers are important link people who educate farmers, impart to them the right knowledge, and introduce them to appropriate modern technologies for use in agriculture.

Factor 2: Attitude towards Information Systems

- This factor evaluates how farmers view, think about, and approach this concept of information systems in agriculture. Social acceptance of these systems plays an essential role in improving their uptake and usage.

Factor 3: Barriers to Adoption of Information Systems

- This factor comprises different factors discouraging the uptake and use of information systems including technical, financial, infrastructural, and training impediments among others.

Factor 4: Adoption and Utilisation of Information Systems

- This factor measures the extent to which the small-scale farmers in the study employ the information systems in their farming processes. In this respect, it depends on other factors like extension officers' support, the small-scale farmers' attitude level towards technology, and information availability among others.

Factor 5: Sources of Agricultural Information

- This factor refers to the sources that small-scale farmers use to access information on matters of agriculture, and these include extension officers, local farmers, public extension organisations, and social media.

4.2.4 Reliability Test

The internal consistency of the various constructs measuring agricultural information systems and extension services was established using Cronbach's Alpha coefficient shown in Table 5. Regarding reliability, data show satisfactory internal consistency for the "Influence and Support of Extension Officers" scale (α = 0.909, 7 items), "Attitude towards Information Systems" (α = 0.943, 7 items), and "Adoption and Utilisation of Information Systems" (Cronbach's alpha = 0.945, 4 items). However, "Barriers to Adoption of Information Systems" had slightly less internal consistency (α = 0.845). The results also indicated that out of all the constructs, "Sources of Agricultural Information" had the lowest level of reliability coefficient (α = 0.779, 5 items).

Table 5: Summary of factor Reliability

Factor	Cronbach's Alpha	Number of Items
Influence and Support of Extension Officers	0.909	7
Attitude towards Information Systems	0.943	6

Barriers to Adoption of Information Systems	0.845	5
Adoption and Utilisation of Information Systems	0.945	4
Sources of Agricultural Information	0.779	5

4.2.5 Correlation Matrix

Table 6 below present the collection of the factors extracted.

Table 6: Correlations

		Influence and Support Of Extension Officers	Attitude towards Information Systems	Barriers to Adoption of Information Systems	Adoption and Utilisation of Information Systems	Sources of Agricultural Information
Influence and Support Of Extension Officers	Pearson Correlation	1	.458**	.234**	.676**	.539**
	Sig. (2-tailed)		<.001	<.001	<.001	<.001
	N	306	306	306	306	306
Attitude towards Information Systems	Pearson Correlation	.458**	1	.261**	.565**	.520**
	Sig. (2-tailed)	<.001		<.001	<.001	<.001
	N	306	306	306	306	306
Barriers to Adoption of Information Systems	Pearson Correlation	.234**	.261**	1	.136*	.254**
	Sig. (2-tailed)	<.001	<.001		.018	<.001
	N	306	306	306	306	306
Adoption and Utilisation of Information Systems	Pearson Correlation	.676**	.565**	.136*	1	.486**
	Sig. (2-tailed)	<.001	<.001	.018		<.001
	N	306	306	306	306	306

Sources of Agricultural Information	Pearson Correlation	.539**	.520**	.254**	.486**	1
	Sig. (2-tailed)	<.001	<.001	<.001	<.001	
	N	306	306	306	306	306

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

The correlation matrix reveals significant relationships between several factors influencing the adoption and utilisation of information systems in agriculture. The relationship between extension officers' influence and support is positively moderately correlated with small-scale farmers' attitudes towards information systems, r =.458, p <.001, and very strongly correlated with actual adoption and utilisation r =.676, p <.001. This addresses research question 3: "How do extension officers influence small-scale farmers in adopting and utilising information systems in their farming practices?". Small-scale farmers are more likely to adopt new technology when extension services are available which, and they can learn about the advantages of new technology through extension services provided by extension officers (Udimal et al., 2017). A study conducted by Singh (2016) concerning the new technologies for rural and agricultural development found that public agricultural extension services have come under fire for having weak technical foundations, and inadequate coverage of, and relationships with, farmers. Thus, it is evident in these results that extension officers play a critical role in promoting the use of information systems among farmers.

Small-scale farming attitude towards information systems is also positively and moderately correlated with the adoption and utilisation of information systems, r =.565, p <.001. This addresses research question 2: "Does the attitude towards information systems affect the decision of small-scale farmers in the use of such technology in farming?". According to Singh et al. (2018), the attitude small-scale farmers have toward a given technology has a significant impact on how quickly it is adopted. The way that small-scale farmers think and perceive their choices is influenced by their attitudes and knowledge about their agricultural techniques and production (Kidane and Zwane, 2022). Therefore, a positive attitude is a determinant of higher utilisation. At the same time, barriers to adoption, including those based on technical and financial constraints, are characterized by a weaker, but still important, correlation with the adoption and use of information systems, r =.136, p =.018. This addresses research question 4: "How does the access to information

on agriculture and barriers relate to the use of information systems among small-scale farmers in the province of Limpopo's Vhembe district?". These results also attest to the findings of Aldosari et al., 2017; Lwoga and Chigona, 2019, that lack of knowledge and attitude are the main barriers to technology adoption in rural farming communities, which are constrained by complicated and interconnected barriers at the national, regional, and international levels that are influenced by sociocultural and environmental factors. It may be suggested that these barriers represent the existing constraints; however, their influence is not determinative.

The sources of agricultural information correlate strongly with both the influence of extension officers, $r = .539$, $p < .001$, and the adoption and utilisation of information systems, $r = .486$, $p < .001$. According to the findings of the study conducted by Lwoga, Stilwell, and Ngulube (2011), local people (neighbors, friends, and family) were by far the best sources of information for farmers, followed by public extension agencies, and in some places, farmers' associations, village meetings, co-operative unions, agricultural input providers, and NGOs were significant sources of agricultural expertise. In addition, the case study done by Ameru, Odero, and Kwake (2018) in Kenya Tharaka Nithi county suggested that for small-scale farmers to make informed decisions about the production and sale of farm products, agricultural marketing information systems are essential. The findings indicate the significant role of the availability of information in the facilitation of adoption. In this way, the results of the hierarchical regression analysis confirm that the critical factors of extension officers, positive attitude, and information availability indeed facilitate the adoption of information systems in agriculture despite the existing barriers.

4.3 level of adoption and utilisation of information systems

Table 7 provides a clear visual of the responses regarding the adoption and utilisation of the information system in the Vhembe district.

