

https://dspace.org/

The adoption of smart technologies in small-scale farming to promote local economic development in Mnquma Local Municipality, Eastern Cape Province, South Africa

Qutu, Bavulele

2024
University of the Witwatersrand, Johannesburg
https://hdl.handle.net/10539/43844

. (2024). The adoption of smart technologies in small-scale farming to promote local economic development in Mnquma Local Municipality, Eastern Cape Province, South Africa [Master's dissertation, University of the Witwatersrand, Johannesburg].WireDSpace.

Downloaded from a DSpace repository. https://dspace.org/

The adoption of smart technologies in small-scale farming to promote local economic development in Mnquma Local Municipality, Eastern Cape Province, South Africa.

Bavulele Qutu

909956

909956@students.wits.ac.za

A research proposal 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 Business Administration.

Johannesburg, 2024

Declaration on plagiarism

I **Bavulele Qutu**, student number: **909956**

I am a registered student for a master's in business administration. I confirm that the work that I will submit for assessment is my unaided work. I will follow the required guidelines in referencing the thoughts and ideas of other writers and authors. I am aware of the correct method for referencing and plagiarism was discussed during the orientation class.

I further note that the University of Witwatersrand takes plagiarism in a serious light and further note that disciplinary action can be taken against me if I fail to correctly acknowledge the sources in my study.

Signature: __B Qutu_____ Date: 28 March 2024

Acknowledgement

To my wife (Saneliso) **and children** (Sinengomso, Asafika and Lulonke), I would like to express my heartfelt gratitude for your unwavering support and understanding during the completion of my thesis. Your patience, encouragement, and love have been my pillars of strength throughout this challenging journey.

I could not have achieved this milestone without your constant belief in me and your willingness to make sacrifices to ensure that I had the time and space to focus on my research and writing. Your presence and understanding have been my source of inspiration, and I am forever grateful for the love and support you have shown me. I am looking forward to celebrating this momentous occasion with you all.

My deepest gratitude to my thesis supervisor, **Dr T.K Pooe** for his guidance, patience, support, and expertise throughout this research journey. I am also thankful to my **family** and **friends** for their encouragement and understanding during this challenging time. Additionally, I want to acknowledge **the participants** who generously shared their time and insights for this study. Their contributions were invaluable to the completion of this thesis.

Lastly, I am grateful for the unwavering support of my **colleagues and mentors** who have inspired and motivated me along the way. To the crazy classmates, 2022/2023 Midyear MBA cohort it was an absolute pleasure to have shared this journey with you all.

Thank you all for being a part of this incredible experience.

Abstract

The thesis explores the adoption of smart technology by small-scale farmers with in Mnquma Local Municipality, Eastern Cape, South Africa to enhance local economic development. It delves into the challenges faced by small-scale farmers in accessing and utilizing smart technology in this region, as well as the potential benefits it can bring to their farming practices and overall economic well-being.

The research highlights the importance of technology adoption in improving agricultural productivity, market access, and sustainability for small-scale farmers. It discusses the various types of smart technologies available to farmers, such as smart phones, mobile apps, sensor-based systems, drones, satellites, autonomous tractors, and precision agriculture tools, and how these technologies can be tailored to suit the needs and constraints of small-scale farming operations in Mnquma Local Municipality. Furthermore, the thesis examines the role of government policies, private sector partnerships, and community initiatives in promoting the adoption of smart technology among small-scale farmers. It also discusses the potential challenges and barriers that may hinder the widespread adoption of these technologies, such as cost, infrastructure limitations, and digital literacy.

The core argument of the thesis is that the strategic adoption of smart technology by small-scale farmers has the potential to drive local economic development, improve food security, and enhance the livelihoods of rural communities in Mnquma Local Municipality. It calls for collaborative efforts from various stakeholders to support and empower small-scale farmers in embracing and harnessing the benefits of smart technology for sustainable agricultural development.

Key Words: Farming, Smart Technology, Fourth Industrial Revolution, Internet of Things, Big Data, Local municipality, Production, Growth, Development, Employment, Poverty, Sustainable livelihood framework, Pestel Framework.

TABLE OF CONTENTS

LIST OF TABLES ix

LIST OF FIGURES ix

LIST OF ACRONYMS x

Chapter 1: Introduction

1.1 INTRODUCTION OF THE STUDY 1

1.2 BACKGROUND OF THE STUDY 1

1.3 PROBLEM STATEMENT 3

1.4 RESEARCH PURPOSE 4

1.5 RESEARCH QUESTIONS 4

1.6 RATIONALE OF THE STUDY 4

1.7 DELIMITATIONS OF THE STUDY 5

1.8 DEFINITION OF TERMS 5

1.9 CHAPTER OUTLINE 6

1.10 CHAPTER SUMMARY 7

CHAPTER 2: LITERATURE REVIEW ON SMART FARMING TECHNOLOGY

2.1 INTRODUCTION 7

2.2 OVERVIEW OF THE SOUTH AFRICAN AGRICULTURAL SECTOR 7

2.2.1 SMALL-SCALE FARMING IN SOUTH AFRICA 10

2.2.2 ACCESS TO DIGITAL TECHNOLOGIES IN RURAL SETTINGS 10

2.2.3 SMART TECHNOLOGIES ON ECONOMIC DEVELOPMENT 11

2.2.4 BIG DATA IN SMART FARMING 13

2.2.5 4IR AND SMART TECHNOLOGIES 15

2.2.6 4IR IN AGRICULTURE. 15

2.2.7 SMART TECHNOLOGIES USAGE IN THE FARMING SECTOR. 16

2.3 CHAPTER SUMMARY.....16

CHAPTER 3: SUSTAINABILITY LIVELIHOODS APPROACH.....17

3.1 INTRODUCTION TO THE THEORETICAL FRAMEWORK.....17

3.1.1. SUITABILITY OF THE FRAMEWORKS.....17

3.1.2. SUSTAINABLE LIVELIHOOD FRAMEWORK.....19

3.1.3. APPLICATION OF THE SLA TO THE STUDY.....21

3.2. THE CONCEPTUAL FRAMEWORK.....22

3.2.1. ADOTOPTION OF SMART FARMING TECHNOLOGY.....24

3.3. CHAPTER SUMMARY 25

CHAPTER 4: METHODOLOGY USED TO IDENTIFY AND ANALYSE INFORMATION

4.1 INTRODUCTION.....25

4.2 RESEARCH APROACH.....26

4.3 RESEARCH PARADIGM.....27

4.3.1. ONTOLOGY.....28

4.3.2. EPISTEMOLOGY.....28

4.3.3. METHODOLOGY.....28

4.4 RESEARCH DESIGN 28

4.5 TARGET POPULATION AND SAMPLE SIZE.....29

4.5.1. NON-PROBABILITY SAMPLING. 29

4.6 DATA COLLECTION METHODS 30

4.7 DATA INTERPRETATION 30

4.8 LIMITATIONS OF THE STUDY 31

4.9 QUALITY ASSURANCE.....31

4.9.1 TRANSFERABILITY AND CREDIBILITY. 31

4.9.2 DEPENDABILITY. 32

4.9.3 CONFIRMABILITY. 32
4.10 ETHICAL CONSIDERATIONS. 32
4.11 CHAPTER SUMMARY.....32

CHAPTER 5: DATA ANALYSIS AND FINDINGS TO THE STUDY

5.1. INTRODUCTION.....33
5.2. POPULATION ANALYSIS OF RESPONDENTS TO THE STUDY.....33
5.2.1. SMALL SCALE FARMER POPULATION ANALYSIS.....33
5.2.2. DEMOGRAPHICS OF SUBJECT MATTER EXPERTS.....35
5.3. HOW RESPONDENTS DESCRIBE PRODUCTIVITY.....36
5.3.1. SMALL-SCALE FARMERS.....36
5.3.2. SUBJECT MATTER EXPERTS.....37
5.4. USE OF THE SLA AS A REFERENCE GUIDE TO DATA ANALYSIS.....37
5.4.1. NATURAL ASSETS.....38
5.4.2. PHYSICAL ASSETS.....39
5.4.3. HUMAN ASSETS.....40
5.4.4. SOCIAL ASSETS.....41
5.4.5. FINANCIAL ASSETS.....42
5.4.6. SMART FARMING TECHNOLOGY AS AN ASSET.....43
5.4.7. VULNERABILITY CONTEXT 44
5.4.8. TRANSFORMING STRUCTURES AND PROCESSES.....45
5.4.9 LIVELIHOOD OUTCOMES.....45
5.5. SMART TECHNOLOGY TRENDS IN SMALL-SCALE FARMING.....46
5.5.1. THE SMART FARMING TECHNOLOGIES IN SOUTH AFRICA.....46
5.5.2. IMPACT OF SMART TECHNOLOGIES IN AGRICULTURE.....47
5.5.3. KEY CONSIDERATIONS WHEN ADOPTING SMART TECHNOLOGY.48
5.6. SUMMARY OF THE CHAPTER.....49

CHAPTER 6: DISCUSSION, RECOMMENDATIONS AND CONCLUSION

6.1. INTRODUCTION……49

6.2. FACTORS THAT INFLUENCE SMALL-SCALE FARMERS IN THE USAGE OF SMART TECHNOLOGY TO INCREASE PRODUCTIVITY……50

6.2.1. POLITICAL FACTORS……50

6.2.2. ECONOMIC FACTORS……51

6.2.3. SOCIAL FACTORS……51

6.2.4. TECHNOLOGY FACTORS……51

6.2.5. ENVIRONMENTAL FACTORS……52

6.2.6. LEGAL FACTORS……51

6.3. RECOMMENDATIONS……52

6.3.1. PROVIDE FINANCIAL SUPPORT……52

6.3.2. STAKEHOLDER PARTNERSHIP AND COLLABORATION……53

6.3.3. INFRASTRUCTURE DEVELOPMENT……53

6.3.4. CAPACITY BUILDING INITIATIVES……53

6.3.5. ENCOURAGE WOMEN PARTICIPATION……54

6.3.6. YOUTH INVOLVEMENT……54

6.3.7. RESEARCH AND DEVELOPMENT……55

6.4. **CONCLUSIONS**……55

REFERENCES 56

APPENDIX A 65

APPENDIX B 71

APPENDIX C 74

APPENDIX D 75

List of Tables:

Table 2.1: The classification summary of farmers……..8

Table 2.2: Big data applications……14

Table 2.3: Agricultural revolutions summary……15

Table 3.1: Summary of the theoretical framework……..18

Table 5.1: Demographic profile of small-scale farmers……..33

Table 5.2: Small-scale farmer portfolio……35

Table 5.3: Demographic profile of subject matter experts……35

List of Figures:

Figure 2.1: The management cycle of smart farming ……...12

FIgure 3.1: Sustainable livelihoods approach …… 19

Figure 3.2: Conceptual framework from the SLF. 23

Figure 3.3: Livelihood asset hexagon including technology as an asset. 23

Figure 4.1: Summary of the research design. 27

LIST OF ACRONYMS

AFDB	AFRICA DEVELOPMENT BANK
AGRITECH	Agriculture Technologies
AI	Artificial Intelligence
AMPI	Africa Mobile Pricing Index
DAFF	Department of Agriculture, Forestry and Fisheries
DALRRD	Department of Agriculture Land Reform and Rural Development
FOA	Food and Agricultural organisation
Ha	Hectare
GDP	Gross Domestic Product
ICT	Information and Communication Technologies
IoT	Internet of Things
SLA	Sustainable Livelihoods Approach

Chapter 1: Introduction and Background

1.1. Introduction of Study

This research seeks to detail how smart-farming technologies can be adopted in small-scale-farming activities to promote local economic growth and development in Mnquma Local Municipality (Appendix C locality map) in the Eastern Cape Province of South Africa. The chapter is outlined as follows: 1.2. Background of the study, 1.3. Problem Statement, 1.4. Research questions, 1.5. Rationale of the study, 1.6. Delimitations of the study, 1.7. Definition of terms, and 1.8. Chapter outline, 1.9. Chapter Summary.

1.2. Background of the study

The global community recognizes the importance of sustainable agriculture in achieving food security, poverty reduction, and environmental sustainability (Oxford, 2018). Initiatives such as the United Nations Sustainable Development Goals (SDGs), particularly Goal 1 (No Poverty) and Goal 2 (Zero Hunger), emphasize the need for sustainable farming practices to alleviate poverty and hunger worldwide (Oxford, 2018).

Dharmaraj and Vijayanand (2018) predicted that by 2050, there will be 2-billion people more living on planet earth, and that arable agricultural land will only grow by 4% during this period. This prediction is a threat to food security around the world particularly in Africa (Sibhatu & Qaim, 2017). The population on the African continent is growing exponentially and it is by enlarge the most affected by food security comparable to other continents (Sibhatu & Qaim, 2017).

