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Technology Adoption by Small-Scale Farmers in the Mid-Vaal Local Municipality

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A research report submitted to the Faculty of Commerce, Law and Management, University of the Witwatersrand, in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business

Johannesburg, 2023

ABSTRACT

It has been demonstrated that using technology in the farming industry increases production, efficiency, and income. Adoption of technology is influenced by a wide range of circumstances, though. The aim of this study was to examine, using the PESTEL framework, how external factors affect small-scale farmers' adoption of technology throughout the Mid-Vaal Municipality. This would help the municipality, policymakers, and other stakeholders, as well as small-scale farmers, identify and prioritise external factors that significantly impact small-scale farmers' adoption of technology and take appropriate action to address or mitigate them through changes in policy or technology.

A qualitative research study using semi-structured face-to-face interviews was conducted with a sample group of 11 participants. The group was made up of farmers with a diverse background in terms of farming experience and educational background. The study also focused on farmers who are involved in selling all or part of their produce operating farms between two and five hectares. A thematic analysis technique was used to identify themes in the data analysis.

Most of the farmers said they are aware that technology can help them be more productive, and efficient, and generate more revenue. However, the findings of the study demonstrated that when it comes to technology adoption, most of the farmers are negatively impacted by external factors. Farmers have expressed frustration with government policies which do not enable them to implement new technology and with the stringent admission requirements of programs designed to help them, it impossible for small-scale farmers to get involved. Farmers also indicated that financial institutions view small-scale farmers as high risk and have less appetite to provide them with financial assistance to help them modernise their businesses using technology. Thus, farmers resorted to monitoring technology trends in the farming space and creating “makeshift” solutions of what is trending at the time.

Furthermore, the findings showed that economics of acquiring and operating the technology is the biggest external factor farmers consider before they acquire any of form of technology. Additionally, farmers prefer using tried and tested methods

as this is less risk and affordable. Moreover, there's a new generation of farmers coming into the Mid-Vaal and have a positive view of new technology, which could lead to the utilisation of the latest technology as the farming operations mature.

Lastly, the study made recommendations to support the adoption of technology amongst farmers to increase productivity, efficiency, and revenue.

KEYWORDS

Small-Scale Farmers, Technology, Technological Platforms, External Factors, Productivity, Efficiency, and Revenue

DECLARATION

I, **Thulani Mindi** declare that this research report is my own work except I have explicitly indicated otherwise. I have followed the required standards in referencing the work, thoughts, and ideas of others. This research is submitted in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business at the University of the Witwatersrand, Johannesburg. I confirm that research report has not been submitted before, in this or any other university.

Name: Thulani Mindi Signature: T Mindi

Signed at …Johannesburg……

On the 30th ……. day of April…… 2024

DEDICATION

I dedicate this research to my family and friends, who have helped and encouraged me throughout the journey.

ACKNOWLEDGEMENTS

I express my gratitude to Professor René Pellissier, my supervisor, for her direction, patience, constructive criticism, and insightful remarks during this research. May God richly bless her, she was understanding and helpful when I was faced with the difficulties which arose while working on the research assignment.

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LIST OF ACRONYMS

PESTEL: Political, Economic, Social, Technological, Environmental and Legal

StatsSA: Statistics South Africa

FAO: Food and Agriculture Organization of the United Nations

OECD: Organisation for Economic Co-operation and Development

DALRRD: Department of Agriculture, Land Reform and Rural Development

EU: European Union

AC: Average Cost

eWTP: Electronic World Trade Platform

ICT: Information and Communications Technology

Apps: Software Applications

CHAPTER 1. INTRODUCTION

1.1 PURPOSE OF THE STUDY

In October 2023, the inflation for food and non-alcoholic beverages accelerated to 8,7% from 8,1% in September 2023 (StatsSA, 2023). The annual rate for eggs was even higher at 13,4% due to the outbreak of the avian flu which affected several small-scale farmers (StatsSA, 2023). Globally, smallholder farmers produce 70% of our food, but individually they are often cut out of the trade which results in increased poverty (FAO, 2020). In South Africa, there is approximately 2 million farms and 98% of them are small-scale farms (FAO, 2020). A study of the economic lives of small-scale farmers in 9 different countries across Asia and Africa as stated by Zande, et al., (2023) revealed that Asian countries experienced higher yields per hectare compared to their African counterparts. Amongst other factors, the difference in yields is mostly attributed to the lack of adoption of modern technology by small-scale farmers in Africa (Zande, et al., 2023). This entails that technology adoption is an important factor in the income generated smallholder farmers.

In 2021, the South African government distributed over 1 billion Rand to over 75,000 small-scale farmers (Popoola & Yusuf, 2021). In addition to the 1 billion Rand, the government provided an additional 100 million Rand COVID-19 relief fund to small-scale farmers through the Land Bank (Land Bank, 2020). Research shows that government attempts to support smallholder farmers have generally been costly and ineffective (Nyawo & Mubangizi, 2021).

According to OECD (2021), market intervention has the potential to alter the dynamics of markets by promoting competitiveness, resilience, inclusiveness, and sustainability, and technology is critical to each of these attributes. Access to information helps farmers improve yield and to connect with supply chains increasing farmer profitability by 45 percent in India (IFC_World Bank, 2018).

The first Electronic World Trade Platform (eWTP) in Africa was launched in Kigali through a partnership between the Rwandan government and Alibaba group,

opening doors for small businesses in Africa to take part in cross-border electronic trade (HKTDC Research, 2023). A few days after the launch of the platform, interest in Rwandan coffee from Chinese consumers increased by 200% (Alizila, 2018) indicating that the use of platforms could enhance access to markets, productivity, and profitability of small-scale farmers. Toukola and Ahola, (2022) confirm that ICT platforms assist in developing a broader network of contacts which helps in making better decisions regarding transportation and logistics, price and location, supply and demand, and cheaper access to inputs.

1.2 BACKGROUND OF THE STUDY

The Mid-Vaal Local Municipality is a municipality situated within the Sedibeng District south of the Gauteng Province (Municipalities of South Africa, 2021). The Municipality covers an area close to 2000 km^2 predominately rural with extensive farming activity, yet the agricultural sector contributes less than 3% to the local economy (Municipalities of South Africa, 2021).

The main agricultural activity in the Mid-Vaal Municipality consists of traditional grain products such as maize and animal production which includes - milk, beef, mutton and lamb, eggs, and poultry (Mid-Vaal Municipality, 2021). This is supported by municipality report data (StatsSA, 2021). None of the recorded agricultural households reported income over 2,5 million Rands (StatsSA, 2021).

Although agriculture contributes less than 3% to South Africa's economy as stated by the Mid-Vaal Municipality (2021), in 2020 when almost all the sectors experienced negative growth, the agriculture sector thrived and grew by more than 13% during a pandemic (StatsSA, 2021). Based on the above, it can be noted that agriculture is a small and resilient industry with lots of potential. It seems like there's an opportunity to grow the industry in the Mid-Vaal Municipality if the relevant technology is adopted by the small-scale farmers.

1.3 RESEARCH PROBLEM

It is estimated that 80% of the farms in Africa are heavily dependent on manual labour and technology adoption is lower compared to other regions (Botha, 2020).

Despite the growth in agriculture, Africa has the lowest levels of productivity and high levels of poverty (Arslan, 2020). According to Kawula (2019), some farmers prefer to continue using proven methods and not experiment with new ways of farming. As a result, most farmers remain unproductive as they ought to be. Factors which affect farm profitability and have been successfully addressed differently in different parts of the world using technology. Small-scales farmers are usually less profitable due to lack of modern technology and, possibly, due to their inability to acquire or implement such technology. Although the term "smallholder farmers" is not well defined or often used, it generally refers to farmers who work small pieces of land—typically less than 10 ha, and frequently less than 2 ha (Gumbi, et al., 2023). The study had identified several unanswered questions for further research. For example, the 2022 State of Food and Agriculture report highlights the low adoption of modern technologies among smallholder farmers in developing countries, affecting their productivity and resilience to shocks. While the study by Lowder et al., (2021) reveals that small-scale farms contribute significantly to global food production but face challenges in accessing and adopting modern technologies. Mwangi et al., (2022) indicated that the barriers to the adoption of new agricultural technology by smallholder farmers in developing countries, included socio-economic, institutional, and technological factors. These sources highlight the persistent challenge of low technology adoption rates among small-scale farmers, often due to a combination of economic, social, institutional, and technical barriers.

Hence, the research problem that informs this study can be stated as:

> *The lack of technology adoption by small-scale farmers impacts on operational efficiency and results in a lack of profitability.*

1.4 RESEARCH QUESTIONS

The purpose of the research is to explore farmer's views on the use of technology and examine factors which drive the adoption of technology and provide frameworks to improve technology adoption based on the problem as stated above.

The research questions are:

a) How does the external operating environment affect the adoption of technology by small-scale farmers?

b) How does the adoption of technology by small-scale farmers affect the productivity, efficiency, and revenue generation?

1.5 SIGNIFICANCE OF THE STUDY

This study added to the body of knowledge regarding the impact of PESTEL (the external environment) on small-scale farmers' adoption of technology. The study also offered an insight into how small-scale farmers might generate income and improve production and efficiency through the adoption of new technologies. Since most previous research on this topic used quantitative literature review procedures, the researcher saw a vacuum in the methodologies and filled it by doing a qualitative study. Several academics have used the qualitative interview method to delve deeper into the subject. The study's goal, according to the researcher, was to provide deeper understanding of the external environment's major components that influence technology adoption by small-scale farmers. The results provide insights for future research and small-scale farmers' adoption of technology.