Table 7: Adoption and Utilisation of Information Systems

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Strongly Disagree	51	16.7	16.7	16.7

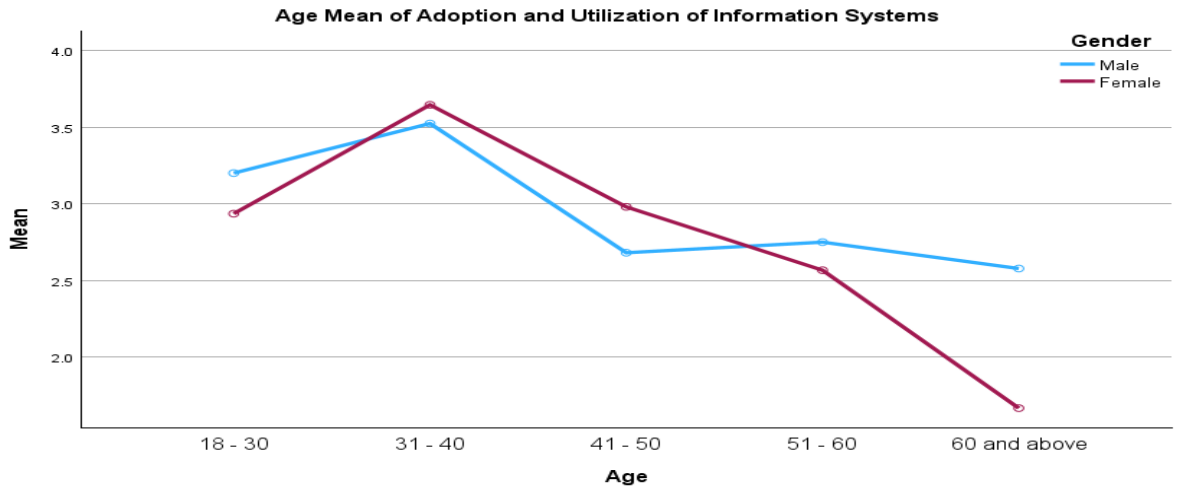
	Disagree	63	20.6	20.6	37.3
	Neutral	62	20.3	20.3	57.5
	Strongly Agree	70	22.9	22.9	80.4
	Agree	60	19.6	19.6	100.0
	Total	306	100.0	100.0	

The results represented in Table 6 reveal a diverse range of opinions from the respondents, which combined (16.7% strongly disagree and 20.6% disagree) 38.3% of respondents are not in favour of adopting and utilising information systems. The adoption and utilisation trends are favourable, though, as indicated by 42.5% of respondents (19.6% agree and 22.9% strongly agree). This would mean that almost half of the farming community is aware of the potential benefits that could be reaped from the adoption of technology to improve the management and productivity of farms, as well as decision-making. Of those surveyed, 20.3% had no opinion at all. This underlines the significance of education and creating awareness, complemented by demonstrations, to enlighten farmers on the benefits and uses of information systems in farming. Bridging such gaps in knowledge might mean a possible increase in the rate of acceptance and adoption of this indecisive group.

These findings show that there is a generally positive attitude toward information systems and that a significant segment of the population supports their integration into farming practices. While a good number of small-scale farmers in the study area are ready to adopt information systems, addressing the concerns and raising awareness for the few who had not been convinced would be instrumental in promoting widespread adoption. Only when this will the agricultural stakeholders maximize the potential of Information Systems and bring actual transformative change with improved livelihoods to the Vhembe district in Limpopo province and beyond.

The below graph displays the adoption and utilisation of information systems estimated marginal means in comprising age groups with female and male small-scale farmers

Figure 5: Age Mean of Adoption and Utilisation of Information Systems



The results represented by Figure 5 show a peak in the age group 31- 40 and a decline from the same age group for both genders on the adoption and utilisation of information systems by the small-scale farmers in the Vhembe district, and on the other hand age group 18 - 40 show moderate rates that significantly increase when moving to age group 31 - 40. Younger generations are more open to embracing new technologies and showing more interest in them, according to Subashini and Fernando (2018). This group undergoes greater exposure to digital tools and platforms from an early stage and, therefore, is better positioned in terms of their readiness to integrate information systems into farm practice. The level of use of technology puts them in a good position to use information systems for better farm management and decision-making, as well as access to markets.

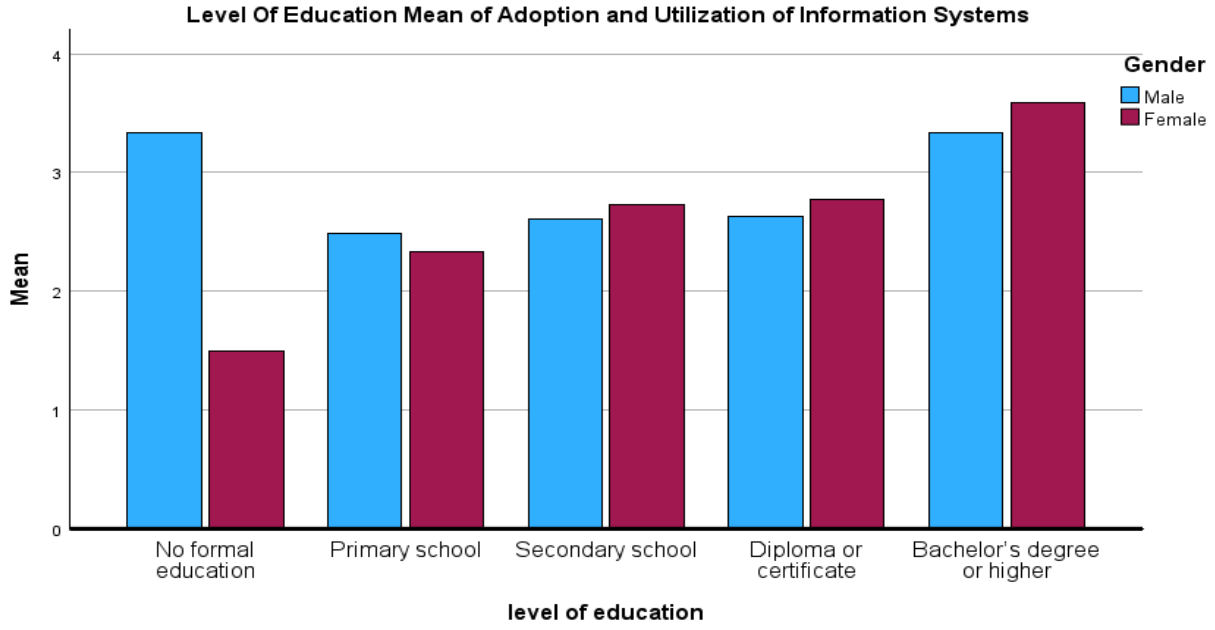
In addition, there is a sharp decrease in age group (51 - 60) and (60 and above), especially females. The results indicate that the younger generation is likely to adopt and utilize information systems for farming activities compared to the older generation in the Vhembe district which is contrary to research by Mignouna et al. (2011) and Kariyasa and Dewi (2013) which revealed that older small-scale farmers were better equipped to assess technological information compared to younger small-scale farmers since they had better knowledge and experience. The results could be that younger small-scale farmers are comfortable and familiar with technology. The decline in adoption that is observed in the Vhembe district among older small-scale farmers could, however, be a result

of such constraints as the perceived complexity of technology, lack of familiarity, or skepticism about its benefits.