In Africa, where agriculture is a significant source of livelihood for many people, promoting sustainable farming practices enhances food security, generate income, and create employment opportunities (Oxford, 2018). Initiatives like the African Union's Comprehensive Africa Agriculture Development Programme (CAADP) aim to boost agricultural productivity, improve rural infrastructure, and promote sustainable farming methods across the continent (Oxford, 2018).

South Africa faces high levels of unemployment and poverty, particularly in rural areas where agriculture plays a vital role in the economy (Stats SA, 2019). To end severe unemployment and poverty in South Africa and the rest of Africa, it is equally crucial to promote sustainable farming techniques and the continued development of rural regions (Stats SA, 2019). Given that between 20% and 50% of South Africans experience food insecurity, this issue will grow more seriously with time (Stats SA, 2019).

Agriculture is a major economic sector in South Africa and the predominant industry in rural regions despite its modest GDP contribution (Stats SA, 2019). Agriculture contributes significantly to employment and is a substantial source of foreign exchange earnings. Moreover, "In South Africa almost 8.5 million people depend on the sector for work and income, either directly or indirectly" (Tennant, 2018, p34).

In South Africa, 885,000 people were working in agriculture as of Q4 2022, however natural disasters, amongst many, draught negatively impacted the sector's performance (Oxford, 2018). The industry can increase its GDP contribution to at least 3%, which was the level in Q3 2022 before the drought (Oxford, 2018).

Technology advancement in agriculture and smart farming technology have revolutionized the way people grow crops and raise livestock. Integration of technology in agriculture is shaping the future of farming and helping to address global food security challenges (Oxford, 2018).

The term "Smart-Farming" is often used to describe the application of smart-technology in agriculture. Using information and communication technologies, Robotics, Internet of Things (IoT), Cloud computing, Gadgets, and Artificial Intelligence (AI) such as drones, in the agricultural sector is referred to as smart farming technology (Jayaraman et al., 2016).

To optimize and improve the quality of agricultural outputs and improve the overall food security, quality and nutrition, farmers are using IoT devices to assess animal welfare, to send digital notifications about the operations, and precisely anticipate and predict weather conditions (Gathorne-Hardy, 2016;

Wolfert et al., 2017). With the adoption of smart technology, farmers can improve food security, boost their overall output, quality, and productivity with less risk, less physical work, and less resources (Doss, 2017).

Smart technology will result in more job creation in the industry (Doss, 2017). Furthermore, there has been a significant increase in agricultural productivity per hectare(ha) of land, greater output for various crops (Cabbage, cotton and maize etc), and better access to markets as technology-based farming solutions have become more prevalent in many regions of Africa and South Africa (Schneider & Gugerty, 2011).

Today small-scale farmers are responsible for 60-70% of the world's food production (Ricciardi et al., 2018). Therefore, this means that the use of smart farming technologies in this sub-sector of the farming industry is a significant tactic in achieving food security and improving productivity (Mwangi & Kariuk, 2015; Jere & Maharaj, 2017). Agricultural productivity is defined as the optimal and effective use of the factors of production. These factors include amongst many, technology, and other physical factors, for better yields (Dharmasiri, 2009).

The study focuses on how small-scale farmers can improve production outputs, reduce poverty, contribute to employment, and eventually improve local growth and economic development in Mnquma Local Municipality and within the broader agricultural sector of South Africa.

1.3. Problem Statement

Rural communities within the Eastern Cape have limited access to smart farming technologies and there is a high rate of poverty and youth unemployment within the municipality. Small-scale farmers play a crucial role in increasing food security, combating poverty and in improving economic growth (Pienaar & Traub, 2015). Small-scale farmers are inherently poor and have no political, social, and technical resources (DAFF, 2012).

Through examination, the lack of these resources within Mnquma Local Municipality has resulted in the omission of small-scale farmers from the entire value chain of agriculture, therefore hindering them from participating and contributing meaningfully to the economic growth and development of the region through providing employment and reducing poverty.

1.4. Research Purpose

The purpose of this study is to understand the use of smart technologies by smallholder farmers in South Africa, and how smart technology could support smallholder farmers in increasing productivity and guide against vulnerabilities. The implementation of smart technology such as mobile applications, IoT devices etc. will lead to increased productivity and efficiency in farming practises amongst small scale famers in Mnquma Municipality.

1.5. Research questions

- **Main question for the study**

  How can smart farming technologies be used by small-scale farmers to improve Local Economic Development in the rural Eastern Cape Province?

- **Sub questions**

  In what way can smart farming technologies be adopted by small-scale farmers to reduce poverty and address unemployment in the Mnquma Municipality?

  Which smart farming technologies be used to reduce the impact of vulnerabilities small-scale farming activities and improve production outputs?

1.6. Rationale of the study

The study will highlight the need to characterize small-scale farming and its role in rural economic development. This research will assist small-scale farmers to determine fundamentals for policy formulation such as managerial strategies that best suit productive agribusinesses. Agribusinesses should be formalized and have a formal structure that should be put in place for administrative purposes to assist small-scale farmers.

This research will provide the fundamental factors in determining the economic characteristics of small-scale commercial farmers. In the study literature standardized definitions and smart farming technologies implications in assisting small-scale farming will be discussed.

1.7. Delimitations of the study

This research focus is on small-scale farmers in rural communities. The small-scale farmers in this municipality inherently have the skills required to farm but do not have access to smart farming technologies. The small-scale farmer may not have funds to purchase the digital technologies that could be used to prosper their business. The big commercial farms are excluded from the study as it is focusing on small-scale farmers in rural communities to identify local economic development initiatives.

1.8. Definition of terms

1.8.1. Smart farming

According to Verdouw, and Bogaardt (2017), smart farming is defined as the use and adoption of current technologies such as, Internet of Things (IoT) devices, Robotics, and Artificial Intelligence (AI) to improve agricultural and farming activities.

1.8.2. Small-scale farming

Different definitions have emerged from the existing literature. Hilson (2016) defines small-scale commercial farming according to land size, usually 1-5 hectares and the use of old methods of farming (labour-intensive). At the same time, Zhigang (2017) defines small-scale farming as the use of small pieces of land to make a positive living.

1.8.3. Remote sensing

Remote sensing technology as the name implies is the remote collection of data from drones and satellites (Khanal et al, 2020). This data assists farmers to make informed decisions regarding things that may impact negatively on their farming activities (Khanal et al, 2020).

1.8.4. Internet-of-Things (IoT)

Internet-of-Things is the technology that allows for remote control and sharing of relevant information (Liu et al., 2012). In farming this concept can be used to collect data through strategically position sensors across the farm. This data is then used to make meaningful and helpful decisions by farmers (Atzori et al., 2017).

1.9. Chapter Outline

The structure of the research is outlined as follows below:

Chapter 1: Introduction and background of study which outlines the purpose and gives a brief overview and background of the study. It also outlines the problem statement, research questions, rationale of the study and delimitations of the study.

Chapter 2: Literature review of on smart farming technology borrows a lot of arguments from carefully selected literature sources. It looks at research conducted nationally and internationally about the use of smart technologies in small-scale farming with the aim to promote local economic development.

Chapter 3: The sustainability livelihoods approach defines the selection of relevant theoretical frameworks and assesses the suitability of the selected

framework to the study. For this study the Sustainable Livelihoods Approach (SLA) was used as a guide. The chapter further assesses the suitability of the SLA for small-scale farmers to enable increased productivity and improve local economic develop using smart farming technologies.

Chapter 4: Methodology used to identify and analyse information outlines what research approach, data collection and data analysis methods used and how data gathering will be conducted.

Chapter 5: Analysis and findings of the study analyses and organises the findings of the study by interpreting the views of small-scale farmers and subject experts on technology trends in agriculture and potential adoption by small-scale farmers. The chapter applied the Sustainable Livelihoods Framework to the analysis and findings.

Chapter 6: Discussion, recommendation and conclusion covers the discussion of results, conclusion, and recommendations of the study.

1.10. Chapter summary

The introduction and background of the study provides context and set the stage for the research that will be conducted. In this section, the researcher introduces the topic of the study, provides an overview of the problem and research questions, and outlines the objectives or aims of the study.

Chapter 2: Literature review on smart farming technology

2.1. Introduction

This section seeks to outline the literature review of the study. How can smart technologies be adopted by small-scale farmers to improve local economic development in Mnquma Municipality? The section is controlled and organised in the following manner: 2.2 highlight the overview of the South African agricultural sector, 2.3 discusses the access to digital technologies in rural areas, 2.4

presents the impact of smart farming technologies on local economic development, 2.5 Using 4IR and smart technologies. This section concludes with a summary of the literature review of all the themes above.

2.2. Overview of the South African agricultural sector.

The agriculture industry of South Africa makes up a smaller portion of the GDP than other economic sectors (Arshed & Danson, 2015). Its percentage contribution of GDP has dropped from 3.9% in 1994, at the dawn of the new democracy to 2% in 2019 (DAFF, 2019). The sectors with the highest growth rates per annum at the end of 2019 were agribusiness, and the department of forestry, and fishery (Gillwald et al., 2019).

In South Africa, agriculture, forestry, and fishing sectors all operate under the auspices of the Department of Agriculture, Land Reform, and Rural Development (DALRRD). Research from the African Development Bank (AFDB) found that during the past century, large-scale and capital-intensive agriculture has by enlarge replaced both mixed subsistence and commercial farming/producer (Gillwald et al., 2019).

In South Africa, the terms "producer" and "farmer" are used interchangeably when referring to farmers (DAFF, 2012). Farmers, however, are divided into six categories as outlined in **Table 2.1** below. The table was cited from the report released by the Departments of Agriculture, Forestry, and Fisheries (DAFF) and Rural Development and Land Reform (DRDLR).

Table 2.1: The classification summary of famers. (DAFF, 2019).

Producers' category	**Characteristics**	**Turnover (per year)**
Household producer (Vulnerable)	•They have low farming skills. • They are vulnerable to natural disasters.	N/A

	• Perceived as poor households.	
Household producer (subsistence)	• Household consumption. • They are vulnerable to natural disasters. • They are slightly poor.	> R50 000
Small- scale producer	• This is an income-driven business. • Restricted household consumption. • **Not poor but have limited resources.**	R50k – R1 million
Medium-scale commercial producer	• This is an income-driven business. • Makes enough revenue to afford its own resources. • They considered rich.	R1 – R10 million
Large-scale commercial producer	• This is an income-driven business. • Makes enough revenue to afford its own resources. • Wealthy.	R10 – R50 million
Mega/corporate producer	• This is an income-driven business. • Makes enough revenue to afford its own resources. • Very wealthy.	> R50 million

The Agricultural sector in South Africa comprises of two parallel systems, the capital-intensive commercial farmers and labour intensive poor small-scale and subsistence farmers (Kirsten & van Zyl, 1998).

The former dominates the agricultural sector and has a massive contribution to production in the sector (Loeper et al., 2016). Due to the nature of the industry and the historical background of the country small-scale producers are inherently excluded in the agricultural value chain today (Loeper et al., 2016).

Due to strong financial muscle (Table 2.1), commercial farmers are technology advanced in their agricultural activities compared to small-scale farmers. This therefore allows them to produce massive outputs, increased productivity, and massive contribution to national economic development (Rose & Chilvers, 2018), while small-scale farmers remain stuck in old and conventional methods of production (Mwangi & Kariuk, 2015).

2.2.1. Small-Scale Farming in South Africa

Small-scale farming is defined in many ways, and it is characterized by a lot of confusion as to what it really is (Aliber & Hall, 2012). The word "Small-Scale" is commonly used in literature interchangeably with phrases like "small holder," "peasant," "emerging," and/or "resource-poor farmer" (DAFF, 2012). There is clearly no one way to define the phrase, small-scale farming.

There is extensive consent in the literature that distinguishes small-scale farming from others based on factors such as amongst many, the size of the farm (usually less than 5 hectares), and limitation of resources (Lowder et al., 2016).

Considering the above, the "Small-Scale Producers" that are “income and household driven farmers” with a revenue of between R50 000.00 to R1 million per year (refer to Table 2.1) are the subject of this research study. This research also accounts for "Household Producers" that are motivated by income but with annual revenues of less than R50, 000 (DAFF, 2019). In this study these two subcategories are defined and referred to as small- scale famers, along with their respective grouping criteria (DAFF, 2019).

2.2.2. Access of digital technologies in rural settings

In South Africa, the digitization of agriculture depends on the availability of data and device costs, as well as adequate access to internet (DAFF, 2019). According to the After Access study (2018) conducted in 10 African countries found that, 53% of South Africans are actively online, and this is the highest poll in the Sub-Saharan Africa (Research ICT Africa, 2018). Moreover, the study has also discovered that with regards to internet usage there is a clear gap between South Africa's citizens living in urban areas and those living in rural areas. The extent and limitations of IT infrastructure that is needed to raise small-scale farmers who are located mostly in rural regions is made clear by this (Research ICT Africa, 2018).