1.6 DELIMITATIONS OF THE STUDY

Two delimitations are deployed in this study.

a) Farmers located in the Mid-Vaal Municipality – the Gauteng Provincial Government has chosen to create an Agri-polis in the Mid-Vaal, and it is likely to provide the much-needed technological support required to transform the area (Mid-Vaal Municipality, 2021).

b) Commercial or profit inclined – farmers who are involved in the selling all or part of their produce, and the ones who intend to sell. Profit can be acquired when money is exchanged for goods and services.

b) Farm size – the study focused on farms which are between two and five hectares in size.

1.7 ASSUMPTIONS

a) Profitability on farms rise when technology is used more frequently. Munz and Schuele (2022) notes that under some circumstances, precision agriculture and similar technologies have been shown to cut input costs, boost productivity, and improve profitability.

1.8 CONCLUSION

This chapter provided the background and reasoning for the study, which served as an introduction to the investigation of the topic under discussion. The study's goal, its objectives, and its research questions were also covered in this chapter.

A review of the relevant literature is provided in the upcoming chapter.

CHAPTER 2. LITERATURE REVIEW

2.1 INTRODUCTION

Literature reviews are critical as they form the basis of any academic study (Xiao and Watson, 2019). Literature review helps one understand what has been done in the field being studied, identify gaps, and create an opportunity to test hypothesis and or create new ones (Xiao and Watson, 2019). To ensure the researcher gets detailed understanding about the value of technology adoption on the profitability of small-scale farmers, academic literature in the chosen field was systematically selected and analysed. The first section provides definition of technology and adoption, followed by the literature review on the operating environment (PESTEL), definitions of profitability and the related literature. A consolidation of the section is provided in the conclusion.

2.2 DEFINITION OF TOPIC OR BACKGROUND DISCUSSION

The definition of technology has been evolving over the years (Shun and Carroll, 2017). Technology is defined as “inherently intelligent enough to either function, be used to function, or be interpreted as having a function that intelligent beings—human or otherwise—can appreciate, something devised, designed (by primary intention), or discovered (by secondary intention) serving particular purposes from a secular standpoint without humankind creating it, or a significant beneficiary of rationally derived knowledge that is “used for” a purpose without itself necessarily being translated into something material that “does” autonomously, or dependently when used” (Shun and Carroll, 2017). However, most people define technology using the “instrumentalist” perspective whereby a tool is used to attain a pre-determined need (Koc and Demirbilek, 2018).

According to Koc and Demirbilek (2018), there are four philosophical views which can be used to create an expanded and inclusive definition as explained below:

1. Instrumentalist – technology is seen as a tool to execute a function to fulfil a need.

2. Deterministic – technology advances regardless of the rate of development in society
3. Substantive – technological efficiency for every stage of human development couple with loss of values
4. Critical – technology and society influence each other from design to implementation.

Based on the above literature, technology may be summarised as the application of skill and or knowledge, with or without human intervention, to efficiently fulfil the society's needs and wants.

2.3 TECHNOLOGY ADOPTION

Technology adoption in the agriculture sector has been studied extensively. Eweoya et al., (2021) identified factors affecting technology adoption are assets, income, institutions, vulnerability, awareness, labour, and innovativeness by small-scale farmers, and they found that technologies that require less investment have a higher chance of being adopted. Mwangi (2015), maintained that, although there are many categories for grouping determinants of technology adoption, there is no clear distinguishing feature between variables in each category. Categorization is done to suit the current technology being investigated, the location, and the researcher's preference, or even to suit client needs.

This review focused on technology adoption factors affecting small-scale farmers by categorizing them into Political, Economic, Social, Technology, Environment and Legal (PESTEL) as applied in previous studies. In addition to external, the study reviewed how technology can improve profitability for small-scale farmers.

2.3.1 *POLITICAL*

Hassel (2015) defines public policy as decisions made by governments to influence society or industry to achieve a particular objective. Lencucha et al., (2020) in their review of quantitative studies written between 1997 and 2018, they found that Government Policy on agriculture depends on ideas of economic development, international markets, local markets, and development institutions

such as IMF and World Bank. In a study by Chen (2020) most small businesses across all sectors including agriculture are unable to pursue digital transformation due to several factors, and the government has to step in and assist with progressive policies, funding, training etc as it is aware of the importance of the SME sector to the economy. For example, to reduce the cost of importing rice and increase local production, the Nigerian government adopted a policy to supply farmers with inputs such as training, high-yield seedlings, fertilisers, and herbicides (Lencucha et al., 2020).

Based on the above, it can be noted that governments can influence technology adoption by small-scale farmers.

2.3.2 *ECONOMIC*

The decision to adopt new technology is strongly associated with access to credit (Shaw, 2014). Access to credit is critical in improving agricultural production and enabling small holdings to acquire inputs and enhancing their long-term capacity (Mohamed and Temu, 2008). In a study by Chowdhury et al., (2019) mid-sized and less risk-averse borrowers were 13% likely to adopt new technology. Lack of access to credit is a great inhibitor to adoption and has been noted in multiple literature as one of the causes of low agricultural output (Chowdhury et al., 2019).

A study by Nugroho (2021) found that economic globalisation (EG) has the potential to impact small-scale farmers positively or negatively in developing countries through access to markets or creating price instability. Improved market efficiency which amongst others includes price stability and access to markets enables higher rates of adoption of agricultural technologies in developing countries (Jack, 2013).

As highlighted, availability of finance and understanding global trends is critical in acquiring and adopting new technology.

2.3.3 *SOCIAL*

The human capital of the farmer is assumed to have a significant influence on farmers' decision to adopt new technologies (Udimal et al., 2017). Farmers' level of education is assumed to have a positive impact in the adoption of technology (Udimal et al., 2017). The education level assists the farmer to effectively evaluating the technology and how to use it (Udimal et al., 2017). In some studies, education coupled with certain beliefs has been noted to have a negative impact especially when it comes to GMO's (Udimal et al., 2017). To get conclusive results in this aspect, further studies were recommended (Udimal et al., 2017).

Age is identified as one on the factors which has influence on the adoption of new technology (Udimal et al., 2017). Older people are generally more risk-averse than young people and not willing to engage in long-term investments or change what works (Udimal et al., 2017).

Studies regarding the role of gender in the adoption of new technology have shown mixed results and thus no conclusion has been made (Bonabana-Wabbi, 2002).

Another key element to consider under this external factor is social interdependences and interactions. Campos (2021), states that individual technology adoption in farming can sometimes be linked to the behaviour of other farmers or parties in the value chain. Campos, (2021) highlights the type of dependencies or interactions as follows:

Vertical interdependencies – this is when farmers adopt technology based on the value chain needs for example suppliers incentivising farmers to purchase a new form of pesticide.

Horizontal interdependencies – this is when adopt new technology because it is beneficiary for them to adopt it as a group then as individuals, thus other farmers producing similar products encourage each other to adopt new technology such as a water management system to protect the water base.

Intra-individual interdependencies - Adoption of a certain technology or behaviour by an individual frequently requires acceptance and/or application of complementing behaviours by the same individual at roughly the same time. Buying sanitary gloves and teaching family members how to use them are just two of the "preparatory behaviours" needed to adopt the use of sanitary gloves when milking cows.

Temporal interdependencies – normally occur when farmers do or do not want to use a certain type of technology because it is or is not aligned with their roadmap, for example hiring technology to enable the production of chicks but planning to breed broilers in the future and not chicks.

Human development and beliefs have an impact on how new technology is adopted. According to Campos (2021), in many models, the intention to adopt a behaviour or technology is often influenced by an underlying predisposition to engage in that behaviour. In the model, the intention to adopt is influenced by attitude, social influence, and ability.

Attitude – people's attitudes towards new technology are influenced by their perceptions of its benefits. They can be positive, neutral, and negative. Attitude is shaped by knowledge and values which are dependant several demographic variables as depicted in figure 2.1.

Social Influence - Social influence is dependent on normative beliefs and the motivation to comply, both of which are influenced by demographic variables and personality traits, as depicted in figure 2.1.

Ability – relates to people's perception of how easy or difficult it is to adopt the technology or perform the behaviour in relation to their own skills, abilities, and self-confidence. Ability to adopt is dependent personality traits as illustrated in figure 2.1.

Understanding what drives a person when introducing a new technology is very important to creating an environment which encourages technology adoption as indicated by connections between the major categories of factors that influence

adoption behaviour, as compiled from several models in figure 2.1.