While the results show that generally younger small-scale farmers tend to have higher adoption rates of information systems in the Vhembe district, there is a need for targeting strategies aimed at closing this adoption gap across these categories. Understanding the age-related challenges and demographic trends would better position stakeholders in agriculture to pursue relevant technologies for sustainable adoption, leading to increased farm productivity and economic growth in the region.

Figure 6: represents the level of education and gender estimated marginal means within the content of farming for adoption and utilisation of information systems in the Vhembe district.

Figure 6: Level of Education Mean of Adoption and Utilisation of Information Systems



The results represented by Figure 6 reveal that farmers with bachelor's degrees or higher had higher information systems adoption and utilisation relative to that by farmers who possessed other levels of education. Surprisingly females had a higher rate than males for a bachelor's degree and on the other hand males had a higher rate of adoption or utilisation compared to females for no

formal education who had higher adoption or utilisation after a bachelor's degree or higher. Education is one of the primary determinants influencing small-scale farmers' decision-making concerning the risks associated with new technologies and modern information resources. Small-scale farmers' rate of adopting technology was positively correlated with their educational attainment (Oyinbo et al., 2019). This result implies that among the learning population, women are more likely than men willing to learn about adopting information systems in farming practices. Such findings do contradict conventional roles of gender in agriculture, demonstrating the reason women's elevation of status is imperative through education and the provision of technological resources. Age and education are major demographic factors that affect the farmers' attitudes toward adopting or rejecting new concepts (Senyolo et al., 2021).

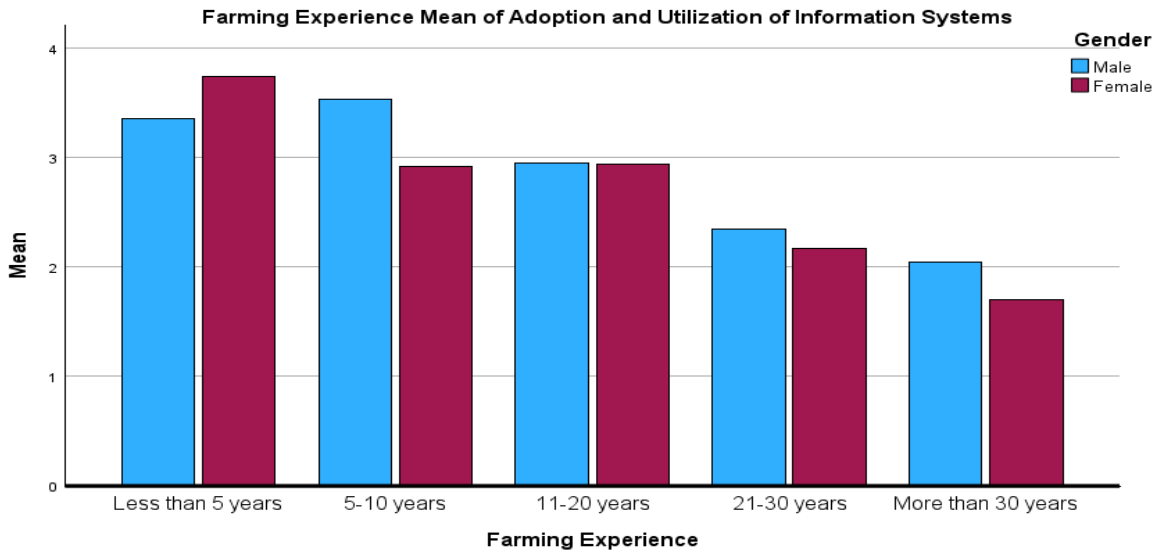
The results of the study reveal that males with no formal education are likely compared to females to adopt and utilize information systems. This can be attributed to cultural background, distribution of resources, and historical nature of roles in agriculture decision-making. Hence, the rise in adoption among less educated males points toward inequalities in different ways through which knowledgeable farming practices are accessed. However, as educational levels increase both males and females are even until to the level of bachelor's degree or higher which shows males slightly lower. This might be the case because a college education gives students the knowledge and skills necessary to understand and utilize these kinds of systems effectively. According to Cassie et al. (2015), small-scale farmers who were deemed educated having completed formal or informal education adopt new technologies more quickly than those who are not educated.

Educational interventions, aimed at the promotion of digital literacy and skills development among farmers in general, but more specifically toward women and those with less education, may help to close the adoption gap. These are programs that provide training, attuned to the requirements and capabilities of the different educational groups, to facilitate equal opportunities in access to and use of information systems in agriculture. Adoption is much influenced by education levels among small-scale farmers in the Vhembe district, gender dynamics within these educational categories are very pivotal. These dynamics can, therefore, be addressed through interventions of

strategies and policies aimed at improving the farming practices of both men and women, promoting more egalitarian and sustainable agricultural practices that considerably contribute to economic growth and food security in the region.

Figure 7: represents the farming experience and gender-estimated marginal means within the context of farming for adoption and utilisation of information systems in the Vhembe district.

Figure 7: Farming Experience Mean of Adoption and Utilisation of Information Systems



The results represented by Figure 7 reveal that small-scale farmers' experience in farming for both genders decreases as the farming experience increases. In the early years of farming of fewer than 5 years, females showed dominance, however as more years of experience increase from 5 - 10 years up to more than 30 years, males had the higher adoption and utilisation of information systems. This reversal in the adoption of information systems trends across genders with the continuum of farming experience may indicate a tendency that leads toward traditional practices or resistance to adopting new technologies among males with more experience in farming.

These findings indicate a need for targeted strategies to make gains in the barriers associated with farming experience. Information system adoption strategies should, therefore, be prepared to address and use specific approaches or tactics across farmers at different career stages. Precisely, for the less experienced and younger farmers, it could mean interventions to create awareness through

training provision and demonstrations of practical benefits of the information systems in improving farm productivity and sustainability.

4.4 Summary

The chapter starts by analyzing the distribution of gender among the respondents revealing that men had the majority in the study at 63.7% and women 36.3% respectively. Undefined, this imbalance has the potential of creating a perception that more men are involved in farming and use of information systems hence impacting on the study findings. The demographic characteristics of the small-scale farmers, which shows that 48.4% of them are within the age bracket that is considered young of the total are 31-40 years, an essential demographic for supporting agri-business in the region.

The group of younger farmers aged 18-30 years comprises 14.4% of the sample respondents, but only 7.2% are of the population aged 60 and above. Such dynamics entail that younger farmers would embrace technological advancement than older farmers can resist it. Another important factor considered is the educational level where 40.2% of respondents who indicated that they have received at least a bachelor's degree. This suggests that increased education levels among farmers lead to the adoption of new technologies and use of multiple sources of information. It draws attention to the differential levels of experience among farmers, of which 37.6% who had less than five years' experience further highlighting the need to have specialized extension services and training.