Even though 84% of South African citizens own a mobile phone, of that only 46% can afford and use smartphones (Research ICT Africa, 2018). This is an important distinction to note as mobile phones have changed the ICT industry and are now a requirement for a number of agrotech solutions (Aguera et al., 2020). According to Research ICT Africa's After Access study, the high-cost devices that also require internet and data to function are the biggest reason 46% of South Africans do not have access to the internet. Other additional reasons include but not limited to, low literacy levels, insufficient computer skills, and perhaps ignorance of what the internet is (Aguera et al., 2020).

As of 2020Q1, South Africa comes 33rd out of 46 countries in the African Mobile Pricing Index (AMPI) for expensive pricing of data (Research ICT Africa, 2020). Telkom and Cell C were offering the lowest rate of R100 per 1GB. This situation has led to the intervention from the Competition Commission to ask the two largest mobile network carriers, MTN and Vodacom, who charge even higher pricing rates, to lower their costs by 71% in December 2019 (Aguera et al., 2020). MTN and Vodacom have finally acceded to reduce their costs to R99 per 1GB as of April 1, 2020. However, Data remains expensive in South Africa relative to other African nations (Aguera et al., 2020).

2.2.3. The smart farming technologies on local economic development

It has become apparent that farming operations will become more and more efficient, driven by data and data enabled as smart devices and sensors are

introduced in farming operations and farms continue to become bigger in scale and difficult to monitor by humans without the aid of technology (Sundmaeker et al., 2016). The buzz phrase known as "Smart Farming" has been brought to light by the Internet of Things as well as Cloud Computing (Sundmaeker et al., 2016). Even though “Precision Agriculture” is usually designed for in-field agricultural activities, smart farming goes far beyond that by greatly assisting in day-to-day management tasks depending on location as well as available data (Wolfert et al., 2014).

Agile activities require real-time assistance from technology, particularly when faced with unexpected natural conditions or other situations. These features often include clever support for setting up, maintaining, and using the technology (Wolfert et al., 2014).

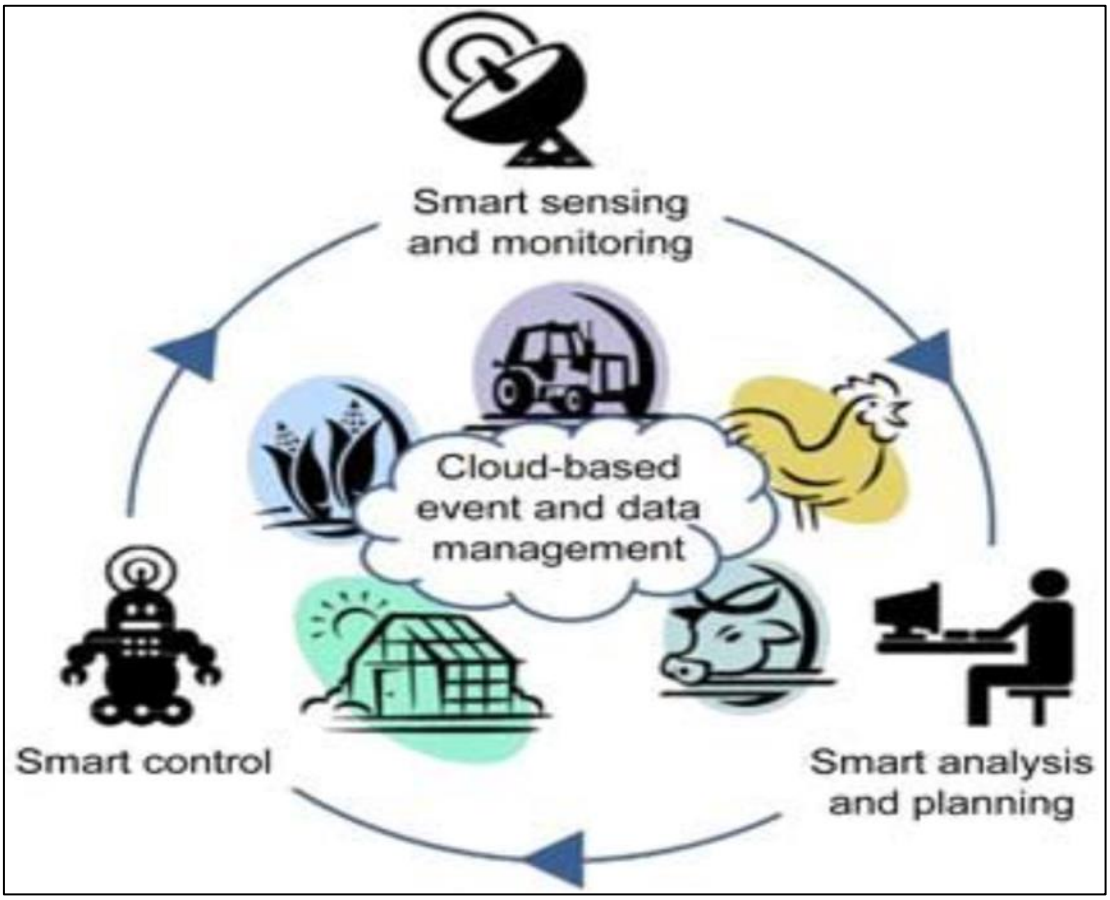


Figure 2.1: The management cycle of Smart Farming (Wolfert et al., 2014).

The figure 2.1 above is a smart farming management cycle showing how smart devices and sensors placed all over the farm and linked to the Internet oversee the entire farm infrastructure system (Wolfert et al., 2014). The sensors on the farm are highly integrated and are able to function autonomously with built-in intelligence, and the ability to do this remotely using smart gadgets to enhance ordinary tools (for example, a rain gauge, tractor, or notepad) (Wolfert et al., 2014).

Although it is already implied in the image above, robots may play a significant part in farming (Wolfert et al., 2014). Therefore, it is reasonable to anticipate that machines will progressively support famers in their roles as analysts and planners, leading to a nearly completely farm management cycle. Although they will always play a role in the process, human beings are becoming more and more intelligent, leaving most farming operational activities to technology (Wolfert et al., 2014).

2.2.4. Big Data in Smart Farming.

Big data is defined as the potential technology that assess and assists in farm-level decision making policy and for enhancing the productivity in agriculture (Noyes, 2014). Moreover, this aids greatly in the sustainable growth of crops, fishery, and livestock by using modern technology (Sun et al., 2013). This technology provides an opportunity to transform farming activities from traditional agriculture to modern agriculture (Yang, 2014). However, such a transformation requires large amounts of data from almost all stages of crop production, fisheries, and livestock production etc. (Noyes, 2014).

Application of big data in agriculture are not only focused on basic production, they also greatly enhance the effectiveness and efficiency of the whole supply chain and all concerns about food security in the country (Chen et al., 2014; Esmeijer et al., 2015). Big data applications talked about in the literature are currently in use in many parts of Europe and by enlarge North America (Faulkner & Cebul, 2014).

However, given the increased interest and focus on big data applications, the number of users is anticipated to extend quickly in other developing nations like

China, Brazil, India, and South Africa (Liu et al., 2012). Examples of Big Data applications or components in various Smart Farming processes are indicated in **Table 2.2** below.

Table 2.2: Big Data applications (Faulkner & Cebul, 2014).

The Cycle of Smart Farming	**Arable**	**Livestock**	**Fishery**
Smart sensing and monitoring	Sensors and Robotics.	GPS tracking, Biometric sensing,	Automated Identification Systems (AIS)
Smart analysis and planning	Seeding, Planting, Soil typing, Crop health	Breeding, monitoring	Monitoring and surveillance.
Smart control	Precision farming	Milk robots Smart abattoirs	Surveillance, monitoring
Big Data in the Cloud	Weather/climate data, Soil types, Market information,	Livestock movements	Market data and Satellite data,

Sensor application and analytics, predictive technologies, and employing improved models and technology to control potential crop failure rate and increase feed effectiveness in animal production are both clear examples of big data analytics use in agriculture (Devlin, 2012). Furthermore, big data will predict future agricultural outcomes, drive farming operational choices in real-time, and reimagine farming business processes to enable quicker, more creative business processes (Faulkner & Cebul, 2014).

Decision making in the future will involve an interplay of humans and technology (Anonymous, 2014). Big data is anticipated to change both the scope and the structure and landscape of farming operations (Poppe et al., 2015). While there are questions over whether big data algorithms will eventually replace the farmers' skills and competencies, big data applications are expected to change how farms are run and maintained (Drucker, 2014). With big data in place, there will be real-time prediction and forecasting of unwanted activities, tracking of tangible objects. (Devlin, 2012).

2.2.5. 4IR and Smart Technologies

The creation and existence of Smart Technology are a product of the increased digitalization in several sectors. The term "Smart" refers to sensor technologies used on the Internet of Things (IoT). These include various devices (such as, sensors, smartphones, cameras, and anything that wears out (Georgakopoulos & Jayaraman, 2016). By allowing intelligent services with the use of smart farming, smart cities, and smart manufacturing, smart IoT applications have also gained popularity across industries (Georgakopoulos & Jayaraman, 2016). The fourth industrial revolution is the term most often used to describe this convergence of smart technologies (Georgakopoulos & Jayaraman, 2016).

2.2.6. 4IR in agriculture.

Between 1774 and 1997, there were multiple revolutions in the agricultural sector, which had a significant impact on how food was supplied to the world's population (Lombardo et al. 2017). In **Table 2.3**, agricultural revolutions are summarized.

Table 2.3: Agricultural revolutions summary (Lombardo et al. 2017)

Agricultural revolution	**Year**	**Revolution innovations**
First (Neolithic revolution).	1774	Theory on mechanical plants powered by water.

Second (British agricultural revolution).	1890	Development of the first gasoline powered tractor and the very first mechanical engine powered by electricity.
Third (Green Revolution).	1915	First Fordson tractor; programmable logic controller.
Fourth (Fourth industrial revolution).	1997	Introduction of digital systems in agriculture management.

2.2.7. Smart technologies usage in the farming sector

To boost food production in large quantities and to minimize process inefficiencies, the fourth industrial revolution has seen the adoption and use of radical technology including sensors, artificial intelligence, and robots (Rotz, et al., 2019). The integration of smart technology in farming helps farmers to boost production volumes, minimize effects on vulnerability, and maximize the use of resources (Yahya, 2018).

According to Sanyang et al., (2016), using smart technology is a very important component of assuring sustainable change in the farming value chain, agricultural industry, and level of food security. From the standpoint of the final consumer, the use of smart technology may lead to an overall decrease in commodities costs, improvement in food quality and improved the countries growth and contribution to economic development (Yahya, 2018).

2.3. Chapter Summary

The literature review chapter provides an overview of the south African agricultural sector. It also highlights the various types of smart technology being employed in agriculture. The literature review also identifies several challenges and barriers to the adoption of smart technology in agriculture and furthermore provides a comprehensive overview of the current state of research on smart

technology in agriculture, highlighting both the opportunities and challenges associated with its adoption and use in the industry.

Chapter 3: Sustainability Livelihood Approach

3.1. Introduction to Theoretical Framework

Scholars have argued that if constraints and challenges that face small scale-farming are minimized, the result of that would be a strong reduction in poverty and increased employment activities particularly in rural areas (Serrat, 2017). This chapter begins by discussing the approaches and the frameworks relevant to the study.

The theoretical framework that is adopted in this study to assess the role of smart technologies in improving economic development and combating poverty in small scale farming in Mnquma Local Municipality are: **(i) The Sustainability Livelihood Approach (SLA), (ii) The basic needs approach, Alsop and (iii) Heinsohn's Empowerment Framework**. In addition to these frameworks is the**, (iv) Enabling rural innovation approach** which illustrates how small-scale farmer market penetration can improve economic development and reduce poverty. All these frameworks are aimed at reducing poverty in poor backgrounds communities. However, this study has adopted the sustainability livelihoods approach as a dominant framework to attempt to understand the livelihoods of small-scale farmers in Mnquma Municipality.

3.1.1. The suitability of the frameworks

According to Serrat (2017), the sustainability livelihoods approach is a tool used to understand the livelihoods of the poor. The aim of the SLA is to assist poor people to achieve sustainability and improved livelihoods (DFID, 2001). The Empowerment Framework on the other hand speaks to the empowerment of individuals or group of people with the aim of improving their contribution in society and in return benefit them from poverty reduction (Alsop et al., 2006).

The basic needs approach is one of the approaches that measure levels of poverty globally however with particular interest to developing countries. It defines the basic minimum resources required for sustainable livelihood usually in terms of consumption of goods and sustainable food production (Ghai, 1977). **Table 3.1** gives a summary of the frameworks adopted in the study as they are suitable to the objectives of the research.

Table: 3.1: Summary of the theoretical frameworks (Booi, 2001).

Framework	**Outcomes**	**Comment**
Sustainable Livelihoods Framework.	• Better income • Better well-being • Reduced vulnerability • Improvement in food security • Better use of natural resources	Places people's livelihoods at the center.
Alsop & Heinsohn's Empowerment Framework	• Increased contribution • Increased capacity • Poverty reduction	Focuses on empowering people and improves their contribution in reducing poverty.
The basic needs Framework	• Water availability • Food availability • Better health and education services. • Shelter • Clothing	This approach seeks to meet the basic needs of all people.