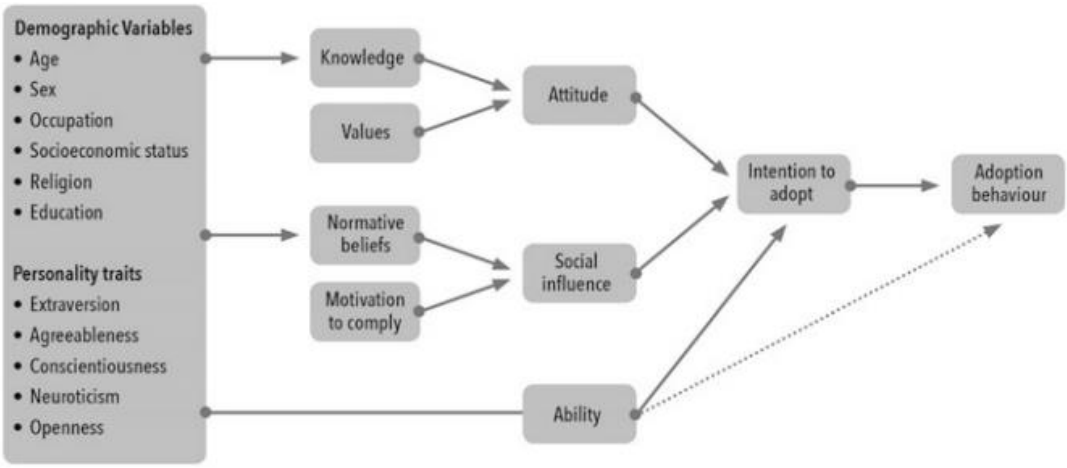


FIGURE 2.1: SOCIAL INTERDEPENDENCES AND INTERACTIONS MODEL

Source: *Campos* (2021)

2.3.4 *TECHNOLOGY*

Technology diffusion and awareness are important preconditions for adoption to occur (Simtowe et al., 2012). In most cases, technology awareness is not random but happens intentionally due to policy or individual self-interests (Simtowe et al., 2012).

In a study conducted by Hasan (2019), to understand the awareness of technology over 110 farmers were interviewed based on a structured schedule checking the extent of their awareness of seven predetermined parameters such as smartphones, apps, and other technology solutions. Correlation tests were used to determine the relationship between variables and the results revealed 23% of the participants had moderate awareness, 60% had low and 12% had very low awareness (Hasan, 2019). Farmers' characteristics such as education, knowledge, ability to use, access to technology facilities, and attitude towards technology had significant positive relationships with their awareness on the use of technology; while age, household size, and annual income had significant negative relationship with the awareness on use of technology (Hasan, 2019). Lack of training facilities on technology, cost of using technology services, low

knowledge on the availability of technology-based facilities, lack of operational knowledge of computer, low bandwidth speed of internet, limited availability of technology services, poor level of education or illiteracy, and so on were identified as the major constraints faced by the farmers (Hasan, 2019).

To adopt a new technology, farmers must know about it and consistent sharing or access to information is critical in enabling technology adoption. The technology itself must be easy to use, complex technology is likely to get low adoption.

2.3.5 *ENVIRONMENT*

Climate change is a threat to agricultural production and innovative solutions are required to boost production while protecting the environment (Senyolo et al., 2018). Generally, most of the farmers prefer to use proven methods and the adoption of new technologies has been a challenge (Kawula, 2019). According to a report by Serote (2021), studies carried out in West Africa discovered that adoption rates were not substantially different based on farm size, but technology adoption in different agro-climatic environments was substantial. Areas with lower rainfall and poorer soils were more likely to adopt the use of fertilizer than those with a decent amount of rainfall and fertile soils (Shaw, 2014).

Based on the above, it can be noted that as the world goes through climate change, to remain sustainable, farmers may be compelled to respond by adopting environment-friendly technology.

2.3.6 *LEGAL*

In South Africa, there are approximately 30 pieces of legislation that regulate agricultural activity (Daff, 2019). National Water Act 36 of 1998, Agricultural Pests Act, 1983 (Act No. 36 of 1983), Genetically Modified Organisms Act, 1997 (Act No.15 of 1997), and Plant Improvement Act, 1976 (Act No. 53 of 1976) are some of the key Acts used by the Department of Agriculture, Land Reform and Rural Development (Daff, 2019). The laws are regularly reviewed to ensure that they are relevant to what is happening currently and align to government policy.

A few legislations that directly affect agriculture underwent significant changes in 2021, either being passed or rejected. The expropriation of land without compensation was rejected by Parliament OECD (2022), which provided some policy predictability for the agriculture industry. The national legislature approved a piece of law in 2021, according to the OECD (2022), giving the Department of Agriculture and Rural Development funding and a responsibility to influence agricultural value chains, innovation, and technology adoption, and promote equality in the sector and rural development. Finally, the OECD (2022) states that import taxes on wheat and sugar were lowered, and South Africa pledged to cut greenhouse gas emissions. Sector-specific objectives may be put into place after the climate change bill was approved.

In the EU Regulation No 1305 which is mostly aimed at preserving the environment and management of the ecosystem, discourages the use of mineral fertiliser and providing funding to farmers who use organic farming methods (Serebrennikov et al., 2020).

Legislation can promote or hinder adoption certain types of technology thereby impacting the productivity and profitability of farmers.

2.4 PROPOSITION 1

Multiple external factors have an impact on how technology is adopted by small-scale farmers. It is key to identify key factors which could significantly enable or impede technology adoption.

2.5 TECHNOLOGY ADOPTION IMPACT ON PROFITS

This section considers the definitions for profits and looks through the literature for enablers of profits using technology. To foster a well-informed comprehension of the concepts covered in this chapter, these definitions are provided.

Profit is defined as revenue realised overrun incurred due to deployment of capital (Roberts, 2009). According to Hayes (2023), revenue is income generated from business operations such as selling to customers in the market. Technology through

various platforms has allowed businesses to engage customers regularly and access markets beyond their operating areas thereby increasing their revenue through technology driven business models (Bouwman et al., 2019). Productivity is the output produced in a certain period Osman (2023) and higher output ensures that demand is sufficiently met. According to a study conducted in southern India by Gathorne-Hardy (2016), the switch from bullocks to tractors revealed that tractors plough nine times quicker than bullocks and that tractor adoption was strong notwithstanding hiring a tractor cost twice as much as hiring a bullock. Despite being more expensive than bullocks, tractors increased production or output, which is why they were employed the most.

Efficiency is how well resources are used during a certain period and it helps with lowering operating costs and increase profits (Osman, 2023). Costs are expenses incurred for making products or services which are sold by a company (Murphy, 2021). To maximise profits, a business can increase its revenue and decrease costs. According to Mwangi and Kariuki (2015), new technology tends to increase output and decrease average cost (AC) of production due to better input/output relationships. This leads to significant increases in farm income and profits.

The use of technology can help to improve productivity of small-scale farmers by enabling them to operate efficiently and increase profits generated on a regular basis.

2.6 CONCLUSION OF LITERATURE REVIEW

There are a lot of factors which affect the adoption of technology by small-scale farmers, ranging from the political environment to the legal environment. Each factor must be analysed and understood on how in influences the adoption of technology as this will assisting in establishing appropriate steps needed to be taken to ensure sustainable adoption. Effective use of technology is likely to lead in an increase in productivity. To maximise profits, small-scale farmers should ensure that the cost of inputs is low and sell at the highest price. Lastly, investment in technology should result in a profitability index greater than 1 to ensure sustainable returns.

CHAPTER 3. RESEARCH METHODOLOGY

3.1 RESEARCH APPROACH

In Chapter 1, the purpose of the study and research questions were presented, and Chapter 2 provided a view literature review to assist in answering the research questions in line with the purpose of the research. This section will outline the research approach in collecting and analysing data to answer the research questions.

The study is aimed at understanding the value of technology adoption on profitability. To answer the research questions, a qualitative method was used. Qualitative research involves several interpretive techniques which seek to describe, and translate a phenomenon, not its frequency (Schindler, 2019). Research can be conducted asynchronously or synchronously, and cross sectionally or longitudinally (Schindler, 2019). This research was conducted as a cross-sectional study and did not intend to compare trends over time.

The qualitative approach was applied to the research question because it provides an understanding of the human condition in different contexts and of a perceived situation (Bengtsson, 2016).

Although the adoption of technology has been explored by several researchers, technology is dynamic, and it is important to continue investigating what drives adoption to get current insights, especially in a market segment that normally gets less attention.

3.2 RESEARCH DESIGN

The descriptive research design was used for this study. The goal of descriptive research is to describe a phenomenon and its characteristics (Nassaji, 2015). Accordingly, descriptive research was applicable to this study as it assisted in understanding if farmers adopt technology to increase profits. Understanding questions such as who, what, where, when, or how much is critical in descriptive research (Schindler, 2019). Interviews assisted in identifying which technology

was used, where the farm is located, during which period and how often. Such information had assisted in responding to the second research question of the study.

Descriptive studies offer an opportunity to observe a phenomenon in a natural environment, and new drivers of adoption may be unearthed which could be used in other research studies (Dudovskiy, 2021). Descriptive studies often are less time-consuming than other research designs (Dudovskiy, 2021). Due to limited time, this advantage for descriptive research was beneficial.

3.3 DATA COLLECTION METHODS

Face-to-face or digital semi-structured interviews were used to collect data from the selected participants. Face-to-face interviews provide an opportunity for participants to freely share their views and experiences concerning the study (Queirós et al., 2017). In-depth insights into what drives the adoption of certain technologies were acquired when participants are free to share their views and experiences. Semi-structured interviews help get meaningful responses (Biggman, 2008).

In addition to a higher return rate than questionnaires, face to face questions allow for an opportunity to ask the follow-up questions to participants (Alshenqeeti, 2014). The ability to ask follow-up questions was critical for this study to reveal deep insights about how adoption patterns affect profits. Lastly, it was also important to receive responses timely as this study needed to be completed within a defined period. In the event the of a lockdown or any other Covid-19 related restrictions, interviews were conducted telephonically or digitally using solutions such as Zoom. Gray et al., (2020) state that some of the advantages of conferencing solutions is that they are timesaving with no need to travel.