The KMO test and Bartlett's Test of Sphericity, both support the suitability of the data for factor analysis. The KMO value was 0.917, which suggests good sampling adequacy and Bartlett's test was significant with the chi-square value of 6601. 994 and p-value < 0.01. Factors influencing the adoption and utilisation of information systems through EFA, identifying five key factors: Influence and Support of Extension Officers, Attitude towards Information Systems, Barriers to Adoption of Information Systems, Adoption and Utilisation of Information Systems, and Sources of Agricultural Information. The reliability test using Cronbach's Alpha confirmed satisfactory reli-

ability for most constructs. The correlation analysis revealed significant relationships between factors, particularly the strong influence of extension officers on adoption and attitudes towards information systems, underscoring the importance of targeted interventions to address barriers and promote technology adoption in agriculture.

CHAPTER 5: SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

The chapter summarises the major findings of the research, including the insights it has managed to draw from the data collected and it outline the results, focusing on the most significant trends and associations coming out in the study. The chapter also described the meaning inferred from the data analysis and its significance in understanding those factors that lead to the adoption of information systems and the use of information systems by small-scale farmers.

More specifically, education was underlined as very important, with very high rates of adoption and usage of information systems by farmers with a bachelor's degree or more. Small-scale farming experience is another very crucial variable that best explains the adoption of information systems, as compared to much older farm households, much more likely to adopt such systems. The data, however, show enormous resistance from experienced, predominantly male farmers regarding the adoption of new technologies.

Factor analysis also determined further that extension officers, positive attitudes to technology, and access to agricultural information were some of the main facilitators in deciding to adopt information systems even when there were encountered some technical and financial obstacles. Highlighting such findings brings to the fore the importance associated with targeted interventions designed to incite the use of technology among divergent demographic groups and classes of farming experience. Such gaps can be addressed, and it could open avenues for further wide-ranging research, considering the current study's limitations, to enhance the adoption of information systems in agriculture.

5.2 Summary of findings

The purpose of this study was to assess small-scale farmers in the Limpopo province, Vhembe district, and their perspectives on the adoption and use of information systems. They included the following: A detailed factor analysis was required to determine the explanatory variables for farmers' choices on the adoption of information systems during this study. The results of the EFA also prompted the labeling of the concept of technology adoption as complex. The study identified five (Influence and Support of Extension Officers, Attitude towards Information Systems, Barriers to Adoption of Information Systems, Adoption and Utilisation of Information Systems, and Sources of Agricultural Information) important factors influencing adoption behaviour based on objective benchmarks like Kaiser's criterion and additional statistical tests like the Bartlett's Test of Sphericity and the KMO measure of sampling adequacy. First, the study focused on 30 items; however, due to multicollinearity, two items were omitted to reduce the dimensionality resulting in 28 items to establish the reliability of the extracted factors.

The study objectives were to assess the extent to which small-scale farmers in the province of Limpopo's Vhembe district utilized and adopted information systems for farming, examined the perceptions small-scale farmers had on information systems and how these perceptions influenced the adoption of such technology in their farming activities, explored the role of extension officer in promoting the adoption and utilisation of information systems among small-scale farmers in the province of Limpopo's Vhembe district, and examined the access to information systems and barriers affecting their adoption and utilisation among small-scale farmers in the province of Limpopo's Vhembe district.

In this study, a clear gender divide was noted with 63.7% of the respondents being male and woman 36.3%. Undefined, this goes against what could have been considered as more expected, especially since women are commonly in charge of food security and are thought to be more likely to adopt the use of ICTs in small-scale farming findings (Sekabira, Bonabana, and Asingwire, 2012). Nevertheless, the results of this study confirm the hypothesis that among respondents, there are more men than women. The largest portion of the respondents (48.4%) are between 31 and 40 years old, which means that young adults or people with their most productive working age were

many in the group of small-scale farmers in the region. The farmers were less represented among the younger population, especially those under the age of 30 (14.4%), and issues of attracting and retaining young farmers can be a factor. Despite these figures showing older age groups having smaller percentages of the population, they remain important contributors in the farming society.

Below is the discussion regarding the research objectives:

- **Assess the extent to which small-scale farmers in the province of Limpopo's Vhembe district utilized and adopted information systems for farming.**

  The findings indicated that 42.5% of the respondents agreed, 19.6% strongly agreed 22.9% with the adoption and utilisation of information systems whereas, 38.3% of respondents strongly disagreed and disagreed because 16.7% and 20.6% respectively tested for a positive attitude towards information systems amongst small-scale in the Vhembe district. Meanwhile, 40.2% of the small-scale farmers had a bachelor's degree or higher, this implies that the small-scale farmers' seeking higher education is an increasing trend; this also confirms the conclusion by Mittal and Mehar (2013), which states that increasing the level of education leads to speedy adoption of new technology.

  The study shows respondents originating from different educational levels as well, about 40.2% of the small-scale farmers had a bachelor’s degree or higher, which may indicate a growing tendency to acquire higher education among farmers in the region. 40.2% had a bachelor’s degree and above, which could indicate that there was an upward trend in the educational level of small-scale farmers in the area and the same findings by Mittal and Mehar (2013) that small-scale farmers with higher levels of education typically adopt new technology more quickly, giving them a platform to employ a variety of information sources and diversify the information they receive. Furthermore, large proportions were technically or vocationally qualified (29.4%) or had completed secondary schooling (23.2%), suggesting the heterogeneity of the population engaged in small-scale farming. A considerable number of the respondents (37.6% of them) had been farming for not more than five years, which points to the fact that there had been an influx of new entrants into

the farming industry. However, a moderate to long-term farming experience is also present as 23.2% of the respondents claimed that they had practiced agriculture for 11 - 20 years respectively. undefined Also, some long-serving professionals had been in the industry for several years, with 8.8% reported to be in the age bracket of 21 - 30 years and 5.9% described themselves as having more than three decades of experience in farming.

- **Examine the perceptions small-scale farmers had on information systems and how these perceptions influenced the adoption of such technology in their farming activities**

  The study found a positive and moderate relationship established between small-scale farmers' attitudes towards information systems and their adoption and utilisation of the systems ($r = .565$, $p < .001$) highlighting the relevance of the farmers' mindset in the advancement of technology in farming. As highlighted by Singh et al. (2018), the attitude of small-scale farmers digital technology influences their uptake of technical advancement. This inclination is so influenced by their culture and their attitudes toward new practices that can help improve farming yields (Kidane and Zwane, 2022). In this regard, positive experiences with technology contribute to the development of such attitudes, as Agnese and Othman (2021) pointed out, having established positive correlations between the identified attitudes concerning digital applications for farm monitoring and farmers' commitment, trust, resources, time, and recognition. Moreover, small-scale farmers' relationship to the land they cultivate, and their traditional beliefs and perceptions affect their readiness to integrate digital technologies.

  Small-scale farmers' perceptions and willingness to adopt new technology are influenced by factors such as age, education level, and experience. According to Mignouna et al. (2011), the understanding of technology, as well as its applicability and appropriateness to the local farmer's circumstances and the environment play a decisive role. This means that the degree to which small-scale farmers would adopt the given technology depends on whether they consider the technology appropriate for their needs and circumstances. Other factors include the age and level of education which gives younger and more educated

farmers a high level of openness to technologies (Senyolo et al., 2021). However, gaps like knowledge and attitude restraining factors continue to hinder the use of technology, especially among rural farming communities as sociocultural and demographical conditions might pose challenges to the use of the available technologies (Aldosari et al., 2017; Lwoga and Chigona, 2019). To overcome these barriers, measures that focus on the awareness creation and altering the attitude of small-scale farmers towards the adoption of information systems are most appropriate.