Enabling rural innovation Framework	• Increased access to markets • Increased entrepreneurial activity	This approach seeks to link to small-scale farmers to markets and improve livelihoods

3.1.2. Sustainable Livelihoods Framework

This research study has adopted the SLA framework. This concept was first created back in the 1980s by Robert Chambers (DFID, 2001). Robert Chambers realized that the old development concepts were not functioning as effectively as they should to yield the desired results. He further adds that the world was facing huge population increases. This is the reason Chambers came up with the concept of “Sustainable Livelihoods” with the aim of improving efficiency of developmental cooperation. Therefore, his concepts provided the foundation for the sustainability Livelihoods Approach as developed by the British Department for International Development (DFID) since 1997. This concept has since evolved and been utilized in all walks of life including, political, social, commerce and developmental learnings (Makoza & Chigona, 2010).

Numerous sustainable livelihood frameworks exist in literature, however, this DFID approach by itself seeks to establish how smart technologies can be used by small-scale farmers to improve productivity, enhance economic development, and sustain livelihoods? The revised SLA framework (Fig 3.1) by the (DFID) is potentially the most used (Liu et al., 2018).

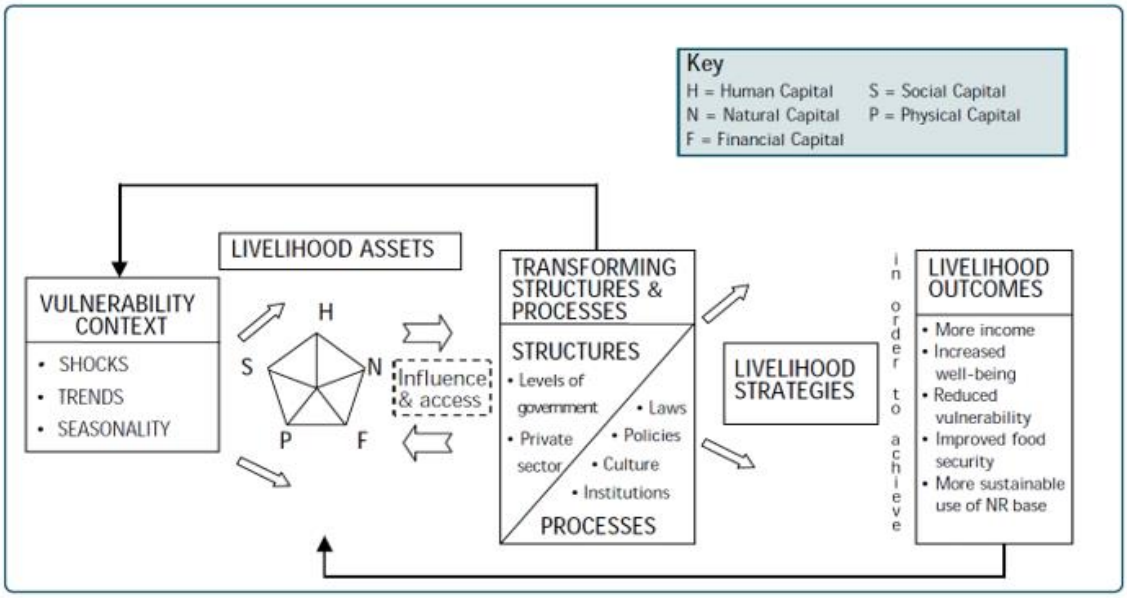


Figure 3.1: Sustainable livelihoods approach (DIFD, 2001)**.**

The framework highlights the biggest contributing factors to people's livelihoods and these factors relate to one another. It can also be useful tool for planning new activities that support people development. According to the DFID (2001), the framework is designed to improve the lives of people especially people from poor backgrounds. Additionally, it influences the way people think about their livelihood and clarifies the many factors that affect people's livelihood.

In particular, the framework:

• "Provides a checklist of important issues and sketches out the way these link to each other" (DIFD, 2001).

• "Draws attention to core influences and processes (DIFD, 2001), and"

• "Emphasizes the multiple interactions between the various factors which affect livelihoods" (DIFD, 2001).

- **Vulnerability context**

Vulnerability defines the uncontrollable external environment in which all people leave and exist (DIFD, 2001). This concept deduces that people's livelihoods are influenced by external factors such as trends (i.e., Resource and economic trends), and shocks (Natural disasters such as floods, earthquakes, diseases, drought etc.) and seasonality (such as prices and new technologies) (Slater &

Yeudall, 2015). Often people have little to no control of these factors (Madhuri, 2014).

- **Livelihood assets**

Livelihoods assets are founded on the belief that people need a number of assets to survive (Slater & Yeudall, 2015). It seeks to understand people's strengths with regards to assets and capital and their ability to convert these assets for better survival outcomes (Yang, et al., 2018). Furthermore, these assets cannot exist in isolation. If people are to achieve positive livelihoods, then these assets must be attained together each in reasonable amounts (Madhuri, 2014).

This is mostly true and valid to poor people whose access to any of these assets is most of the time limited. There five categories of the livelihoods assets needed to support livelihoods are: Natural assets (such as land, water, forests, air quality etc.), physical assets (roads, affordable transport, shelter, clean affordable energy, storage facilities, equipment etc.), Human assets (skills, labour, good health and knowledge), Social Assets (networks and social circles), Financial Assets (Capital) (Serrat, 2017; Pour, Barati, Azadi, & Scheffran, 2018).

- **Transforming structures and process**

Transforming Structures and Processes seek to define the assisting organizations, policies, intuitions, and legislation that aid in reaching individual outcomes and strengthen livelihoods (Lowe & Schilderman, 2001). These parameters are the conduits to accessing assets and livelihood strategies. (Lowe & Schilderman, 2001).

- **Livelihood strategies**

Livelihood strategies include a combination of activities and to a certain degree choices that individuals take to achieve their survival goals (Krantz, 2001). These strategies include coping strategies, adaptive strategies, and livelihood strategies. It intends to promote opportunity, diversity, and choice (Krantz, 2001).

- **Livelihood outcomes**

Livelihood outcomes are built from livelihood strategies (Yang, et al., 2018). These outcomes include amongst many, reduced vulnerability, increased well-

being, more income, improved food security, and sustainable use of natural resources (Glopp, 2008).

3.1.3. Application to the SLA to the study

The SLA is a useful tool for planning new activities that support people development. According to the DFID (2001), this framework focuses on people's livelihoods, particularly the poor. It is used for planning and implementation intervention strategies that aid in the reduction of poverty and promotion of socio-economic development (Murambadoro, 2009).

This is the sole purpose of the SLA; however, it has also been used to confront challenges brought about natural disasters that affect agricultural activities. The SLA is suitable to the study in the sense that small-scale farmers can use smart farming technologies to confront the vulnerabilities mentioned above. Small-scale farmers can use SLA to include technology as an asset to reinforce small-scale the livelihoods of small-scale farmers and the communities in which they live in. For small-scale farmers to be sustainable they need all the individual livelihood assets on the SLA (Norton & Foster, 2001).

Small-scale farmers are comprising of marginalized people from poor background. For survival these people rely heavily on farming practices (FOA, 2018). Improvements in farming productivity can be achieved through achieving all livelihood assets and the adoption of smart technologies (Asfaw et al, 2012). Therefore, it would be particularly interesting to see what impact smart technologies have on the productivity of small-scale farmers in Mnquma Local Municipality.

3.2. The Conceptual Framework.

The conceptual framework in Figure 3 below is derived from the Sustainability Livelihood Framework. The aim of the conceptual framework is to identify variables, their interrelationships and how they assist in giving direction to the study to solve a particular problem (Asfaw et al, 2012). The problem that the study seeks to resolve is the adoption of smart farming technologies to improve local

economic development and reduce poverty in Mnquma Local Municipality, Eastern Cape.

The SLA highlights some of the important livelihood assets that people require for a successful living. These assets are mentioned and defined above and cannot be used independently for a positive livelihood outcome (DIFD, 2001).

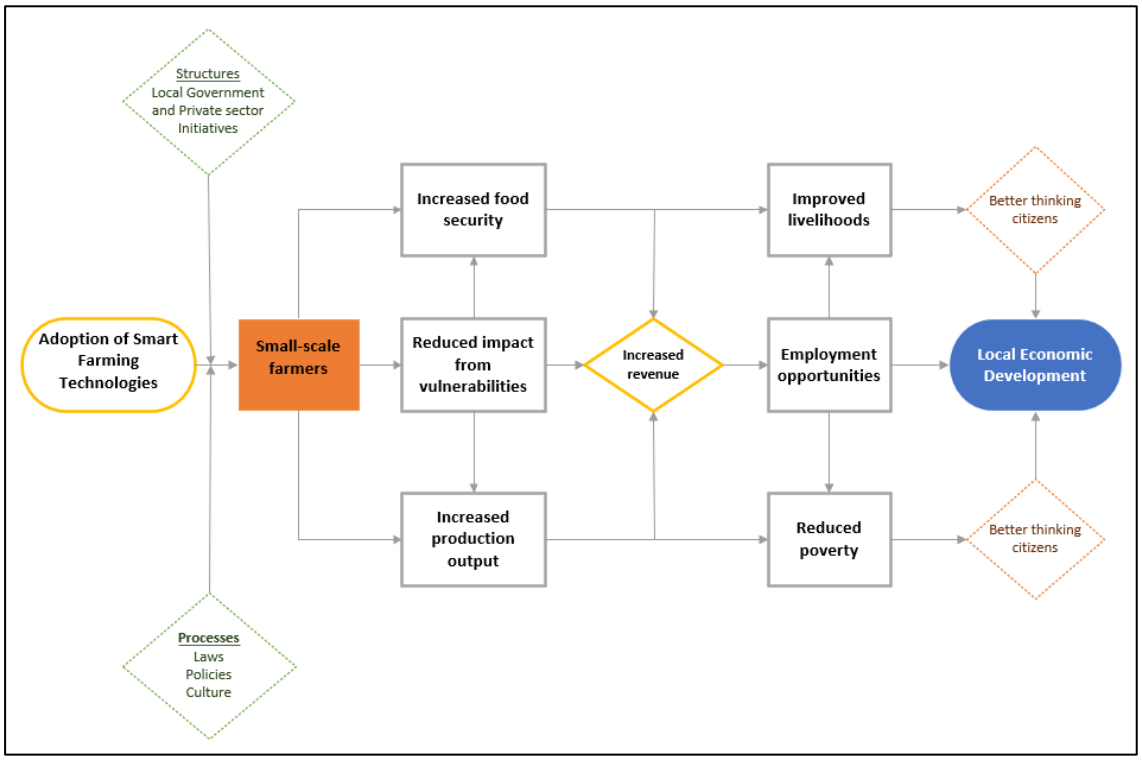


Fig 3.2. Conceptual framework derived from the SLF.

The Livelihood assets lever of the SLA makes no mention of Technology as one of the important assets required for improved livelihoods in poor communities. Therefore, the study introduces a new Technology Asset dimension as depicted in figure 3.2 below.

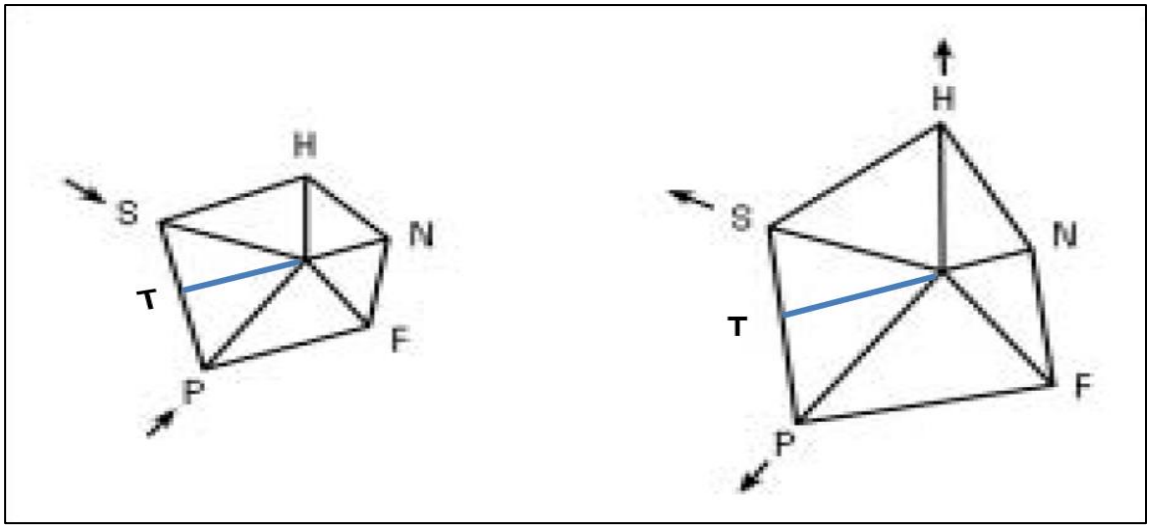


Figure 3.3: Livelihood asset hexagon including Technology as a Livelihood assets (DIFD, 2001).