3.4 POPULATION AND SAMPLE

3.4.1 *POPULATION*

Population is defined as the entire group of people, events or things that interest the researcher wishes to investigate (Sekaran and Bougie, 2016). The target population for this research are farmer-owners and managers based in the Mid-Vaal Municipality in the Sedibeng Region.

3.4.2 *SAMPLE AND SAMPLING METHOD*

Convenience and purposive sampling were used for this study. Convenience sampling entails selecting participants near the researcher (Cohen et al., 2011). Convenience sampling was selected as it was economical for the researcher.

Purposive sampling uses certain criteria to select cases and there are two major types – judgment and quota sampling (Schindler, 2019). Judgement sampling is when the sample is selected to meet a certain criterion especially people with the knowledge of what is being studied (Schindler, 2019). The study involved small-scale (1-20 hectares) commercial farmers with and without experience. It was important to focus on small-scale farmers in business to make a profit.

Quota sampling aims to improve representativeness, that is ensuring the population is fairly represented (Schindler, 2019). Representativeness was not crucial for this study; thus, quota sampling was not accounted for in this study.

The proposed sample size for this study is 20 farmers. Marshall et al., (2013), state that saturation is not achievable for sample sizes below 20, and there is normally no new insight after the 30th participant.

3.5 THE RESEARCH INSTRUMENT

A 12-question scheduled interview was designed, and it was divided into four sections which were used to collect and collate data.

Section A – Demographic Data

Section B – Business Operations

Section C – Operating Environment

Section D – Open-ended questions to allow additional insights.

3.6 PROCEDURE FOR DATA COLLECTION

As highlighted before, to ensure a higher rate of return and enriched insights, data was collected via face-to-face interviews. Therefore, taking notes while participants are speaking may distract them and there is an opportunity to miss critical information while taking notes (Biggman, 2008). Henceforth, interviews with participants were recorded to ensure no detail is lost and data was transcribed accurately. Participants were required to provide permission to record the interview.

3.7 DATA ANALYSIS AND INTERPRETATION

Newton (2010) states that data analysis is critical since data from all sources is analysed and decisions are made whether to continue with the study or not. Content and thematic are the two research methods used to methods used to analyse messages (Neuendorf, 2018). Thematic analysis was applied to this study. The content method was applied to messages in an objective manner most used in quantitative studies and the thematic method involves the interactive process of interpreting a set of messages and it is mostly used in qualitative studies (Neuendorf, 2018).

A thematic analysis was deemed to be appropriate for this study as it enables the grouping of the data collected and makes it easier to identify themes and recurring patterns. The thematic analysis method organizes a group of repeating ideas to enable the researcher to answer the study questions (Elo, 2014). The results of the analysis were used to create themes to explain how small-scale farmer's profits is affected by technology adoption.

3.8 LIMITATIONS OF THE STUDY

- Sample size and sampling scheme not representative of the population.
- Covid-19 lockdowns and other measures related to curbing the spread also impact on data acquisition.

3.9 VALIDITY AND RELIABILITY OR TRANSFERABILITY AND DEPENDABILITY

3.9.1 *TRANSFERABILITY*

Transferability refers to the degree to which the results of a qualitative research study can be transferred into different contexts with different samples (Anney, 2014). Transferability can be enhanced by enriching the research context, theory and clarifying the assumptions that were central to the research (Moon, 2016). In this, extensive background to the study was provided and a peer-reviewed literature relevant to the study was used to improve the transferability of the study.

Transferability depends on the environment in the primary and target context as well as on the process of transfer and the person transferring is responsible for evaluating receptivity (Schloemer & Schröder-Bäck, 2018).

3.9.2 *CREDIBILITY*

Credibility refers to level of truth to which the views of the participants are represented in the study (Moon, 2016). Credibility may be enhanced through peer briefing i.e., feedback is requested from other scholars, triangulation i.e., validating with another data sources, and member checking i.e., participants are asked to validate results (Moon, 2016).

To ensure credibility in this study, the supervisor and the review panel participated in the peer briefing and the study was member-checked by some participants who were randomly selected.

3.9.3 *DEPENDABILITY*

Dependability refers to the consistency and reliability of the research findings and the degree to which research procedures are documented, allowing someone outside the research to follow, audit, and critique the research process (Moon, 2016). Dependability is achieved through an available audit trail, stepwise replication, and a code-recode strategy (Anney, 2014). The responses of the participants were kept allowing for an audit trail. Stepwise and code-recode strategy were not utilised for this study.

3.10 ETHICAL CONSIDERATIONS

The research was conducted in line with the Wits University guidelines. Clearance to conduct a study was requested from the Mid-Vaal Municipality. Participants were interviewed after providing permission to the researcher and were advised before on the purpose of the study.

The personal data of the participants was treated with confidentiality and results were anonymised.

Interviews were only be conducted after ethics clearance has been received from the University.

CHAPTER 4. PRESENTATION OF FINDINGS

4.1 INTRODUCTION

The purpose of this section is to present the findings based on the studies conducted. The presentation of findings starts with outlining the demographics of the respondents, and themes for findings, analyse findings concerning the propositions and end with a summary and conclusion of the findings. Thematic analysis was employed to summarise the results. Where applicable, the data was presented using quotes that were understood separately or in combination to illustrate the nonverbal communication seen during the interviews.

4.2 BACKGROUND OF PARTICIPANTS

This sub-section presents the respondents' demographic profile, which consists of gender, race, marital status, farming type, educational background, farming experience, and age. All the interviews were conducted face-to-face. Based on the agreed confidentiality with the respondents, they were identified as R1, R2, R3, up to R11.

The study group was dominated by married or people who have been married before with 5 years of experience in farming or more. 70% of the respondents depend on their farming operations for income. Most of the new farmers who entered farming recently have tertiary qualifications. Blacks and Whites dominate the participants of the study. All respondents are involved in crop farming, however, most of the participants who have less experience are involved in both Crop and Livestock farming.

TABLE 4.1: LISTS ALL THE RESPONDENTS' INFORMATION

Code	Gender	Race	Marital Status	Farming Type	Education	Farming Experience	Farmer's Age	As a Source of Income
R1	Female	Black	Married	Crop	Matric	8	36	Primary
R2	Male	White	Divorced	Crop	Post Matric - Fit and Turner	27	52	Primary
R3	Female	White	Married	Nursery	Matric	51	69	Primary
R4	Male	White	Divorced	Crop and Livestock	Std 8	35	69	Primary
R5	Female	Black	Married	Vegetables	Diploma	5	45	Primary
R6	Male	Black	Married	Crop and Livestock	Diploma in Agriculture	5	51	Primary
R7	Male	Black	Married	Crop and Livestock	Masters	14	37	Primary
R8	Female	Black	Single	Crop and Livestock	Honours	4	34	Secondary
R9	Male	Indian	Married	Crop and Livestock	Undergraduate	3	38	Secondary
R10	Male	Coloured	Married	Crop and Livestock	Matric	21	51	Primary
R11	Female	Black	Single	Crop and Livestock	Undergraduate	6	37	Secondary

4.3 THEMES FOR FINDINGS

After being coded, the research findings were categorized and given themes. These codes, motifs, and categories were found using thematic analysis (Braun & Clarke, 2006). The emerging themes from the research are Political, Economic, Social, Environmental, Legal and productivity. These were synthesised from the respondents' insights. In the next section, this study explores the results pertaining to each proposition. Table 4.2 below represent the summary of themes per proposition.

TABLE 4.2: SUMMARY OF PROPOSITIONS AND THEMES

Propositions	**Themes**
Consistent and successful technology adoption is dependent on several factors (PESTEL). Identifying and addressing the significant factors is critical to the successful adoption of new technology.	• Political • Economic • Social • Technology • Environmental • Legal
The use of technology can help to improve the profits of small-scale farmers by enabling them to operate efficiently and increase productivity generated regularly.	• Productivity • Efficiency • Revenue

4.4 RESULTS PERTAINING TO PROPOSITION 1

The results on small-scale farmers' adoption of technology, as reported by the respondents, are shown in this subsection. This section presents the categories and themes and the opinions made on the following proposition:

Proposition 1: *Consistent and successful technology adoption is dependent on several factors (PESTEL). Identifying and addressing the significant factor is critical to the successful adoption of new technology.*

KEY FACTORS TO ENABLE ADOPTION OF TECHNOLOGY

The respondent's first category was the external operational environment, which suggests that it is essential for farmers to adopt new technologies. Within the range of criteria deemed necessary for technology adoption, respondents nominated 31 codes. Lack of government backing, lack of knowledge, cost, funding, tried-and-tested technology, and climate change emerged as the main factors. These factors gave rise to five themes: political, economic, technological, and environmental. The participants ranked these essential success characteristics on a scale of high to low. By-laws and other easily applied by small-scale farmers variables were ranked lower, however government backing, and cost were highlighted as make-or-break elements.

4.4.1 *POLITICAL*

Under this theme, most participants said they were unaware of any government or local policies or support that would enable farmers to adopt technology and become more productive. The theme's key codes included the absence of local government showcases, information exchange, government assistance, and new tech showcases. However, respondents highlighted government as a crucial factor in enabling farmers to adopt new technology which can help them to improve productivity. Some of the respondents argued that government can start with basics such as reaching out to them on a regular basis to understand their challenges, and work with them to resolve them and identify opportunities for increasing productivity.