- **Explore the role of the extension officer in promoting the adoption and utilisation of information systems among small-scale farmers in the province of Limpopo's Vhembe district.**

The study found positive correlations between extension officers' influence and support to small-scale farmers on their attitude toward information systems ($r = 0.458$, $p < 0.001$), and their adoption and utilisation of the information systems were ($r = 0.676$, $p < 0.001$) demonstrate the significant role of extension service in enhancing technology adoption among the small-scale farmers. Small-scale farmers equally benefited from the extension services because extension officers act as middlemen between institutions involved in research around agriculture and the farming communities in disseminating knowledge on the new technologies and their benefits (Udimal et al., 2017; Adejuwon, 2019; Oyinbo et al., 2019). Direct contact with farmers not only increases awareness but also trust that is needed to persuade farmers of the benefits of using new technologies in the farming sector (Genius et al., 2013).

Furthermore, extension services are central to addressing other related issues like information costs, and related complexities of technology. In so doing, extension officers assist farmers in their ability to comprehend and follow instructions to farm technologies (Genius et al., 2010). This kind of approach is very relevant in farming communities where the level of formal education especially technical knowledge might be low (Oladele, 2015). However, there are limitations such as the change in dynamics of communication technologies where extension services must change the kind of technologies they use in reaching out to

farmers (Mabe and Oladele, 2012). It is necessary to focus on the development of extension services' capacities in the promotion and utilisation of ICT resources to improve agents' efficiency in the dissemination of information on inputs, finances, marketing, and other important aspects of contemporary farming (Singh, 2016; Thapar, 2014).

The study provides evidence of the need to establish a strong linkage between the various agricultural research organisations, extension agencies, and farmers to enhance the development and diffusion of improved technologies in agriculture. This way, policymakers, and stakeholders can increase extension officers' capacity for the timely delivery of relevant information and so support sustainable agricultural development, food security, and economic growth of rural societies (Vidanapathirana, 2012). Remedial measures should also involve enhancing the following areas of extension service delivery; enhancing communication structures, using ICTs to disseminate knowledge, and integrating extension services to meet the evolving needs of farmers operating under different agronomic environments.

- **Examine the access to information systems and barriers affecting their adoption and utilisation among small-scale farmers in the province of Limpopo's Vhembe district.**

The results suggest that information sources used are significantly related with the extension officers influence ($r = .539$, $p < .001$) and the adoption and use of information systems ($r = .486$, $p < .001$), putting into evidence the critical role of information to small-scale farmers in the determination of the farming practices and decisions. Information is far from being just a tradeable object but a valuable means, that people require for the successful accomplishments of their tasks and further progression of livelihoods in rural areas. According to Haliso and Ajayi (2014), the use of ICT plays a critical role in the acquisition and delivery of information in a manner that can benefit small-scale farmers and get accurate agricultural info through mobile apps, emails, or even the internet. However, differences in the use of ICTs have not disappeared; they remain amplified in rural areas, where the lack of infrastructure makes it even more difficult to extend the use of such tools to farmers (Treinen and Van der Elstraeten, 2018).

The small-scale farmers mentioned above depend on various sources of information from word of mouth to formal sources such as the friendly grown extension services and agricultural associations (Lwoga, Stilwell, and Ngulube, 2011). This inclusive method of information acquisition shows the complexity of the demands made by farmers for information and advice on crop and animal production, market information, and finances, as well as new technologies (Elly and Epafra Silayo, 2013). These factors seem to suggest that the credibility and familiarity of the media in the exchange of information within developing communities particularly those involved in agricultural activities are valued more than any other form of media (Mignouna et al., 2011). Further, social relations are highlighted in the study done by Katungi and Akankwasa (2010), which found that farmers are in a better position to adopt new technologies than those on an individual basis since they learn, from experience, and support themselves.

Based on these studies, it can be concluded that improving the availability and credibility of information sources on agriculture, both printed materials and online resources, are essential for assisting small-scale farmers in the decision-making process and increasing yield. Addressing the digital divide and promoting Inclusive ICT solutions in agriculture should remain a priority since the last one to make sure that as many small-scale farmers as possible can benefit from technology in this field regardless of the regions they come from or the resources they have.

Challenges towards the adoption of information systems in small-scale farming include technical and financial, which are important barriers that affect the rates at which small-scale farmers can be taken through digital transformation. The findings also reveal that there was a modest direct relationship between these barriers and information systems adoption as measured by the correlation coefficient ($r = .136$, $p = .018$). It is against this backdrop that Nmadu, Aiyelitsoya, and Sallawu (2013) noted that language barriers, poverty, and low literacy levels are among the key challenges small-scale farmers in Nigeria encounter whenever they try to input digital technologies to help them access vital marketing information. Odini (2014) found that limited access to information, lack of access to

physical infrastructure, lower literacy level, low-quality information services, and dearth of technical know-how as factors that act as constraints to efficient use of information systems for small-scale farmers in Kenya.

One of the most interesting findings in this study is the correlation between the independent variable which is the level of education and information systems adoption. Small-scale farmers with a bachelor's degree or higher are more likely to adopt and use information systems than other small-scale farmers with lower education levels. This can be attributed to the fact that higher education provides the needed skills for small-scale farmers to embrace technology. The study also revealed a significant gender discrepancy where females with bachelor's degrees have a relatively higher adoption rate than male counterparts, while males without formal education had a relatively higher adoption rate than females without formal education. This provides evidence that, in different ways, gender moderates the effect of education on technology usage. The study revealed that age had little influence on the use of the information systems and the impact was insignificant. This indicates that age is not as significant a factor as education in determining the small-scale farmers' attitudes to the use of technologies. Education emerged as a strong predictor of attitudes towards information systems adoption and was followed by gender, while experience and age had little and non-significant impacts on the dependent variable respectively.

Following the DOI Theory, the process of taking up new technologies is determined by characteristics such as relative advantage, compatibility, complexity trial, and observability. This research supports the theory in addressing ways of improving the relative advantage and trialability of information systems by extension officers' support and the availability of reliable information to fasten the rate of adoption. This work further underscores the need for enhancing specific strategies to create favourable perceptions towards the use of information systems and to provide relevant information that will help sustain the use of information systems among the small-scale farming community.

5.3 Conclusion

This cross-sectional study carried out involving small-scale farmers in the Vhembe district of Limpopo province employed both correlations as well as factor analysis to determine the factors that may have influenced the uptake and use of information systems among the small-scale farmers. The study also embraces the evident roles of extension officers bearing in mind that their presence and support affect the small-scale farmers' perceptions and behaviour towards information systems and adopted and utilised information technologies. This is an essential factor highlighting that positive attitudes strongly influence the extent of information system utilisation by small-scale farmers.