3.2.1. Adoption of smart farming technology

Technology improvements tend to have a positive impact on the livelihood of people and in turn high economic growth and development (Rotz, et al., 2019). The application of technology in small-scale farming means that the farms can be more productive and economic growth will advance at a lower cost (Yahya, 2018). Local government that recognizes smart farming technology as one of the five livelihood assets are more likely to have higher growth rates and improved standard of living for their people (Rotz, et al., 2019).

Technology Innovation improves economic output and results in better living environment for everyone. In the conceptual framework in figure 3.2 above, technology adoption by small scale farmers is an independent variable that influences the lives of small-scale farmers (dependent variable).

It is the role of local government to rebuild local communities by supporting all sectors within their area of influence. This action will stimulate local, social and economic development. Therefore, to achieve this government together with the private sector provides comprehensive support programmes, finances, and mentorship to small scale farmers. Government and the private sector (e.g., Commercial farms) are moderating variables between technology adoption and small-scale farmers as they provide the means and financial support to poor

small-scale farmers. Government processes (laws and policies) can also play as moderating variables by reducing red tape, providing a leveled and fertile ground (market) and make doing business easy for small scale farmers.

Effective adoption of smart technology by small-scale farmers will lead to the ability to predict the future and reduce the impact of uncontrollable external factors such as natural disasters like flooding, soil erosion and draught etc. (DIFD, 2001). In addition to this, there will be improved food security as farmers are able to produce more, efficient, and sustainable output without huge losses (DIFD, 2001).

All these lead to higher revenues by the farmers and more labour required to keep up with the demand and eventually higher employment rates in Mnquma municipality. Increased local employment results in reduced poverty rate, lower inequality and better livelihoods for all people who live within that economy. However, the ultimate achievement is a stimulated, improved, and sustainable local economic growth and development in Mnquma Municipality.

3.3. Chapter Summary

This study adopts the use of the SLA to address issues faced by small-scale farmers in Mnquma Local Municipality. The chapter discusses the entire value chain of the SLA as it is centered around poor people's livelihoods and suggests interventions that must be put in place to improve their social status using technology. The chapter also discusses the conceptual framework, which is used to identify variables, their interrelationships and how they assist in giving direction to the study to solve the problem n hand.

Chapter 4: Methodology used to identify and analyse information.

4.1. Introduction

Research methodology is a systematic tool whose primary purpose is to assist researchers to collect data on a particular research problem (Robinson, 2014). The objective of the study is to assess and explore how small-scale farmers can take advantage of smart technology to improve local economic development and growth in Mnquma Local Municipality, Eastern Cape Province.

To achieve the objectives of the study, I used certain research approaches, methods and instruments as outlined: Section 4.2. Research Approach, Section 4.3. Research paradigm, Section 4.4. Research design, Section 4.5. Target population and sample size, Section 4.6. Data Collection Methods, Section 4.7. Data interpretation, Section 4.8. Limitations of the study, Section 4.9. Quality Assurance, Section 4.10. Ethical considerations. These are methods that have been developed to ensure data reliability and validity.

4.2. Research Approach

Because this is a social study by nature and involves humans and their interaction, and that the methodology involves collecting and analyzing non-numeric data, this study is best served by a qualitative research approach (Teherani et al., 2015). This method is one of the respectable methods used to conduct research. It is often used for exploring and understanding the meaning of individuals and groups of people who share common interests in a specific habitant (Teherani et al., 2015).

Qualitative research is exploratory in nature because it seeks to investigate a problem that has not been clearly defined in the past (see Fig 4.1 below). Therefore, the study adopted an exploratory research approach which gave me the opportunity to engage and ask the respondent's question that seek to explore what the problem actual is and what are the potential solutions (Saunders et al., 2016). My aim was to understand how small-scale farmers can use smart technologies to improve growth and economic development.

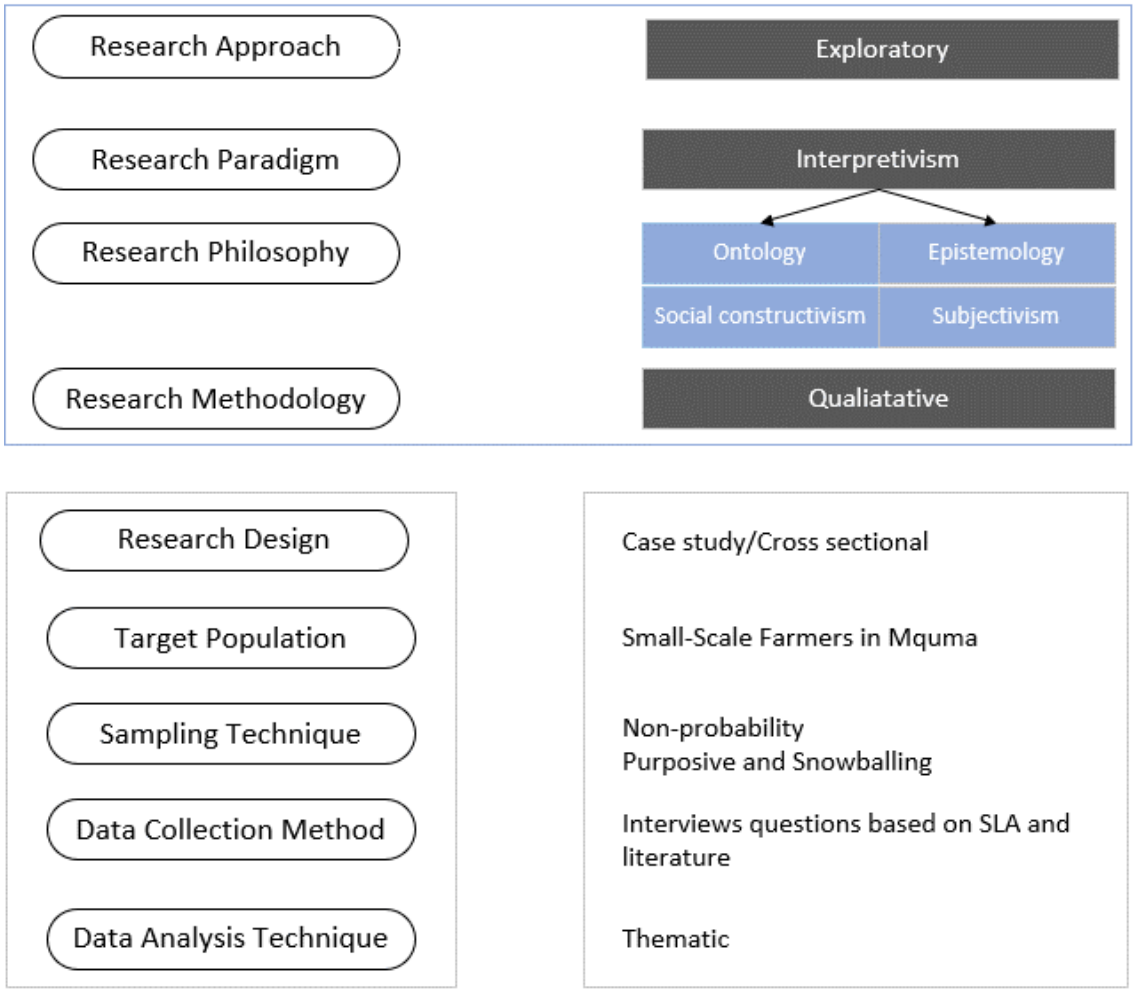


Figure 4.1: Summary of the research design.

4.3. Research Paradigm

A research paradigm (Fig 3.1) is a philosophical framework that suggests a pattern of beliefs and understandings for a particular research study (Rehman & Alharthi, 2016). My study is based on theory of Interpretivism which is a method of research that concerns itself with the following elements: The structure, beliefs, norms, values and functioning of humans in a society in which the study takes place (Rehman & Alharthi, 2016). For this study to be successful, it is therefore important for me to study and understand these elements and seek to see reality from the perspective of the respondents (Thanh & Thanh, 2015). Interpretivism has three components: Ontology, epistemology, and methodology as discussed below.

4.3.1. Ontology

Ontology concerns itself with the study of existence and reality (Al-Saadi, 2014). This philosophy seeks to determine if things exist or not. It is grounded on the belief that reality is multifaceted and subjective (Saunders et al., 2016). Therefore, I shall not influence nor impose my own view of reality to the respondents. I will seek to immerse myself and seek to understand their reality as an insider instead of outsider (Harrison et al., 2017).

4.3.2. Epistemology

Epistemology is a theory that concerns itself with knowledge (Kivunja & Kuyin, 2017) It deals with how knowledge is collected and gained and the general process of getting to know something and from which source e.g., Interviews to be conducted to the respondents (Rehman & Alharthi, 2016). It was important for me to understand and interpret the meaning of small-scale farmer behaviours in relation to the usage of smart technologies in their agricultural activities.

4.3.3. Methodology

A research framework is a systematic tool whose primary purpose is to assist searchers to collect data on a particular research problem. According to Sileyew (2019), research framework refers to the steps taken by a researcher upon conducting research. The steps approach shows how research problems and challenges as well as objectives are established and overcome, including how the results of the data gathered are presented (Robinson et al, 2014).

4.4. Research design

According to Abutabenjeh and Jaradat (2018), a research design is a plan that guides and direct the research process in its entirety. Its purpose is to clearly outline (Fig 3.1) how the study will be conducted and implemented starting from the research purpose and research question to the results. This is completed through a long and thorough process of ground data collection and desktop analysis that will help in making the study topic more clearly and understandable (Abutabenjeh & Jaradat, 2018).

The case study method is very helpful when the research includes a small number of respondents, more especially when those respondents are put together as a group and share common social interests like the group considered for this study (Saunders et al., 2011). The timeframe is cross-sectional as the research looks to describe how small-scale farmers can make use of smart technology to improve local growth and development (Saunders et al., 2011). Therefore, data will be collected at a single point in time.

4.5. Target population and sample size

The target population for the study is all small-scale farmers under Mnquma Municipality. However, for any qualitative study, it is impossible to reach the entire population and therefore a sample population is required (Wallian, 2011). A sample population is a portion of a population that is thought to be representative of the entire population (Emerson, 2015). In this study, the sample chosen includes between 10 and 20 small-scale farmers regardless of what they farm. These will be targeted farmers within my reach.

4.5.1 Non-Probability Sampling

According to Wallian (2011) this sampling technique is a method where not all population participants have an equal chance of being selected. Non-probability sampling approaches include but not limited to the snowball sampling method, convenience sampling, judgement sampling, and quota sampling (Emerson, 2015).

The study will use purposive and snowball sampling method for selecting the participants. As the name implies, the units are selected purposefully and based on the judgement of the researcher because they have certain characteristics needed to provide enough and substantive knowledge to achieve the objectives of the research (Wallian, 2011).

4.6. Data Collection Methods

Garg (2018) has defined research instruments for collecting, such as a questionnaires and interviews (Appendix A and B). These tools are used to collect research data on a certain topic of interest from willing participants (Garg, 2018). Moreover, the information gathered by the research tools should be able to answer the research questions (Frey, 2018). According to Tracy (2020), questionnaires and interviews are the most used research instruments especially research focused on social issues. However, the targeted population (Appendix D) is mostly located in rural areas and does not or have limited access to smart farming technologies and therefore they will not be able to participate in an online survey or questionnaire.

Their level of exposure and knowledge of smart farming technologies is low and is different for each willing participant. Therefore, physical interviews will be conducted and will allow us to also take into consideration all the small differences. For example, some participants may have used a drone compared to some participants who may have never held a drone. Allowing the participants to complete a survey questionnaire on their own leaves a room for inaccurate capturing of answers lack of interest, and misinformation because of inexperience in completing surveys or questionnaires.

4.7. Data interpretation

The data collected from the respondents will be analysed. According to Bassot (2020), there are two ways to analyse such data: trend comparison (where "patterns coming from data are matched"); and explanations construction (where "explanations about the case" are created). Because content analysis is the foundation of qualitative data analysis and allows for pattern matching, the researcher has chosen this analytical strategy.

Furthermore, a three-stage open coding technique suggested by Bassot (2020), will be used in this study's content analysis. All the responses from the participants will be grouped together, and then undergo the open coding process. The data will be grouped in stage two based on the questions put together. In the last step of the open coding process, the data will be further subdivided into

themes and sub-themes. These will provide a logical structure when analysing qualitative data, and they will also serve as the foundation for the analysis and discussion in section 5 (Analysis and Findings) of this study (Bassot, 2020).