*"I believe the municipality can do better by buying and lending equipment to new emerging farmers at affordable rates. For example, a tractor costs between R200k - R900 depending on the condition and model. This is a lot for small farmer and not practical since the tractor may not be used extensively due to the size of the farm" – **R5**.*

Out of the 12 respondents interviewed, only 2 were aware of government sharing information related to funding of Small-Scale farmers or getting assistance in vaccinating livestock. However, one of the respondents indicated it is cumbersome to participate in some of these initiatives due to the requirements.

*"Yes, I am aware of policies which promote agriculture in the SME space such as the PepsiCo which was promoted by the department of agriculture. The programme was meant to create employment opportunities and increase PepsiCo local food procurement" – **R8**.*

4.4.2 *ECONOMIC*

This theme was highlighted by most of the respondents as the most critical factor in adopting new technology as it enables acquisition. A responded expressed a view, "without money, you cannot acquire new technology and the cost of the latest technology is inhibiting" – ***R11.*** This indicates that the responders appreciate the value money in their operations. As farm owners, they innovate or adapt mostly based on how successfully they make extra money or attract capital from other sources. Financial strength is one of the factors which provides them with a competitive edge. A responded shared how his financial strength enabled him to acquire new technology and grow his farming operations:

*"I used profits from my operations to buy a plucking machine which is more efficient and cost effective. The machine is quicker, and the output is smoother compared to manually plucking. This has led to increased customer satisfaction and boosted revenue in recent times" – **R8.***

Due to the highly unpredictable nature of their business, almost all respondents stated that they use profits or savings to purchase new technology. However,

some farmers use their own funds because they are not accustomed to borrowing and believe that using credit is a bad idea. Thus, most farmers indicated that interest rates have little to no impact on their operations since they do not use bank funds.

“All my operations are self-funded - This is cultural. I grew up in an environment where you pay everything for cash. However, due to Covid, I am now looking into borrowing” – ***R5.***

Asked if they track revenue and expense, most respondents indicated that they do not need to do so since they run family businesses.

“I do not keep records for any transactions performed. It is a complete task to keep and manage records”. – ***R2***

When asked about accessing government funding, majority of the respondents informed the researcher that they are not keen on it due to extensive requirements and delays in the releasing of funds. Others believe they are not eligible to apply for funds because most governments funds are directed to previously disadvantaged groups.

“I do apply for government funding; however, they take time to respond. For example, if I think I will not afford chicken feed in the next 2 months and then I apply for government funding, they will respond after 3 months or more and those chicks would have already died”. – ***R6***

“I bought my farming equipment using my own savings. I did not make use of grants because some of them have certain restrictions such as targeting the unemployed, required for tax or vat registration”. – ***R8***

“We do not get any government assistance because we are of the wrong colour”. – ***R2***

Cost was another factor which was identified by respondents as a key determinant in acquiring new technology. Latest or cutting-edge technology is generally expensive and most of the respondents informed the researcher that if

they acquire technology, it is generally second-hand technology which is cost-effective.

"I recently bought a used tractor from a bigger farmer for R180,000, however, a similar brand-new tractor would set me back over R600,000". – **R2**

4.4.3 *SOCIAL*

Respondents indicated that it is important to understand how they can interact with each other for the benefit of their community and farm production. Some of the key codes under this theme were population growth, community market and association, and theft. According to some respondents, the partitioning and then selling of the smaller plots has led to an increase in population in the Mid-Vaal area. The population growth has created a new market for farm produce, an increase in technology usage and a more diversified society coupled with an opportunity for people to learn other cultures.

"There is a flea market which the community sells and showcases its produces on Saturdays, it was growing, however, this was negatively affected by covid, and it is no longer as frequent as it was before covid. To support demand the community has created a Facebook page and plans are in place encourage more farmers come together and partner with food delivery service provider". – **R7**

"I belong to a Boerie association which provides us with good agricultural advice like what crops are in demand, market prices, possible shortages in the market". – **R4**

As much as the growth in population has brought opportunities which increase revenue for the farmers and enable them to acquire new technology, it has also brought on challenges such as drop in the underground water level as indicated by one of the respondents*: "Population growth has led to an increase in the number of boreholes in the area which has negatively affected the underground aquifer".* – **R10**

The growth in population has also led to an increase in the theft of livestock and farm produce. This factor was raised by almost all the respondents. Below are some of their feedbacks:

"They steal a lot of vegetables in this area". – **R5**

"In this area they steal too much. Security is needed to protect your crops and your family". – **R9**

Some of the population growth challenges have compelled farmers to adopt new technologies such as the latest security or access control systems. According to the farmers, not only do security systems protect them from theft, but they control access which ensures only authorised personnel access the farm thus preventing the spread of crop and animal diseases.

The researcher also noted that the older generation of small farmers inherited their farms, and it is one of the reasons why the land has been portioned. The family splits the inheritance, and the remaining members retain their share. On the other hand, the new generation of farmers acquires their farms by purchasing the portioned land with funds from savings, family loans and lump sums from other sources such as pensions received when they resign their formal jobs.

"I was born, raised here and inherited this farm from my parents. I am also not part of any association". - ***R2***

"When I our company shut down, I took my package and decided to venture into farming. I decided to farm crops because people will always need to eat". – ***R8***

Unemployment in South Africa has increased over the years, and some attribute to the increased adoption of technology as indicated by one of the respondents*: "I do not have a lot of technology, I prefer using manual labour so that I can support my community or create employment for the unemployed. However, I sometimes use other neighbour's equipment and that helps to reduce time to work the land*". – ***R4***

4.4.4 *TECHNOLOGY*

Whether through the adoption of fundamental or tried-and-tested technology or cutting-edge or most recent technologies, in addition to other key themes, technology also emerged as a prominent theme in the study. Most respondents highlighted that they may not always be able to acquire technology, they acknowledged that it helps to monitor technology trends in farming and other industries. Being aware helps them to plan and save to acquire the relevant technology or create a makeshift which serves the same purpose as the one they desire.

"It has become very expensive to farm and to do trial and error will cost you a lot of money, that is why we don't use any fancy technology and stick to the tried and tried-and-tested technology". – ***R1***

"In recent times I've noticed that most of the crop farmers use nets or green houses, however I cannot afford them at the moment and to adapt to the new ways, I use traditional methods like stacking up sticks to cover my plants". – ***R3***

Additionally, age, educational background, and cost are some of the key codes raised under this theme. Younger people or new farmers are more optimistic about applying new technology in their operations than the older generation of farms. Farmers who have tertiary qualifications have an appreciation of new technology and some of them did indicate that they not only monitor what their neighbours are using, but also read about it.

"My university background in agriculture has come in handy for me so far, as it helps, me to monitor and effectively evaluate new technology even though I haven't acquired technology in recent times, I use the skill in my Agric consulting business." – ***R7***

4.4.5 *ENVIRONMENT*

Under this theme, most respondents said they had observed changes in the climate over time, noting things like reduced rainfall, harsher winters, excessively

hot summers, low water bases, and the need to adapt to the changes through technology or other natural means.

"I house my seedlings in structure which we built some time ago and it helps to protect the plants from harsh weather. It also enables me to deliver my products to my clients all year round. To warm my seedling in winter I burn wood in the early hours of the morning and smoke the plants. I do this because I cannot afford the fancy technology, however I have to respond to climate change." – ***R4***

"I've not used any technology due to climate change or environmental reasons. However, I would like to acquire a greenhouse which would enable me to plant and harvest all year round". – ***R5***

"I have a few sheep here and it helps to keep the grass short and eliminate weeds. Mixed farming helps me to counter adverse weather conditions while keep my operating costs low. I also don't buy as much fertiliser as I use manure from chickens, cattle to enhance the growth of my vegetables which friendly to the environment". – ***R6***

Reduced rainfall has led to lower water bases and farmers have had to find ways to find water by using technology to drill deeper to ensure consistent supply of water.

"My borehole is still pumping out lots of water and this is likely because I'm on a low level. Other guys on higher levels are now complaining about the amount of water they get from their boreholes. They now drilling more boreholes or getting water from rivers to augment their boreholes". – ***R4***

4.4.6 *LEGAL*

Under this theme, most respondents said they were not aware of any laws which promote or enable small farmers to adopt new technology. According to the farmers, they may not know about the laws because due to lack of effective enforcement. Key codes under this theme were, no legal requirements, animal identification law, water, and soil management. However, the municipality

enforces some of its laws, which were seen to be archaic by some farmers as expressed by **R11**:

“Yes, I am aware of agricultural laws. For example, I wanted to build a Pig Pan and I was advised that I must get approval from the municipality and ensure that the pan meets the specified by-laws. I had to reduce the number of pigs in my farm because of the bylaws. The reduction in the number of pigs led to a reduction in revenue and which meant that I could not acquire the latest technology”.

To curb or prevent theft, the Department of Agriculture introduced animal identification mark or mechanism in line with the Animal Identification act. According to some of the farmers, this is a progressive piece of legislation, however, the government needs to be more introduce a more efficient application and license or mark-issuing process.