This study further expanded the findings with additional factor analysis that provided specific dimensions that influence adoption and utilisation. Based on the results of EFA using maximum likelihood estimation and Promax rotation, five factors were identified from the survey results, including the Influence and Support of Extension Officers, Attitude towards Information Systems, Barriers to Adoption of Information Systems, Adoption and Utilisation of Information Systems, and Sources of Agricultural Information. The findings were in line with the hypothesised expectations that extension officers' influence is the most influential source of information, associated with a positive attitude and higher adoption of improved planting materials. Challenges, such as technical barriers, were elicited as significant but solvable factors that affected adoption rates to a slightly lesser extent. Accessibility to information was also important, which married well with the relative extension of influence that extension officers possessed and the extent of information system adoption, hence supporting intensity for information dissemination as a factor that determines technology adoption.

The research concluded that the age group for small-scale farmers likely to adopt and use the information systems is between the age of 31 - 40 years with this group amounting to 48.4% of the respondents. This goes with the theory from the DOI Theory that advanced age is a sign of lower innovation adoption. On the other hand, the rate of using the recommended practices was statistically lower among small-scale farmers aged above 51 years, thus they preferred traditional methods. The analysis of the gender distribution also showed that the male participants 63.7% and 36.3% female respondents were identified in the study, nevertheless, empowered females, those

who acquired the least education (bachelor's degree or higher) had higher adoption rates as compared to males. This trend shares consistency with such a study that shows the increased education level facilitates a fast rate of uptake of technology. Farming experience also did have a big influence on the small-scale farming experience of 5 years and below was most likely to adhere to the information system which was 37.6% of the respondents. This means that young small-scale farmers were more willing to adapt to technology when it comes to farming as a practice. On the other hand, those who had worked for more than 30 years of experience had received lower rates of use of the new techniques perhaps because they refused to embrace change and had developed new ways of working.

According to the DOI Theory, the perceived benefits (positive attitude towards information systems), change agents (extension officers), and communication channels (access to agricultural information) were essential for the adoption of innovations. In summary, the study finds that besides focused support, effective extension services, positive perception of the farmers on technology, and availability of vital information are some of the key approaches important for the embrace of information systems. These factors can go a long way in increasing agricultural yields and food security in the Vhembe district, hence improving the economic and social turnaround of the area.

These findings have enormous implications in practice and policy. The result, therefore, based on the practitioners, insists on the need for the extension services to be tailored to suit various demographic groups. For example, up-scale training and strategic support programs ought to target younger small-scale farmers with higher education levels to maximize the adoption of information systems. There should also be an attempt to involve more female small-scale farmers since this is the group that usually adopts new technologies once properly educated.

The study thus suggests that policymakers need to have very strong extension services that would be able to communicate the benefits of information systems and offer follow-up support to farmers. Policies targeted at increasing the capacities of extension officers would help magnify their role as change agents in society. Technical and financial adoption barriers can be smoothened by way of subsidies, grants, or low-interest loans to make the adoption of the information system faster among small-scale farmers.

The findings from the study appear to imply that better education opportunities and, also specifically for women, stronger extension services are the levers that would foster the adoption of information systems in agriculture. These measures may prove very instrumental in improving agricultural productivity and food security in the Vhembe district, hence offering better economic and social outcomes for the region. More studies in the future should continue to involve such dynamics in the process of working out proper, well-aimed interventions to overcome the barriers and leverage the facilitating factors that will turn up in technology adoption.

5.4 Recommendations

Based on the findings and conclusions of the study, the following recommendations were made:

- Combining the results of the study, researchers could conduct comparative research that would help them compare the implementation and use of information systems in various regions and subsectors in agriculture. These studies should choose areas in which differences in geography, socio-economic characteristics, and agriculture can be identified. Analyzing the use of information systems in different settings can help to reveal patterns and conditions that may be missed when focusing on one organisation or application area. Beyond increasing the generalisability of findings, this comparative approach contributes to understanding the regional approaches for improving the use of information systems in agriculture.

- Focus on Emerging Technologies: Further recommendations include focusing on the use and consequent benefits and difficulties of new technologies like mobile applications, smart farming devices, and online market platforms. With such potential, these technologies can transform the way farming is done by enhancing food production, planning, and marketing for small-scale farmers. It would be useful to understand what made the adoption of these technologies successful and what hindered it in planning interventions and poli-

cies. Sociologists should use both qualitative and quantitative research methods when conducting surveys, interviews, and focus group discussions to capture a broad picture of the farmer's perceptions, barriers, and choices concerning these technologies.

- Gender-Sensitive research: future investigations based on the presented findings about the gender differences in technology adoption should explore other potential factors that may positively or negatively influence the choice and usage of innovations by male and female farmers. This entails considering issues relating to culture, range, and availability of resources, education, or preferences for technology utilisation. In this way, male and female farmers can be reached with gender-sensitive studies that allow investigators to tailor effective interventions. This approach not only meets the purposes of inclusion but also improves the excellence of technology implementation strategies in agriculture.

The above-proposed recommendations can only be achieved effectively through the involvement of researchers and policymakers, extension officers, and agriculturists. This encompasses the development of robust research methods, application for funding for cross-sectional studies, collaboration with different farming populations, and communication of results through policy briefs and stakeholder meetings. Thus, the elaboration of these lines of work will be useful in the further development of efficient information system solutions for increasing the productivity of small-scale farmers and improving sustainable agricultural development.

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APPENDICES

APPENDIX A: QUANTITATIVE SURVEY QUESTIONNAIRE

Questionnaire

(Tick that is appropriate with an X)

Section A: Demographics

1. What is your gender?

Male	
Female	

2. What is your age?

18-30	
31-40	
41-50	
51-60	
61 and above	

3. What is your highest level of education?

No formal education	
Primary school	
Secondary school	
Diploma or certificate	
Bachelor's degree or higher	

4. How many years have you been involved in farming?

Less than 5 years	
5-10 years	

11-20 years	
21-30 years	
More than 30 years	

Section B: Information Systems Adoption and Utilisation

- Please indicate your agreement with the following statements using scale (Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree) by using X concerning the level of adoption and utilisation of information systems:

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
My farming operations today make use of information systems.					
Information systems have helped me become more efficient in my farming operations.					
To access agricultural data relevant to my farming methods, I regularly employ information systems.					
In my farming operations, I use information systems for planning and decision-making.					
To handle data and maintain track of records on my farm, I use information systems.					
Overall, Information systems are helpful for enhancing my farming practices					

Section C: Attitudes toward Information Systems

- Please select your agreement with the following statements using scale (Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree) by using X concerning your attitude towards using information systems:

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
I believe information systems can make my farming practices more productive.					

I am interested in utilising modern information systems and other technologies in my farming operations.					
I am motivated to adopt and employ information systems for my farming practices because of my favourable approach towards them.					
I view information systems as useful instruments for making wise farming decisions.					
I think information systems can keep me informed about the most recent agriculture techniques.					
The way I feel about information systems has a beneficial impact on how I use these technologies.					