4.8. Limitations of the study

- I used a laptop and cell phone to record telephonic interviews. Due to this approach, the quality of recordings was not consistent and had slowed down the time I took to transcribe the interviews. The author had to listen attentively and recite recordings made with interviewees.
- Load shedding affecting network – the study area has a poor telephone signal it might be not easy to contact the participants telephonically and therefore a physical visit will serve the study best.
- Smart farming technologies – some people might not understand the terminology which why face-to-face interviews is are best suited for the study.
- Poor road infrastructure – This might limit access to some of the farmers due to poor maintenance of gravel roads.

4.9. Quality Assurance

Trustworthiness and dependability are essential to ensure the quality of qualitative research. Welman (2018) establishing the following four criteria which are discussed in more depth below is the foundation of trustworthiness and dependability:

4.9.1. Transferability and credibility

The credibility and transferability of the study will be assessed using qualitative research methods. All interviews conducted will be recorded at the participants consent. Before the data is used it will be subjected to the theme analysis process tool where the data will be acquired, arranged, and classified (Welman, 2018).

The study talks to the concepts of transferability by gathering data through direct interviews and then analysing it (Tracy, 2010). Transferability is the ability of

qualitative research to demonstrate that the results of one study may be used to inform decisions in other contexts to similar studies (Tracy, 2010).

4.9.2. Dependability

Dependability concerns itself with the information's reliability through time and in many contexts (Tracy, 2010). Can another researcher with equal experience used the data and come to the same conclusion. And can the data be stored safely and usable in future.

4.9.3. Confirmability

The level of objectivity in the research study's conclusions is known as confirmability Welman (2018). To put it in another way, this means that all subjectivity and bias by the researcher must be removed. The conclusions reached must be entirely based on the responses of the participants. Qualitative researchers must offer an audit trail on each stage of data analysis used to support the decisions and conclusions reached to establish confirmability. This makes it easy to prove that the conclusion to the research study accurately and that they reflect the responses of its participants (Welman, 2018).

4.10. Ethical considerations

The researcher must always seek for the participants consent by making sure that each respondent interviewed provides written consent and awareness that participation is voluntary, and they can request to be excluded at any time upon request.

If remote interviews are conduct in an event that physical interviews cannot be conducted, then the researcher must provide a guarantee of the respondent’s confidentiality of the telephonic or online interviews. Data will be stored in encrypted devices and password protected.

4.11. Chapter summary

The research methodology chapter outlines the approach and methods used to investigate the implementation and impact of these technologies in agriculture.

The research methodology chapter provides a detailed overview of the techniques and procedures used to investigate the adoption of smart farming technologies, ensuring a rigorous and systematic approach to data collection, analysis, and interpretation.

Chapter 5: Data analysis and findings to the study

5.1. Introduction

This research study seeks to understand how smart technologies can be adopted by small-scale farmers to reduce impact from natural disasters, improve production output, and increased food security in Mnquma Local Municipality in the Eastern Cape Province of South Africa. How can these technologies be used to create more revenue that in turn improves the livelihood of small-scale farmers and their local communities, create employment opportunities, fight poverty and eventually make a sustained contribution towards local economic development in the region.

This research study considers the opinions and views of small-scale farmers, subject matter experts within the public and private sector. The chapter is outlined as follows: **Section 5.2.** The population analysis of the participants in the study, **Section 5.3.** Discusses ways in which small-scale farmers define the importance of their contribution towards economic development, **Section 5.4.** Discusses how the SLA was used as a reference guide to the data.

5.2. Population analysis of respondents in the study.

This section analyses the demographic profile of the participants involved in the study. The smalls-scale farmers and the subject matter experts from both public and private sector.

5.2.1. Small-Scale farmer population analysis.

Out of a total of 15 registered small-scale farmers under the department of agriculture in Mnquma Local Municipality, a sample of 8 independent farmers and 2 co-operatives (comprising of 6 members each) participated in the research study (refer to: Table 5.1). The intention was to reach out to all 15 farmers, however due to the remote nature and location of some of the farms, weather conditions, poor transport infrastructure (gravel and muddy roads), and poor network signal, some of the potential participants could not be reached.

Of the sample taken, all participants were males including the inter-cooperative participants. Unfortunately, no women participants were encountered. In terms of age, there was younger participants that took part in the study. Majority of participants hold diplomas and only one with high school education. The majority 6 participants had 1 – 10 years farming experience and not married. Evidently there is a very strong presence and a clear trend of young people taking part in farming in Mnquma Local Municipality.

Table 5.1: Demographic profile of small-scale farmers.

Age Group	**14 - 21 years**	**22 - 35 years**	**36 - 60 years**	**>60 years**
Tally		5	3	2
Education Level	**Grade 5 – 12**	**Diploma**	**Degree**	**Honour+**
Tally	1	9		
Farming Experience	**1 - 10 years**	**11 - 20 Years**	**21 - 30 years**	**>30 years**
Tally	6	1	2	1
Sex	**Male**	**Female**	**Other**	
Tally	10			
Marital Status	**Single**	**Married**	**Divorced**	**Widowed**
Tally	6	4		

Majority of the participants (9) had owned land largely between 1 – 20ha. Some of the land is used for both crop and vegetable farming and grazing for livestock. A very important factor to note was the distinction between grazing and arable land for our understanding of the intended use of the land. Majority of the participants were diversified in their choice of commodities farming confined to mainly crops, vegetables and livestock perennially. Seven participants had

annual turnover between R50k and R500k and lived mostly in remote areas around Butterworth as it is the biggest town in terms of size, market, and population. The aim of this research was to collect data of participants who have an annually revenue between R50k to R500k and only seven were available and interviewed.

Table 5.2: Small-scale farmer portfolio.

Land Size	**1 - 5ha**	**6 - 15ha**	**16 - 20ha**	**>21ha**
Tally	2	4	2	2
Land Ownership	**Owned**	**Leased**	**Communal**	**Other**
Tally	9		1	
Commodity	**Crops**	**Vegetables**	**Livestock**	**Dairy**
Tally	4	7	6	1
Annual Revenue	**R0 - R50 000**	**R51k – R500k**	**R500k – R1m**	**R1m >**
Tally	1	7	1	1
Town	**Butterworth**	**Centane**	**Nqamakwe**	**Idutywa**
Tally	9	1	0	0

5.2.2. Demographics of a sample of subject-matter experts

The study had a total representative sample of 8 farming professionals. Majority of the sample were males (6) and only two were females. One participant was youth and seven fall between the age category of 36 and above. The same participant has farming experience between 11 and 30 years and holds a diploma in agriculture while and most participants have more than 21 years of experience in livestock and crop farming, four holding a degree in various fields of study and three have honours. Majority of participants are married, two are married and one divorced. Five of the participants were government officials, one consultant and the other two were entrepreneurs.

Table 5.3: Demographic profile of subject matter experts

Age Group	**14 - 21 years**	**22 - 35 years**	**36 - 60 years**	**>60 years**

Tally		1	3	4
Education level	**Grade 5 – 12**	**Diploma**	**Degree**	**Honour+**
Tally		1	4	3
Farming Experience	**1 - 10 years**	**11 - 20 Years**	**21 - 30 years**	**>30 years**
Tally		1	5	2
Sex	**Male**	**Female**	**Other**	
Tally	6	2		
Marital status	**Single**	**Married**	**Divorced**	**Widowed**
Tally	2	5	1	

5.3. How respondents describe productivity and its significance to local economic development.

5.3.1. Small-Scale Farmers.

Small-scale farmers view productivity as a crucial aspect of their farming operations. They understand that increased productivity output is essential for the economic sustainability and the overall success of their farms is important to poverty eradication in their local municipality. To achieve high productivity, farmers understand that innovative farming techniques and technologies could allow for faster decision making with significantly less manual labour.

However due to lack of resources access to cheap data, smart gadgets etc., they are unable to stay updated with the latest advancements in agriculture and leverage them to improve their efficiency and production outputs. This includes using improved seed varieties, implementing precision farming practices, and adopting mechanization where feasible and technology that will build resilience against vulnerabilities. Some farmers focus on diversifying their production to include a variety of crops and livestock, which they see as a measure of productivity and building resilience against natural disasters.

Moreover, farmers view their contribution towards local economic development as essential and impactful, if necessary, care is given. They understand that their agricultural activities not only provide food security but also generate income and employment opportunities within their communities. These farmers take pride in

their ability to sustainably produce high-quality crops and livestock, contributing to the local economy by supplying fresh produce to local markets and supporting local businesses.

Additionally, these farmers do not have educational background in farming. It is through their upbringing in farming environments coupled with their love and passion for farming that led them to this path. However, they recognize the importance of knowledge and skills development as they are actively seeking for training opportunities and engage in capacity-building programs to enhance their understanding of best practices in farming.

These small-scale farmers understand the significance of their contribution and continually seek ways to enhance their impact, ensuring a sustainable and prosperous future for their communities.

5.3.2. Subject Matter Experts

Subject matter experts in both the private and public sectors define the productivity of small-scale farmers in Mnquma Local Municipality based on various factors. These factors include crop production, income generation, resource efficiency, sustainability, and overall livelihood improvement. They indicate that productivity is often measured by the quantity and quality of the crops produced, as well as the profitability of the farming operation.

Additionally, experts consider the efficient use of resources such as labour, financial capital, land, water. They also assess the ability of small-scale farmers to adapt to changing environmental conditions and market demands. The experts noted that farmers are more likely to reduce the operational costs when they could respond quickly to shocks and vulnerabilities. The experts also indicated that technologies have the ability of enhancing trust between the farmer and the market, which could link to their ability to supply more produce. Ultimately, and as they mentioned their goal is to enhance the productivity of small-scale farmers in Mnquma Municipality, leading to improved livelihoods and food security in the region.

5.4. Use of SLA as a reference guide to data analysis.

This section uses the SLA to assess the current livelihood assets available to small-scale farmers in Mnquma Local Municipality.

5.4.1. Natural assets

Small-scale farmers rely heavily on natural assets such as land, water, and soil to sustain their agriculture activities. Eighty percent (80%) of farmers that participated in the study had their own land and only 16% operated on communal land. Both owned and communal land are used for various reasons mainly crop and grain farming, vegetable farming, grazing for livestock farming and a very small percentage for residential reasons. The soil is fertile and is highly suitable for all their faming activities.

One farmer commented that: "*As you can see umhlaba (the soil) is red and fertile, our livestock is big, and we get enough milk from them. Our vegetables are of high quality".*

The farmers alluded that they have enough land to accommodate all their farming practises.

Another farmer commented: *"We have enough land, and it is rich and fertile for all farming activities which can also be expanded given enough resources".*

Most of these farms are strategically situated near and along riverbanks. These rivers are non-perennially in nature with no reliable constant supply of water.

Water is essential for agriculture, but many small-scale farmers in Mnquma face unreliable water supply due to prolonged dry seasons.

The farmers indicated that *"This often leads to crop failures, loss of livestock, lower production outputs, and decreased income for us".* The soil in Mnquma is often nutrient-poor and prone to erosion during high rainfall seasons, making it difficult for small-scale farmers to grow healthy crops. Poor soil quality can also lead to decreased crop yields, increased vulnerability to pests and diseases, and reduced income for farmers.

The limited natural assets such as land, water, and soil in Mnquma Municipality has severely limited the ability of small-scale farmers to sustain their agriculture activities and earn a living.

5.4.2. Physical Assets

The research study identified various categories of physical assets that are in position to some of the small-scale farmers. These assets include, various types of farming equipment, electricity, irrigation systems, fencing, animal feed and better road infrastructure however, not one famer has all. Limited access to these assets has a significant negative impact on the productivity and sustainability of small-scale farmers.

Most farmers even though located along riverbanks do not have proper water infrastructure. As a result of this, farmers struggle to irrigate their crops, leading to reduced outputs and poor crop quality. In many instances, inconsistent water supply also results in crop failure during dry periods, affecting the farmer's income and food security.

"If government can supply us with boreholes and proper irrigation systems, we can produce anything, but we get no help from them" said one farmer.

Moreover, poor road infrastructure makes it difficult for farmers to transport their produce to the markets, leading to delays, increased transportation costs, and potential damage to goods. This limits the farmer's access to markets and reduce their competitiveness in selling their products.

One farmer commented *"Government only cares about fixing the road only when it's voting time".*

The farmers also complain about lack of access to modern farming equipment such as tractors, plows, and irrigation systems. Because of this, farmers rely on manual labour and outdated farming techniques which is very unsustainable for the business. This can result in lower productivity, as manual labour is often slower and less efficient than mechanized farming methods.

Some famers complain about the lack of proper fencing which exposes them to risks such as crop damage by wildlife, theft of livestock, and conflicts with neighbouring landowners. This results in financial losses and hinder farmers' ability to expand their operations or invest in new farming practices. Without

access to electricity, farmers struggle to power essential equipment such as irrigation systems, refrigeration units, and lighting for night-time work. This limits the farmers productivity, increase manual labour requirements, and hinder the adoption of modern farming techniques.

The lack of access to these essential infrastructure elements not only hampers the productivity and profitability of small-scale farmers but also limits their ability to adapt to changing environmental conditions and market demands.