“As the number of sheep increases, I am compelled to sell them since we do not have space. Back in the days it was easy, but it has now become a challenge because of the Animal Identification Law. I have applied for the license or unique mark and they very slow. The department has not responded to my request for over 3 months”. – ***R4***

However, some of the participants have indicated that the Animal identification act enabled the market to develop livestock tracking technology thus modernising agriculture and reducing losses from theft and spread of diseases.

Water is a scare resource, and in South Africa there The National Water act provides guidelines on how farmers use water in their operations. Most of the respondents, indicated that they were aware of the act, however, they think it does not apply to them because their small-scale farmers. Thus, all of them use borehole water for irrigation purposes and they do not see the need to introduce technology which can help them manage their water resource effectively.

"My borehole works fine; I don't think I need any technology better than that even though the water base is declining. Is there a technology to make additional water or change water laws?". – ***R3***

The Conservation of Agricultural Resources Act 43 of 1983 aim to protect the agricultural environment and the soil amongst other factors of production. Poor soils lead to poor yield or output. Minority of the respondents seem to be aware of this act and use traditional or non-permitted fertilisers, unintentional harming the environment.

"Applying a lot of fertiliser helps to improve the survival rate of my crops. Is the application of fertiliser regulated?" – ***R2***

4.5 RESULTS PERTAINING TO PROPOSITION 2

The findings of the factors that respondents described as enabling for employing technology to improve profits are presented in this subsection. This section presents the categories and themes and the opinions made on the following proposition:

Proposition 2: *The use of technology can help to improve productivity of small-scale farmers by enabling them to operate efficiently and increase profits generated on a regular basis.*

4.5.1 *PRODUCTIVITY*

There is a strong understanding amongst the respondents that increased output has been a definitive factor for them to remain viable. Therefore, for farmers to increase their competitive advantage, they needed higher yields.

"Most farmers go out of business because they cannot meet demand, or they are not able to predict their output. Customers prefer a farmer who can provide with produce whenever they require it, and technology has helped me to produce a lot of vegetables all year round and not lose customers to other farmers. Although expensive, tunnels have helped me to increase my output and meet customer demand". – ***R9***

4.5.2 *EFFICIENCY*

The farmers were ardent about increasing efficiency in their operations. The vital codes were the tried and tested technology, low labour costs and increased variety. One of the farmers argued the desire to increase efficiency is not limited to farming but across all other industries and technology is at the heart of it.

Respondents were very clear that they prefer tried and tested technology, as new technology is risky, costly, and not predictable, and can lead to their operations being shut down as indicated by the responses below:

"I recently installed a dripping system, which is a simple technology and has proven to work across the industry. It helps me to use my water efficiently and effectively deliver nutrients or fertiliser to my crops thus lowering my operational costs". – ***R11***

Additionally, according to some farmers, mixed farming is essential as it helps with diversifying risk and can sometimes create an ecosystem whereby outputs or waste from other farming activities is used as inputs in other.

"I started with crop farming and a few years ago I decided to add chickens as part of diversifying my operations. We use basic technology to collect chicken dripping which in turn is used as organic fertiliser for our crops leading to lower operational costs and a higher output". – ***R8***

Some farmers also indicated that technology has helped lower production costs as it is more efficient than manual labour as highlighted by one of the respondents below:

"I use tried and tested methods. We have recently acquired a Tractor, bed maker and it reduced cost, for example manual labour would cost me R20,000 and take over 3days, but with a tractor I can till the land in 2 hours". – ***R1***

4.5.3 *REVENUE*

Farmers indicated that increased productivity and improved efficiencies due to technology led to increased revenue and profits.

*"Although the technology I have is basic or old, it has helped me to increase my output, be able to deliver to my customers on a regular basis, increase my revenue and profit". – **R1***

Respondents also cited that technology lowers their costs of operations; hence they can still offer their produce at affordable prices thus increasing their profits.

*"Because of technology I'm now able to deliver products at lower prices and I always never return with stock home since I sell everything at the market. Before I used charge high prices to recover the cost of labour and from time to time, I had to throw away some of my produce which didn't sell at the market because of high prices. Technology has helped me reduce stock that I have to throw away because my prices are now competitive, and I sell out more often than not, thus increasing my profits". – **R11***

4.6 CONCLUSIONS ON THE FINDINGS

The research participants exhibited a range of backgrounds and experiences, but they shared a recognition of the necessity of implementing technology to enhance their profitability. Most of them, however, did admit that they haven't purchased the newest technology because it is too expensive, preferring to improvise to stay competitive.

Lastly, there's a new generation of farmers coming into the Mid-Vaal and have a positive view of new technology, and we might see the latest technology being used as their operations mature.

To summarise the key finding per proposition based on the research questions:

Proposition 1: Consistent and successful technology adoption is dependent on several factors (PESTEL). Identifying and addressing the significant factors is critical to the successful adoption of new technology.

- Participants confirmed that it is critical to be aware of the external factors since it greatly influences their ability to acquire new technology. Additionally, farmers emphasised that some external elements are more significant than others. For instance, some argue that the political climate

has a greater impact on technological adoption than other factors, while others suggest that social issues have a greater influence.

Proposition 2: The use of technology can help to improve the profits of small-scale farmers by enabling them to operate efficiently and increase productivity generated regularly.

- Participants stated that whenever technology was used, they saw an increase in output and, in certain cases, a decrease in operating costs, which translated into higher profits. Finally, the respondents expressed a preference for tried-and-tested technology that allows them to farm a wide range of produce at the lowest feasible cost.

The next section discusses the findings in this chapter concerning the literature in Chapter 2.

CHAPTER 5. DISCUSSION OF THE RESULTS OR FINDINGS

5.1 INTRODUCTION

The results of the study covered in Chapter 4 are discussed in this chapter. These results are compared with the literature reviewed in Chapter 2 to address any similarities or discrepancies. This discussion addresses the study's objective, to recommend methods to improve technology adoption and profitability for small-scale farmers.

The themes that were produced in relation to the research questions and propositions based on the review that was conducted are shown in Table 5.1.

TABLE 5.1. THEMES AND PROPOSITIONS

Research questions, propositions, and final themes Research Questions	**Propositions**	**Themes**
Question 1: How does the operating environment affect the adoption of technology by small-scale farmers?	***Proposition 1:*** Consistent and successful technology adoption is dependent on several factors (PESTEL). Identifying and addressing the significant factors is critical to the successful adoption of new technology.	• Political • Economic • Social • Technology • Environmental • Legal
Question 2: What technological measures can be implemented to increase profitability of small-scale farmers?	***Proposition 2:*** The use of technology can help to improve profits of small-scale farmers by enabling them to operate efficiently and increase productivity generated on a regular basis.	• Productivity • Efficiency • Revenue

As a result, the methodology employed highlights the crucial conclusions from Chapter 2 and draws a comparison between them and the results of the analytical investigation. The research questions indicated above are taken into consideration when discussing the findings with regards to the propositions.

5.2 DISCUSSION PERTAINING DEMOGRAPHIC PROFILE OF PARTICIPANTS

5.2.1 *AGE GROUP*

The average age of the research participants is 47 years old, which is considered middle age according to (Dolberg and Ayalon, 2018). There is mounting evidence, according to Mitzner (2019), that younger adults are embracing technology more quickly than older adults. This is corroborated by responses from the young and new farmers who indicate they would appreciate access to new technologies, and the older generation stated that they prefer tried-and-tested ways of doing things. Farmers below the age of 40 stated that they are involved in farming to supplement their income and or cautiously enter the farming industry as it is risky. This statement is supported by literature from Mmbengwa (2011) in which they stated that a study revealed that the South Africa small-scale farming industry experiences an 80% failure rate.

5.2.2 *GENDER*

There is no gender bias in this study. The study's findings showed that there was an equal distribution of genders among men and women, however, most of the younger farmers who recently acquired farms are female. The higher percentage of males who have been in the industry for longer could be attributed to gender inequalities of the past whereby men had more access to resources than women.

According to the FAO (2023), women farmers produce almost 80% of the food in underdeveloped nations. Even though women dominate the business because of higher productivity, male farmers in emerging nations make up most of the industry's income (FOA, 2023). According to Doss (2017), women's productivity and incomes can be raised by having better access to financial services and cutting-edge technology. Since most participants did not feel comfortable sharing the revenue they make from their agricultural operations, there is no correlation between the study's income and the farming income literature.

5.2.3 *FARMING EXPERIENCE*

This study was open to any farmer whose farm is between 2 and 5 hectares; prior farming experience was not required. With remarks like "Boer maak 'n plan”, the researcher did observe that experienced farmers, when it comes to maintaining or improving productivity, prefer to improvise rather than purchase new technology.

The above observation is contrary to the literature which states that workplace novelty and improvising are positively related, and this also drives employee creativity (Yang Chen, 2020). This is also confirmed by (Jay O’Toole, 2020) who asserts that experience moderates the value of the presence of improvisation. This may suggest that improvising by experienced farmers may be due lack of capital to acquire technology than lack of desire to adopt new technology.

5.3 DISCUSSION PERTAINING TO PROPOSITION 1

The external environment has an impact on the adoption of technology in farming. The study used the PESTEL framework to evaluate the impact of the study's findings, which indicated that the external environment influences how new technology is adopted. A discussion of the corresponding themes is given below:

5.3.1 *THEME 1: POLITICAL*

According to Chen (2020), government intervention in small business digital transformation journey is vital and this involves supporting them through funding, training, information sharing or showcases and progress technology adoption policies. This view is aligned to the response from the participants who indicated financial assistance or grants from government would go a long way in ensuring that they acquire the latest technology to improve their output.