Section D: Influence of agricultural extension officers

- Please select your agreement with the following statements using scale (Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree) by using X concerning how the agriculture extension officers influence you to adopt information systems:

Statement	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Agricultural extension officers regularly push me to think about implementing information systems for my farming practices.					
Agricultural extension officers provide me with advice and training on how to use information systems in my farming activities.					
I believe that agricultural extension officers are helpful and play a significant role in encouraging farmers to use information systems.					
The difficulties associated with adopting information systems are properly addressed by extension officers.					
The assistance of extension officers is essential in removing obstacles to the adoption of information systems.					
Extension officers create awareness about the advantages of using information systems in farming.					

Section E: Access and use of agricultural information

- Please select your agreement with the following statements using scale (Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree) by using X concerning how you currently access agricultural information:

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I rely on agricultural extension services to provide me with knowledge about farming techniques.					
I use websites and online platforms to research agricultural practices.					
I consult other farmers and local networks to find out knowledge about agriculture.					
I rely on radio and television programmes about agriculture for information.					
I use pamphlets and brochures printed on paper to get agricultural information.					
Overall, I have no trouble getting the agricultural information I need for my farming activities.					

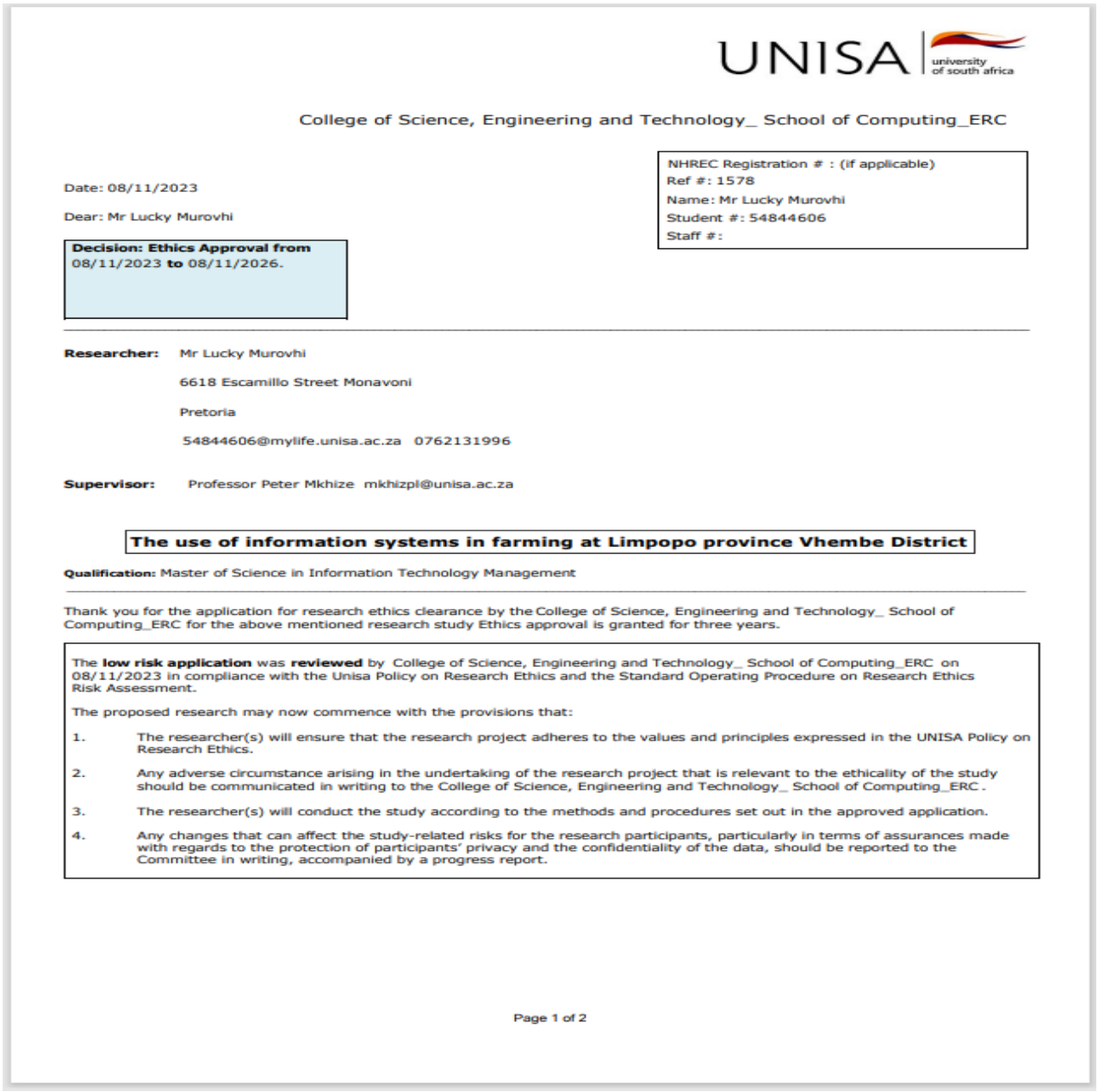
Section F: Factors affecting information systems adoption

- Please select your agreement with the following statements using scale (Strongly Disagree, Disagree, Neutral, Agree, and Strongly Agree) by using X concerning factors that affects you to adopt information systems:

Statement	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The complexity of information systems affects my willingness to adopt them					
It is difficult for me to use information systems successfully because of my lack of technical expertise and experience.					
The expense of obtaining and using information technology is a significant barrier for me.					

Information systems are harder to deploy since people are unaware of their advantages.					
I do not have reliable internet connectivity, which affects my ability to use information.					
My decision to implement information systems is influenced by recommendations from other farmers or agricultural professionals.					

APPENDIX B: ETHICAL CLEARANCE LETTER



UNISA university of south africa

College of Science, Engineering and Technology_ School of Computing_ERC

NHREC Registration # : (if applicable)
Ref #: 1578
Name: Mr Lucky Murovhi
Student #: 54844606
Staff #:

Date: 08/11/2023

Dear: Mr Lucky Murovhi

Decision: Ethics Approval from 08/11/2023 **to** 08/11/2026.

Researcher: Mr Lucky Murovhi
6618 Escamillo Street Monavoni
Pretoria
54844606@mylife.unisa.ac.za 0762131996

Supervisor: Professor Peter Mkhize mkhizpl@unisa.ac.za

The use of information systems in farming at Limpopo province Vhembe District

Qualification: Master of Science in Information Technology Management

Thank you for the application for research ethics clearance by the College of Science, Engineering and Technology_ School of Computing_ERC for the above mentioned research study Ethics approval is granted for three years.

The **low risk application** was **reviewed** by College of Science, Engineering and Technology_ School of Computing_ERC on 08/11/2023 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Science, Engineering and Technology_ School of Computing_ERC .
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.

Page 1 of 2

5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.

6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.

7. No field work activities may continue after the expiry date (08/11/2026). Submission of a completed research ethics progress report will constitute an application for renewal, for Ethics Research Committee approval.