5.4.3. Human Assets

The research has revealed that small-scale farmers in Mnquma Local Municipality have various levels of education, experience, and training exposure to farming. Most of these farmers do not have formal education in agriculture. However, the skill was passed on to them by virtue of their upbringing in farming environment and through on the job training and legacy left in their hands by previous generation, their parents.

"Ndayifunda kuTata ifarming" meaning I learnt about farming from my father. As most farmers have limited education and training, they struggle to implement modern farming techniques, improve crop yields, and navigate market challenges.

Because of this, small-scale farmers would approach local commercial farmers for mentorship, coaching and advice. It is as this point small-scale farmers gain access to knowledge and skills to effectively manage their farms and adopt sustainable agricultural practices and adapt to changing environmental conditions.

Small-scale farmers often rely on their own labour or that of family members to work on their farms.

One farmer mentioned that "*The availability of skilled and reliable labour impact the productivity and overall success of our farming operations"*.

"*A lack of labour that is not adequately trained, can lead to inefficiencies and poor crop quality"* said one farmer.

Although the intention was to attain a gender balanced sample, there was no female representatives in the sample. This could be because there was no reach to some of the farmers due to reasons mentioned above or perhaps there are no women empowerment initiatives to attract enough women at all in the region.

Government does not give adequate assistance to provide access to extension services, training programs, and capacity building initiatives to improve their knowledge, skills, and practices.

5.4.4. Social Assets

The study has revealed that most participants in Mnquma Municipality were encouraged by officials to join or form part of farmer support associations where they create relationships, and increase their chances of getting support, access to resources, information, and opportunities. The farmers mentioned that it is easier to get government support to a group of farmers rather than as individuals.

One farmer admitted that *"without any farmers association, we struggle to advocate for our rights, access government support, and participate in collective actions that could benefit our community*".

"Government officials would advise us from time to time to form a cooperative of six people for us to get government services and some of us have done that but still" said one farmer.

Some of the farmers are standalone farmers who are not part of any social connections as result struggle to secure essential resources, hindering their ability to establish and sustain successful farming operations. They rely on their families and some community member for support.

"But what are about us who own their land as legacy, must we now join hands with strangers in order to get government support. It doesn't make sense to me" mentioned one farmer.

One government official stated that, *"some small-scale farmers are stubborn and refuse to join any social networks", Farmers who lack social connections will have limited access to information about market prices, weather forecasts, best agricultural practices, and government programs".*

"*Networks can serve as sources of valuable information and knowledge for small-scale farmers"* said one expert.

"Social assets can provide small-scale farmers with emotional support, assistance during times of need, and opportunities for collaboration and knowledge sharing" another expert mentioned.

"Farmers who lack social support may experience feelings of isolation, stress, and insecurity, making it harder for them to cope with challenges and take advantage of opportunities" one expert alluded.

Most small-scale farmers do not have a collective voice to advocate for their interests, and influence policies and decision-making processes.

5.4.5. Financial Assets

Small-scale farmers often struggle to access formal financial institutions and credit facilities due to limited financial literacy. Most famers state that without access to credit, they are unable to invest in seeds, fertilizers, equipment, or irrigation systems, hindering their productivity and profitability.

When asked about government grants and funding, the response was that *"Government does not assist with enough money. In fact, government grants are no accessible in cash".*

"Money that is set aside for small-scale farmers never reaches us for its intended purpose" said one farmer.

Some farmers stated that they get called in by officials in government institutions to sign off documents to receive funding that never reaches their hands.

"They are corrupt, they eat the money. We can't report them because we are afraid of victimisation and end up losing the little, we get e.g. pesticides and a few bags of fertilizers".

The study has noted that financial constraints prevent small-scale farmers from adopting modern agricultural technologies, purchasing quality inputs, or implementing sustainable farming practices.

“We sometimes struggle to transport our produce to markets because there is no money to enable us to”.

Due to this, farmers lack the resources to access distant markets, negotiate better prices with buyers, or invest in market infrastructure.

Furthermore, lack of capital exposes farmers to numerous risks, including weather-related disasters, pest infestations, price volatility, and market uncertainties. Without financial assets, farmers struggle to diversify their income sources, or build savings to cope with emergencies. This increases their vulnerability to shocks and setbacks.

Furthermore, financial constraints hinder small-scale farmers' ability to expand their operations, invest in farm improvements, or diversify their income streams. Without access to capital, farmers are unable to seize new opportunities, improve their farming practices, or scale up their businesses. This impedes their long-term sustainability and resilience.

5.4.6. Smart-Farming Technology as an Asset.

The understanding of small-scale farmers regarding smart technology in their operations varies depending on various factors such as access to information, education level, and exposure to modern farming practices. Most farmers in Mnquma Municipality lack these factors as result still rely on conventional farming techniques.

“We rely heavily on manual labour to execute our task, which is very expensive. And people are not reliable sometimes they come and sometimes they don’t come.” Said one farmer.

These farmers’ especially old ones above the age of 40 years, lack deep understanding of smart technology and its potential benefits. This is due to limited access to resources and education and in some instances ignorance and complacency.

One farmer commented that, *“My child I don’t even have a smart phone. These things cost an arm and leg. Why can’t government assist?”*

However, as technology continues to advance and become more accessible, there is a growing awareness among small-scale farmers especially the young ones, about the potential benefits of using smart technology in their operations.

Most farmers understand that the adoption of technology in their operations would make a difference however they just do not know how. Some of the young farmers who have access to information and resources understand that smart technology can help improve efficiency, increase productivity, reduce costs, and improve overall farm management. They also recognize the potential for smart technology to help them adapt to changing weather patterns, market conditions, and other external factors.

While there may be some gaps in understanding among small-scale farmers regarding smart technology, there is a growing awareness and interest in adopting these technologies to improve their farming practices and sustainability. Additionally, as mentioned by one respondent that government and private sector fail to provide the necessary training and awareness and support to help small-scale farmers better understand and utilize smart technology in their operations.

5.4.7. Vulnerability Context

Small-scale farmers in Mnquma Municipality face unique set of shocks, trends, and seasonality factors that can impact their livelihoods.

According to the farmers the region is prone to drought. This has a devastating effect especially to those farmers who rely on rain-fed agriculture. Water scarcity is also a challenge, particularly to farmers where access to irrigation is limited. Climate change in the region is leading to more frequent and intense weather events, such as hailstorms, floods, and heatwaves. These conditions damage the crops and livestock, affecting small-scale farmer’s production and income.

Seasonal variations in rainfall and temperature impact small-scale farmer’s planting and harvesting schedules, as well as the availability of water and grassland feed for livestock.

These farmers also often struggle to access formal markets and face challenges such as price fluctuations, lack of market information which impact their income and profitability.

Changes in government policies, regulations, and support programs also affect the farmers, influencing their access to resources, markets, and services.

5.4.8. Transforming structures and processes

The farmers that participated in the study have limited access to government services within the farming industry. The farmers complain that government support in the region is inadequate. "*The department of agriculture does offer assistance in agricultural related activities however in small amounts".* Most farmers alluded that they struggle to access essential resources such as water, seeds, and technology, which are crucial for their agricultural production.

Some of the farmers lack training and education on modern farming techniques, sustainable practices, and market access. Due to this, farmers struggle to improve their skills and stay competitive in the agricultural sector. This limits their ability to adapt to changing market conditions and other factors such as climate challenges. Some of the farmers understand the need to partner with government and private sector for the success of their operations.

Government policies also have a significant impact on the success of these farmers. These policies are ineffective and unsupportive and hinder the development and success of small-scale farming operations.

5.4.9. Livelihood Outcomes

Lack of livelihood assets such as tools and resources, and slow interventions by the government and private sector results in limited livelihood outcomes (such as, increased wellbeing, improved revenue, employment opportunities, poverty reduction, food security, increased production and reduced vulnerabilities) for the farmers in Mnquma Municipality.

One of the farmers raised a comment regarding the importance of increased production outputs and adopting sustainable farming practises to achieve food

security in the region as a contribution to the community and their wellbeing. Food security amongst these farmers can be achieved for various reasons, for individual, household and community reasons. One farmer alluded that they would like to produce all that they consume. Another respondent would like to achieve food security for their family and many others for their community and commercial purposes.

Increased income and profitability were amongst some of the most critical requirement by the farmers. These requirements are important to the livelihood of the farmers as they give them the ability to supply for themselves and also affords them access to limited resources in order to become more resilient, sustainable, and successful in their agricultural endeavours. Other farmers aspire to increase their production scale with the aim of providing employment and eradicate poverty within their local communities. Some aspire to produce good and quality produce and be able to be able to supply the local stores and supermarkets.

5.5. Smart technology trends in farming and usage by small-scale farmers.

This section seeks to outline the smart farming technologies available in South Africa, the impact of these technology on productivity as perceived by officials and subject matter experts, key considerations for smart technology adoption, technology usage rate in South Africa, factors impacting current rates of adoption, and recommendations for introducing smart technologies to farmers.

5.5.1. The smart farming technologies in the South African context.

Various expert participants mentioned that smart technologies have already long existed in the farming sector in South Africa. However, it is only available for large scale commercial farmers and specific commodities.

The observation and views of experts and small-scale farmers conforms to the findings in the literature in section. These views and technologies are but not limited to:

- **Precision agriculture** which includes GPS and satellite imagery to monitor and optimize farming practices, such as planting, irrigation, fertilization, and crop monitoring. One expert alluded that *"by utilizing precision agriculture, farmers can maximize crop yields while minimizing resource inputs".*
- **Drones** for monitoring crop health, map fields, and even deliver small payloads such as pesticides or fertilizers. One expert participant commented that *"Drones can provide small-scale farmers with valuable data and insights to make informed decisions about their crops"*.

  One farmer alluded that *"Drones can also assist in remote monitoring of our livestock, and we can spot wild animals such as baboons looking to pray on their livestock and damage our crop".*
- **Crop monitoring system** that utilizes sensors, cameras, and other technologies to monitor crop health, soil moisture levels, and weather conditions. One expert commented that *"this technology can help small-scale farmers optimize their farming practices and reduce risks of crop failure which they often experience".*
- **Mobile apps and smart phones** which provide tools for crop management, weather forecasts, market prices, and other useful information. Experts posit their "these apps can help farmers make informed decisions and improve their productivity and profitability".
- **Water-saving technologies** such as drip irrigation, rainwater harvesting, and soil moisture sensors. "*These technologies are crucial for sustainable agriculture and help small scale farmers conserve water resources and improve crop productivity"* said one expert.
- **Big data and data analytics** for resource optimization. Farmers can use this technology for real time data.
- **Robotic technologies** such as tractors, planting and harvesting machines basically the use of mechanisation an automation of some the farmers activities. One farmer mentioned that *"If I can get two tractors and a harvester so that I don't rely on manual labour because sometimes I first have to teach people how do the job and don't always do it the right…...Its time consuming and requires a lot of money...."*

5.5.2. Impact of smart technology on agriculture as perceived by subject matter experts.

Subject matter experts are of the view that technology has a positive influence on production outputs and that technology can assist to greatly uplift and improve the lives of small-scale farmers. These technologies have had a significant impact in changing agricultural practices over decades. The expert's further state that the main productivity outcomes driven by smart technologies include increased efficiencies, strategic decision making, reduced labour costs, sustainable farming practices, access to information, increase crop yields, adaptation to vulnerabilities.

One expert posits that, *"smart technologies have the potential to transform the small-scale farming activities and address the challenges of feeding a growing local population in Mnquma Municipality while minimizing environmental impact".*

5.5.3. Key considerations when adopting smart technology as proposed by the subject matter experts.

Some subject matter experts posits that when considering the adoption of smart agricultural technologies by small-scale farmers, several key factors would need to be taken into account to ensure successful implementation. These considerations include but not limited to:

Affordability: *"Another big challenges technology comes at cost and small-scale farmers often have limited financial resources, so it is essential that smart technologies are affordable and provide a clear return on investment"*.

User-friendliness: One expert mentioned that *"Some farmers have limited technical skills and literacy therefore operating these smart technologies could be a challenge to them.*

Adaptability: Another private sector expert mentioned that *"these smart technologies should be adaptable to the specific needs and conditions of small-scale farmers. This may involve customization of the technology, considering*

factors such as crop types, soil conditions, climate variability, and local farming practices".

Connectivity and infrastructure: *"Another expert comments that given the remote nature of the farms, farmers may struggle with reliable internet connectivity, access to electricity and infrastructure challenges, such as limited network coverage or power outages, may need to be addressed to ensure effective implementation".*

Most expert posits that "*by addressing challenges, small-scale farmers in Mnquma Municipality can successfully adopt and benefit from smart agricultural technologies, leading to increased productivity, improved livelihoods, and long-term sustainability in the agricultural sector in the region".*

5.6. Chapter Summary.

This section analyses and discusses the findings of the study considering the views of expert participants in line with the SLA framework. Small-scale farmers are heavily susceptible to vulnerabilities due to lack of various livelihood assets. Lack of these assets negatively affects their livelihoods. Adoption of these assets heavily depends on the assistant from transforming structures to build better livelihood strategies for the farmers. Smart technologies on the other hand can positively impact on the livelihoods of these farmers by increased efficiencies and quality produce, enhancing strategic decision making, reduced labour costs, sustainable farming practices and improved food security, provide access to information, increase crop yields, adaptation to vulnerabilities.