Exposure to new technology would also help them to have an appreciation for it and maybe save to acquire solutions which will add value to their businesses and make them more competitive.

According to survey participants, a well-defined policy aimed at investing in small-scale farmers will enhance their output and stimulate innovation within the industry, ultimately contributing to the expansion of the agriculture sector and the broader economy. A study conducted by Wang (2018) provides support for this evaluation by comparing Singapore, where there is significant government support for the target industry and higher levels of innovation than in Hong Kong, with Hong Kong, where there is less government interference.

5.3.2 *THEME 2: ECONOMIC*

Access to funding is critical for technology adoption (Shaw, 2014). The priority on this factor is echoed in other studies as well. Rayhan et al., (2023) identified access to credit as a key component for acquiring new technology and improving agriculture production. The study's participants expressed some agreement with the literature, but they were also concerned about the fact that banks require collateral when lending to small businesses and this discourages farmers from taking out loans to purchase new technology because they run the risk of having their assets repossessed if they are unable to repay the money that the banks have supplied. Given the risks associated with farming, farmers emphasized that they would rather use retained income, save money gradually, or borrow equipment from other farmers.

Based on the above, farmers indicated that they do have a keen interest on other economic phenomena such as globalisation, economic growth, inflation rates and interest rates as they are not directly affected by an increase or decrease in the repo or prime lending rates. Others indicated that they do not know how economic data affects them.

Nugroho (2021), indicated that it is important for farmers to be aware of economic globalisation as this can impact farmer’s ability to adopt new technology.

5.3.3 *THEME 3: SOCIAL*

Under this theme we discuss the impact of social interdependencies raised in the previous chapter and other codes since demographics have been discussed in

the introduction. Based on the feedback from some of the farmers who were interviewed, they indicated that they sell produce at a community flea market, also encouraged farmers in the area to join the Facebook community page to list their products. They also looking into pursue delivery of produce. This is in line with the literature which according to Campos (2021), who states that in vertical integration, farmers encourage each other adopt a certain form of technology within the value chain due to the changes in the operating environment and customer preferences. The adoption can only be successfully if a substantial number of farmers work together, thus creating social interdependence.

Campos (2021) states that farmers may interdepend horizontally through sharing information or adopting certain technology to help them operate efficiently such as using planting the same type of pesticide to minimise the spread of a disease. This is consistent with the responses from the participants who some of them indicated that they are part of an association which informs them on latest inputs to use so that they can get the maximum output for their efforts.

Maluleke (2016) claims that in addition to the many difficulties farmers have, they also have to deal with stock theft, which may cost them millions of dollars at times. To prevent stock theft, advanced security measures must come before the necessary operational funding leading to lower investment in farming. To identify stock and discourage theft, farmers have resorted to hot-iron branding, freeze-branding, Tattoo mark as the Animal Identification Act (Act No. 6 of 2002) (Maluleke, 2016). According to Maluleke (2016), SAPS has an opportunity to increase capacity to deal with stock theft effectively. However, participants involved in mixed farming i.e., livestock and crop indicated that livestock theft is not severe as crop theft since most of the crop farms are not properly secured and securing them is costly as per the literature by (Maluleke, 2016). Farmers agree that they security beams could be useful in preventing theft, however, they can’t afford to maintain them even though install is “technically free” due to irregular income. There is an opportunity enhance agricultural security and boost investment in the industry.

5.3.4 *THEME 4: TECHNOLOGY*

Technology diffusion and awareness are important precondition for adoption to occur (Simtowe et al., 2012). This is aligned to the responses from the participants who indicated that they track new technology trends in the market so that they can understand better and more efficient ways of farming. However, instead of acquiring the new technology due to costs, some participants indicated that if possible that create makeshift of the technology which is marketed.

The responses from the participants also revealed that demographics have an impact on how participants view technology. For example, young have a positive appreciation of technology and older participants were not so keen on understanding new technology trends. It was also noted that participants with higher levels of education were more optimistic about adopt technology than those who are less educated. The findings are aligned to the literature as stated by Hasan (2019) that farmers' characteristics such as education, knowledge, ability to use, access to technology facilities, attitude towards technology had significant positive relationship with their awareness on use of technology; while age, household size and annual income had significant negative relationship with the awareness on use of technology.

5.3.5 *THEME 5: ENVIRONMENTAL*

According to the participants, there have been negative changes in the environment over time, including lower water bases, harsher winters, shorter summers, and less rainfall. Technology may be able to help address these difficulties brought on by climate change. This is consistent with research by Senyolo et al., (2018), which claimed that climate change poses a risk to agricultural productivity and that creative solutions are needed to increase output while preserving the environment.

Farmers claimed that because experimenting with new technology would be costly and would put them in danger of going bankrupt, they use conventional methods to handle some of the climate-related issues. This is in line with claims

by Kawula, (2019) that farmers often choose traditional methods and have found it difficult and expensive to adopt new technologies.

5.3.6 *THEME 6: LEGAL*

The national legislature considered a few measures in 2021 that directly affected the agriculture industry, according to the OECD (2022). Nonetheless, most interviewees said they were unaware of any laws that were approved by parliament. Therefore, farmers are unable to benefit from some of the laws that would enable them to adopt new technology. For instance, according to the OECD (2022), the 1-billion-rand Agri-Industrial Fund was established in 2021 to support the growth and development of the agricultural sector by helping producers and entrepreneurs establish, grow, acquire, and integrate operations in value chains that are prioritised.

According to a journal article by Newton (2020), people's willingness to act upon government information is significantly influenced by their level of trust in the government. The study examined the British government's track record of disseminating information about its policies and performance. People's disinterest in government policy may also be a result of a loss of trust in our government, which could have an indirect detrimental impact on the adoption of technology.

5.4 DISCUSSION PERTAINING TO PROPOSITION 2

The use of technology can help to improve profits of small-scale farmers by enabling them to increase revenue, productivity and operate efficiently on a regular basis.

5.4.1 *THEME 7: PRODUCTIVITY*

As defined in the literature, productivity is the output produced over time Osman (2023) and can be improved with adoption of technology. Most of the respondents corroborated what was highlighted in the literature and stated that technology has helped improve their annual output and enabled them to meet customer demand.

For example, some of the participants indicated that the use of boreholes instead of solely depending on rainy increased their operating costs, however, it led to increased output and predictability in their operations.

5.4.2 *THEME 8: EFFICIENCY*

In the literature, Osman (2023) states efficiency is how well resources are used to lower operational costs while increasing revenue and profits. Some of the respondents informed the researcher that the use of the water dripping system reduced the cost of operations and help them increase the output produced. This indicates that the effective management of inputs using technology can help lower costs while increasing output.

5.5 CONCLUSION

The discussion revealed that there is close alignment between what was highlighted by literature and the experiences of farmers with regards to the adoption of technology as captured by the researcher albeit with some slight differences. As an example, farmers' level of education is assumed to have a positive impact in the adoption of technology as stated by Udimal et al., (2017) and this matches the observation of the researcher based on the information provided by the participants. The literature outlined that external factors have an impact on whether farmers adopt technology or not. However, some of the factors are more pronounced than others. All the farmers who were interviewed indicated that the biggest external factor they consider before they acquire any of form of technology is the economics of acquiring and operating the technology.

The importance of understanding the difference between productivity and efficiency was highlighted as this helps farmers determine the purpose of adopting technology. Based on the discussion, it was noted that most farmers adopted technology to increase productivity, efficiency, revenue and ultimately profits.

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

6.1 INTRODUCTION

The conclusions drawn from the research questions posed in the first chapter are presented in this chapter. It has some limitations and offers some preliminary recommendations for further studies. The main purpose of the study was to find out how the external environment influences the adoption of new technologies and how technology adoption small-scale farmers' profitability in the Mid-Vaal area.

The external factors unpacked in this study were essential for small-scale farmers to build and improve their competitive advantage. They are outlined in the PESTEL model which is used to evaluate the external environment impact on technology adoption. The aim of driving technology adoption by small-scale farmers is that it has been proven to assist in improving productivity, efficiency, revenue, and profitability. It also assists with ensuring food security and addressing unemployment in developing countries. It was highlighted that it is important for farmers to identity factors which affect them the most when it comes to technology adoption and respond accordingly.

Finally, the research yielded essential themes that emphasised important areas of significance. Chapter 4 presents views derived from participant replies in the interviews, while Chapter 5 discusses the alignment between chapter 2 and 4. The important issues that small-scale farmers in the Mid-Vaal region must prioritize are listed in detail in Chapter 6. By presenting the study's findings in connection to the research questions, the first section of the chapter addresses the goals of the investigation. Recommendations for technology adoption in a farming environment are provided, and suggestions for further research are made, based on the study's conclusions.

6.2 CONCLUSIONS ON FARMER'S VIEW ON THE USE OF TECHNOLOGY

The study was carried out in a location which could be considered as an agricultural area with a rich history of farming since some of the farmers have been there for decades. Older and established farmers tend to exercise caution when it comes to the use of new technology. Most of the older generation of farmers in response to the questions posed to them indicated that they prefer "what they know" and are not keen on using or adopting new technology as they think that it will take a lot of time for them to learn how to use and it is costly. The older generation indicated that the just want increased access to the market without the use of fancy technology so that they can increase revenue and profits. In contrast, the younger generation of farmers who are coming into the area indicated that they would appreciate access to the latest farming technology since it would help them increase their productivity, efficiency, profitability and ensure that they remain competitive in the market.