Additional Conditions

1. Disclosure of data to third parties is prohibited without explicit consent from Unisa.
2. De-identified data must be safely stored on password protected PCs.
3. Care should be taken by the researcher when publishing the results to protect the confidentiality and privacy of the university.
4. Adherence to the National Statement on Ethical Research and Publication practices, principle 7 referring to Social awareness, must be ensured: "Researchers and institutions must be sensitive to the potential impact of their research on society, marginal groups or individuals, and must consider these when weighing the benefits of the research against any harmful effects, with a view to minimising or avoiding the latter where possible." Unisa will not be liable for any failure to comply with this principle.

Note

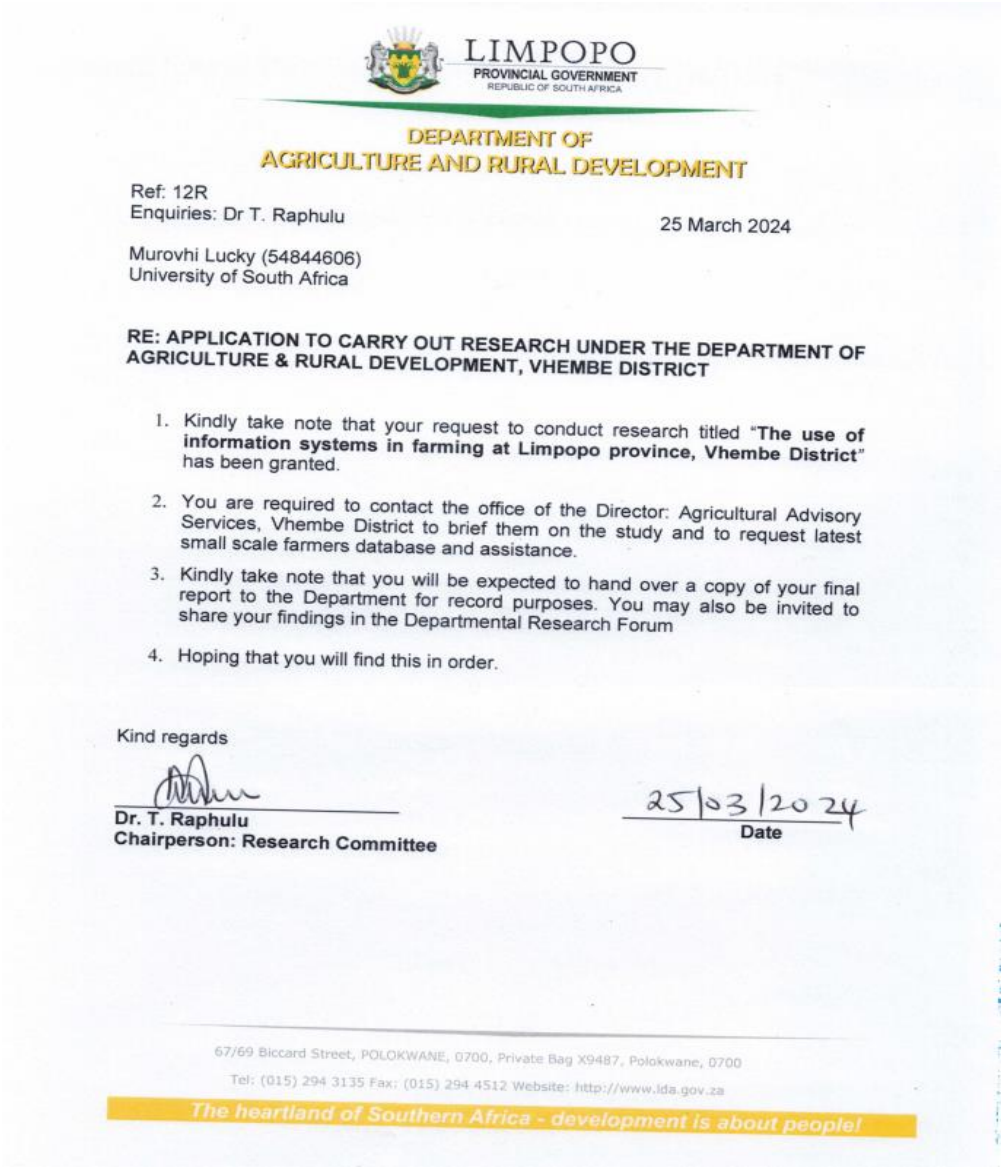
The reference number 1578 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,

Dr Danie Bisschoff
Chair of College of Science, Engineering and Technology_ School of Computing_ERC
E-mail: Dbischof@unisa.ac.za

Prof SJ Johnston
Executive Dean / By delegation from the Executive Dean of College of Science, Engineering and Technology_ School of Computing_ERC
E-mail: johnssj@unisa.ac.za

APPENDIX C: PERMISSION LETTER FROM GATEKEPPER



LIMPOPO
PROVINCIAL GOVERNMENT
REPUBLIC OF SOUTH AFRICA

DEPARTMENT OF
AGRICULTURE AND RURAL DEVELOPMENT

Ref: 12R
Enquiries: Dr T. Raphulu

25 March 2024

Murovhi Lucky (54844606)
University of South Africa

RE: APPLICATION TO CARRY OUT RESEARCH UNDER THE DEPARTMENT OF AGRICULTURE & RURAL DEVELOPMENT, VHEMBE DISTRICT

1. Kindly take note that your request to conduct research titled "**The use of information systems in farming at Limpopo province, Vhembe District**" has been granted.
2. You are required to contact the office of the Director: Agricultural Advisory Services, Vhembe District to brief them on the study and to request latest small scale farmers database and assistance.
3. Kindly take note that you will be expected to hand over a copy of your final report to the Department for record purposes. You may also be invited to share your findings in the Departmental Research Forum
4. Hoping that you will find this in order.

Kind regards

Dr. T. Raphulu
Chairperson: Research Committee

25/03/2024
Date

67/69 Biccard Street, POLOKWANE, 0700, Private Bag X9487, Polokwane, 0700
Tel: (015) 294 3135 Fax: (015) 294 4512 Website: http://www.lda.gov.za
The heartland of Southern Africa - development is about people!

APPENDIX D: CONSENT LETTER

CONSENT TO PARTICIPATE IN THIS STUDY

I, _____ (participant name), confirm that the person asking my consent to take part in this research has told me about the nature, procedure, potential benefits, and anticipated inconvenience of participation.

I have read (or had explained to me) and understood the study as explained in the information sheet.

I have had sufficient opportunity to ask questions and am prepared to participate in the study.
I understand that my participation is voluntary and that I am free to withdraw at any time without penalty (if applicable).

I am aware that the findings of this study will be processed into a research report, journal publications and/or conference proceedings, but that my participation will be kept confidential unless otherwise specified. I agree to the recording of the information systems data.

I have received a signed copy of the informed consent agreement.

Participant Name & Surname…… (please print)

Participant Signature……..

Date……

Researcher's Name & Surname……(please print)

Researcher's signature……..Date……

APPENDIX E: TURNITIN REPORT RESULTS