Post-matric educated farmers across all ages and genders have an appetite for new technology and informed the researcher that they monitor latest trends of technology in agriculture which helps them understand how to use it and possible value which can be derived from its usage.

To advance farming in the Mid-Vaal area it would be advisable to use less complex technology to assist the older generation to access the market and find ways to provide access to the latest technology to the younger generation of farmers. In the next will provide a conclusion how the external factors affect the adoption of technology by farmers in the Mid-Vaal area using the PESTEL methodology.

6.3 CONCLUSIONS ON HOW THE EXTERNAL OPERATING ENVIRONMENT AFFECT THE ADOPTION OF TECHNOLOGY BY SMALL-SCALE FARMERS

Several authors have written on how external factors affect the adoption of technology by farmers. However, it has proven challenging to locate research which analyses the adoption of technology by small-scale famers using the PESTEL framework which has been applied in this paper. For instance, Muzari (2012), reviewed several factors which impact the adoption of technology by farmers, however he highlighted four of the elements of the PESTEL indirectly. Thus, insights were drawn from multiple papers covering 21st century adoption of technology in the agricultural sector and aligned to the PESTEL framework.

The study provided some thought-provoking discoveries and found that some of the PESTEL factors were more pronounced than others depending on several factors which define the farmer. Established farmers indicated that they would like to use tried and tested technology and economic factor was more important to them. On the other hand, the new generation of farmers are more excited about new developments or technology with a focus on prospects, and the technology factor is key to them. Conclusions on elements of the PESTEL model in relation to technology in small-scale farming is shared below.

6.3.1 *POLITICAL*

Majority of the farmers indicated that they were not aware of governments efforts or initiatives to promote adoption amongst small-scale famers. This could be attributed to policy or lack of effective communication. Thus, it is advisable for government at all levels to work together to drive the use of technology in farming as this is vital for economic growth. This could involve improving or changing policies and use modern technologies to effectively communicate to small-scale farmers on how technology could benefit them and or how they can easily access it.

6.3.2 *ECONOMIC*

To acquire new technology, farmers need to have the funds or access to funding. The research and responses to the question from the researcher indicated that farmers struggle to get access to markets and funds to for several reasons. Local or National government may be required to support the development of bespoke financial solutions from financial and developmental institutions targeted at enabling small-scale farmers to acquire new technology which will enable farmers to be competitive in a globalised market. Technology can also be used to connect farmers with buyers across the globe for produce which is marketable globally.

6.3.3 *SOCIAL*

In the literature and responses from farmers, it was noted that several individual and group traits have an impact on the adoption of technology by small-scale farmers. Generally, young and educated people are more willing to adopt new technology. Other factors which affect the operation of a value chain or community also have an impact on the adoption of new technology for instance a supplier may phase out an old product and introduce a new one inadvertently compelling a farmer to adopt the new solutions.

Supporting self-development and finding ways to work with different stakeholders to influence the views on new technology may assist in driving the adoption of new technology in farming.

6.3.4 *TECHNOLOGY*

A study conducted by Hasan (2019), found that 72% of the farmers had low awareness of technology. This could be attributed to individual characteristics such as age and other external low bandwidth speed of the internet, and limited availability of technology services. Access to information and user-friendly technology are some of the drivers identified which could assist in speeding up technology adoption.

Availing information about the latest technology to farmers using traditional and latest means of communicating with potential users could assist in the adoption of technology.

6.3.5 *ENVIRONMENT*

As climate changes, farmers will be required to adopt by using technology so that they can remain viable. Installation of water management systems and windbreakers will be key moving into the future. A tough operating environment may require farmers to acquire off-the-grid tech solution as South Africa continues to suffer from load-shedding.

6.3.6 *LEGAL*

South African agricultural industry is governed by several laws some of them promoting, while others hinder the adoption of technology. Thus, farmers will need to be agile and navigate the laws of the land with the use of technology so that they can remain profitable.

6.4 CONCLUSIONS ON THE USE OF TECHNOLOGY CAN HELP SMALL-SCALE TO IMPROVE PROFITS EFFICIENTLY AND INCREASE PRODUCTIVITY.

In the previous chapters, definitions of profit, efficiency and productivity were presented to provide context on how technology helps to improve the viability and sustainability of farm operations. The use of technology allowed farmers to increase their output, and in some instances assisted in increasing output with minimal inputs thus leading to increased profits.

Thus, farmers need to be objective when acquiring technology as to what goal are they trying to achieve, i.e., increase market share through high productivity or increase profits through high efficiency.

6.5 RECOMMENDATIONS

- **POLICY REFINEMENT AND EFFECTIVE COMMUNICATION**

The world is now very dynamic, thus local governments at all levels may need to be agile and review policies which affect agriculture regularly so that they can enable farmers to adopt the relevant technology which can assist them to increase their output and profits. This may include but is not limited to tax rebates on farming equipment acquired by small-scale farmers.

Some farmers indicated that they do not know of any government initiatives to support small-scale farmers. Localised traditional and non-traditional forms of communicating may assist in bridging this gap. Communicating government initiatives via low-cost social media platforms such as Facebook and advertising on monthly municipal bills which get sent out to residents in the Mid-Vaal municipality.

- **ACCESS TO FINANCE AND MARKETS**

Most respondents indicated that they cannot adopt new technology due to a lack of excess funds or access to credit. Banks normally decline their applications since they consider small-scale farming risky especially if the operations are not fully developed. Extending enterprise development loans and grants to acquire technology with repayments based on output or revenue could lead to technology adoption. Additionally, the municipality can partner with other developmental institutions and offer incubation services for farmers in the area to help them grow. Farmers' growth will lead to more activity in the area leading to an increase in municipal revenue.

- Farmers also indicated that they struggle to access markets in other areas, and the creation or onboarding of them onto an online platform to connect buyers and sellers could assist in accessing markets currently far from reach with minimal marketing costs.

- **TRAINING AND AWARENESS**

In the literature, it was noted that technology adoption is also highly dependent on how users are aware of it and its associated benefits. To increase awareness, the municipality can host a quarterly or annual trade show in which suppliers of technology in the agriculture sector can display their products to farmers.

In addition to that, the municipality can host masterclasses and workshops to educate farmers on new technology which they can use to increase their output and profits.

- **ACCESS TO TECHNOLOGY**

Farmers indicated that they also struggle to find people who can hire out technology at a low cost. Thus, to enable farmers to access technology at a lower cost, the municipality can create a marketplace platform which can enable other farmers to hire out their equipment when it is lying idle. Additionally, the municipality can also drive programmes which incentivise bigger commercial farmers in the area adopt, mentor, and provide technological support to smaller farmers.

Lastly, the municipality can acquire technology and hire it out to small-scale farmers in the area, and this will make technology accessible while creating a new revenue stream for the municipality.

6.6 LIMITATIONS

Established commercial farmers were not included in the research sample size since they are not considered small-scale farmers. Instead, the research sample size was restricted to small-scale farmers. As such, thoughtful observations regarding the method by which established commercial farmers incorporate technology are excluded from this research. It was challenging for the researcher to perform an analysis on how the adoption of technology affected revenue or profits since farmers did not feel comfortable disclosing the turnover details.

Finally, the study's background restricts its applicability to other subtleties that might emerge in other circumstances.

6.7 SUGGESTIONS FOR FURTHER RESEARCH

Additional research is recommended in the following areas:

- The research study focused on small-scale farmers and a study to understand how commercial farmers' technology adoption is affected by PESTEL and if the learnings from there can be used by small-scale farmers.
- The geographical focus of the study was the Mid-Vaal municipality and studies in other areas to check similarities are encouraged as this will assist policy makers to build broad policies.
- Conduct a study to understand the significance of each of the PESTEL elements on the adoption of technology in small-scale farming. This will enable farmers and policymakers to prioritise accordingly and use resources efficiently.
- Use a quantitative study to quantify the profit uplift derived from the adoption of technology by small-scale farmers.
- Explore the impact of load shedding and COVID-19 on the adoption of technology by small-scale farmers.

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APPENDIX (A) INSTRUMENT

INTERVIEW FRAMEWORK

Section A – Demographic Data *(The purpose of this section is to determine the influence of demographics in the adoption of technology)*

- Age
- Marital Status
- Sex
- Farming Experience
- Highest Qualification
- Annual Turnover

Section B – Business Operations *(The purpose of this section is to understand how technology has been utalised on the farm and assess the impact thereof)*

Do you prefer tried and tested or experimenting with technology?

Which technology is has been used over the years and why?

Did the technology implementation result in higher yields?

Did the technology implementation result in increased profits?

Section C – Operating Environment *(The purpose of this section is to understand how the external environment has affected the adoption of technology)*

Are you aware of any policies which promote technology adoption in farming?

How do you finance the acquisition of new technology and why?

Which economic factors affect you the most when deciding to acquire technology?

Do other farmers in the area use technology to farm and why?

Does the municipality provide programmes to create awareness about new farming technology and how?

Have you adopted new technology due to climate change?

Which laws have compelled you to adopt new technology?

Section D – Open-ended questions to allow additional insight *(The purpose of this section is to gather additional insight)*