Chapter 6: Discussion, Recommendations and Conclusion

6.1. Introduction

The aim of the study on the adoption of smart technology by small-scale farmers was to understand how these farmers can utilizing and benefiting from smart technology in their agricultural practices. The study aimed to explore the

challenges, opportunities, and impact of adopting smart technology on the productivity and sustainability of small-scale farming operations in Mnquma Local Municipality. Additionally, the study sought to identify best practices and recommendations for improving the adoption and integration of smart technology among small-scale farmers.

This chapter discusses the findings of the study, provides recommendations, and conclusion to the study. The chapter is outlined as follows: Section 6.1. Introduction, 6.2. Discussion of the study in relation to PESTEL (Political, Economic, Social, Technological, Environmental and Legal) Framework, Section 6.3. Recommendations on how smart technology can be used to improve the livelihoods of small-scale farmers and 6.4. Conclusion to the study.

6.2. Factors that influence small-scale farmers in the usage of smart technologies to increase productivity.

A PESTEL framework is a strategic tool used to assess and discuss the external political, economic, social, technological, environmental, and legal factors that impact an organization or industry (Whittington et al, 2020). When applied to small-scale farmers in Mnquma Local Municipality, the following points were identified and discussed in relation to the PESTEL framework:

6.2.1. Political Factors

The study noted that there is inadequate to no government support for small-scale farmer to access smart technology. Small-scale farmers face challenges related to complex regulations, licensing requirements, and bureaucratic hurdles that hinder their operations and access resources. This has a significant impact on the adoption of smart technologies by small-scale farmers.

In some instances, the funding to support small-scale farmers is available however it is hardly used for its intended purpose due to corruption and furthermore does not encourage small-scale farmers to invest in in smart technology for better productivity and competitiveness.

The study also noted lack of inter departmental collaboration between government, private sector and academic institutions which poses a major challenge to the adoption of technology by small-scale farmers.

6.2.2. Economic Factors

The study noted that the high cost of smart technologies and access to funding can be a major barrier for small-scale farmers in Mnquma Municipality. Technology investment requires high capital investment and maintenance. This resource does not come cheap and therefore farmers would struggle with maintenance cost as they already have low capital resources. Current economic conditions do pose a negative influence on the farmer's ability to invest in smart technologies affecting their production output, income, and livelihoods.

6.2.3. Social Factors

The study notes that, traditional farming practices and cultural norms hinder the adoption of modern technologies and sustainable farming methods among small-scale farmers. Social factors such as education levels, attitudes towards technology, and access to information has a profound influence on small-scale farmer's adoption of smart technologies. People especially uneducated people generally do not like change however, farmers who are more educated and have access to information are more likely to adopt new technologies.

Government even though they encourage social networks and cooperative structures for information sharing amongst farmers, they however do not actively encourage and support farmers well enough as a result of this most farmers still rely on old traditional, manual farming practises and lack of knowledge on smart technologies. This affects small-scale farmer's resilience and ability to cope with shocks and vulnerabilities.

6.2.4. Technological Factors

The study further notes that even though there is high appetite for the use of smart technology in the farming sector, there is still limited access to and adoption of innovative agricultural technologies amongst small-scale farmers. Smart technology is readily available and accessibility in rural areas which impact farmer's ability to adopt these tools. Factors such as connectivity, infrastructure, and technical support will pose huge challenge to the farmer's ability to use smart technologies effectively.

6.2.5. Environmental Factors

Environmental factors such as climate change have a significant impact on small-scale farming operations in the region. These farmers do not have means to guide against natural disasters such as draught, hailstorms due to the absence of knowledge regarding smart technologies and how they help them adapt to changing environmental conditions and reduce their vulnerability.

6.2.6. Legal Factors

Some Farmers may be hesitant to adopt new technologies because they are unsure about the legal implications or if they feel their data is not secure.

6.3. Recommendations

Considering all the problems and challenges identified above the following section provides a several recommendations on how small-scale farmers in Mnquma Local Municipality can improve their efficiency, productivity, sustainability with the aim of improving local economic development in the region.

6.3.1. Provide financial support.

The local government must continually offer subsidies, grants, or low-interest loans to small-scale farmers to invest in smart technology tools and equipment.

Because they are so expensive, this financial support can help offset the initial costs of adopting these technologies. Government and private sector institutions have the responsibility to provide the simplest and affordable smart technologies to small-scale farmers and progress of usage must be done on an annual basis without fail.

6.3.2. Stakeholder partnership and collaboration

For a successful introduction of smart technologies to small-scale famers, local government must encourage partnerships between government agencies, technology providers, research institutions, and farmer organizations to create a supportive ecosystem for the adoption of smart farming technologies in the region. Government must encourage farmers to form farming co-operatives or join farmer support groups that will help small-scale farmer's draw resources and knowledge about the adoption of smart technologies. This can make the adoption process more affordable and accessible.

6.3.3. Infrastructure Development

Government must provide access to reliable and affordable internet connectivity in rural areas to enable farmers to access and utilize smart farming technologies. Establishing technology hubs and training centres in the region to provide farmers with hands-on training on how to use smart farming tools and equipment effectively. Provide ongoing technical support and assistance to farmers who are adopting smart farming technology to ensure successful implementation and utilization. Advocating for policies and regulations that support the adoption of smart farming technology, such as incentives for technology adoption or funding for research and development in the sector.

6.3.4. Capacity building Initiatives

One subject matter expert suggested that the information derived from smart technologies cannot be effective if small-scale farmers do not understand how to interpret and use it. It is important that farmers should be able to understand what

the data is telling them to make meaningful decisions. One expert commented that educating small scale-farmers on the use these technologies will significantly increase their rate of adoption.

To achieve this, smart technology training and capacity building programmes must be developed, and extensive training must be provided to small-scale farmers to improve their skills and knowledge. Attending training sessions and workshops on smart agriculture technologies will help them understand how to effectively use these tools and integrate them into their farming practices. Online courses, webinars, and virtual field demonstrations can help farmers learn about new techniques, practices, and technologies to enhance their productivity and sustainability.

6.3.5. Encourage women participation in agriculture.

Government must encourage and support women participation in agriculture. This is not only essential for gender equality and women's empowerment, but also for sustainable development and food security.

Government must invest in education and training programs that specifically target women in agriculture. Often women face barriers to accessing land, credit, and technologies, which hinders their ability to fully participate in agricultural activities. By addressing these barriers and ensuring that women have equal access to resources, they can increase their productivity and contribute to overall agricultural development.

6.3.6. Youth involvement in farming

Government must encourage youth involvement in farming**.** Youth are often more tech-savvy and comfortable with using digital tools and technologies. Their familiarity with smartphones, apps, and other digital platforms can facilitate the adoption and integration of smart technologies on farms. Youth bring fresh perspectives, creativity, and innovative thinking to the agricultural sector. Their willingness to experiment with new ideas and technologies can drive the adoption of smart farming practices. By actively engaging youth in farming and agriculture,

stakeholders can leverage their skills, enthusiasm, and potential to accelerate the adoption of smart technologies, leading to more efficient, sustainable, and resilient farming practices.

By implementing these measures, the government can play a crucial role in facilitating the adoption of smart technologies by small-scale farmers in South Africa, ultimately improving their productivity, resilience, and livelihoods.

6.3.7. Research and development

Local government and private sector must invest in research and development initiatives to adapt smart technologies to the specific needs and challenges faced by small-scale farmers in Mnquma Municipality.

Taking such initiative would greatly accelerate the successful adoption of smart technologies by small-scale farmers in Mnquma Local Municipality. However, there must be a deliberate partnership between local government and the private sector to drive and implement all the above recommendations.

6.4. Conclusion to the study

The adoption of smart technology by small-scale farmers in Mnquma Municipality is a promising step towards mitigating vulnerabilities, improving livelihoods, and contributing to local economic development. By leveraging smart technology such as mobile apps, sensors, and data analytics, farmers can access real-time information on weather patterns, market prices, and best farming practices. This can help them make informed decisions, increase productivity, reduce risks, and ultimately enhance their income and quality of life.

Furthermore, the use of smart technology can create new opportunities for farmers to connect with markets, access financial services, and participate in value chains, thereby contributing to the overall economic development of their communities. The adoption of smart technology holds great potential for small-scale farmers in Mnquma municipality to build resilience, improve sustainability, and thrive in an increasingly digital world. However, for this to be possible there

must be deliberate strong partnership between the government and private sector institutions.

A substantial topic for further research could be investigating the socio-economic impact of smart technology adoption on small-scale farmers in South Africa. This research could delve into how the access and utilization of smart technologies affect not only the productivity and efficiency of farming practices but also the livelihoods, income levels, and overall well-being of small-scale farmers. By examining the broader implications of smart technology adoption, researchers can gain insights into the potential benefits and challenges faced by this demographic in adopting and integrating technological solutions in agriculture.

References

Abutabenjeh, S., & Jaradat, R. (2018). Clarification of research design, research methods, and research methodology: A guide for public administration researchers and practitioners. Sagepub, 36(3)

Aliber, M., & Hall, R. (2012). Support for smallholder farmers in South Africa: Challenges of scale and strategy. Development Southern Africa, 29(4), 548-562

Alsop, R., Bertelsen, M. F., & Holland, J. (2006). *Empowerment in Practice from Analysis to Implementation.* Washington: The World Bank.

Al-Saadi, H. (2014). Demystifying Ontology and Epistemology in Research Methods. *Research Gate, 1*(1), 1-10.

Anonymous, 2014b. The Digital Transformation of Row Crop Agriculture: A Report to the Iowa AgState Group. The Hale Group, Ltd; LSC International, Inc. https://www.iowafarmbureau.com/page/file?path=Files%2Fwebsite%2FNews%2FPDFs%2Fages1. pdf (Accessed: 14 March 2023).

Arshed, N., & Danson, M. (2015). The Literature Review. Wolvercote, Oxford: Goodfellow Publishers Limited.

Asfaw, S., Shiferaw, B., Simtowe, F., & Lipper, L. (2012). Impact of modern agricultural technologies on stallholder welfare: Evidence from Tanzania and Ethiopia. *Food Policy, 37*, 283-295.

Atzori, I. Iera, A. Morabito, G., (2017). Understanding the internet of things: definition, potentials, and societal role of a fast-evolving paradigm, Ad Hoc Netw. 56 122–140.

Awotide, B. A., Karimov, A. A., & Diagne, A. (2016). Agricultural technology adoption, commercialization, and smallholder rice farmers' welfare in rural Nigeria. Agricultural and Food Economics, 4(1), 3.

Booi, S. L. (2001). How can smart technologies be applied by smallholder farmers for increased productivity and sustained livelihoods. [A Final Masters Dissertation presented to the Department of Information Systems, University of Cape Town]. Accessed: 14 March 2023, from https://open.uct.ac.za/handle/11427/35639

Chen, M., Mao, S., Liu, Y., 2014. Big Data: a survey. Mobile Netw Appl 19, 171–209.

DAFF. (2012). A framework for the development of smallholder farmers through cooperative development. Pretoria: DAFF.

DAFF, R. (2019). Executive Summary for the National Policy on Comprehensive Producer Development Support. Pretoria: Department of Agriculture Forestry and Fisheries.

DFID (2001): Sustainable Livelihoods Guidance Sheets. Department for International Development. Accessed: 14 March 2023, from www.livelihood.org/info/info_guidancesheets.htm.

Devlin, B., 2012. The Big Data Zoo—Taming the Beasts: The Need for an Integrated Platform for Enterprise Information. 9sight Consulting.

Dharmaraj, V., & Vijayanand, C. (2018). Artificial Intelligence (AI) in Agriculture. International Journal of Current Microbiology and Applied Sciences. Accessed: 14 March 2023, from https://www.researchgate.net/publication/329905781_Artificial_Intelligence_AI_in_Agriculture

Dharmasiri, L. M. (2009). Measuring Agricultural Productivity Using the Average Productivity Index (API). *Sri Lanka Journal of Advanced Social Studies, 1*(2), 25-44.

Doss, C. R. (2017). Women and agricultural productivity: Reframing the Issues. DevelopFaulkner, A., Cebul, K., 2014. Agriculture Gets Smart: The Rise of Data and Robotics, Cleantech Agriculture Report. Cleantech Group

Drucker, V., 2014. Agriculture Springs into the Digital Age. Fund Strategy. Accessed: 14 March 2023, from: https://www. fundstrategy.co.uk/issues/fund-strategy-sept-2014/agriculture-springs-into-the digital-age/

Emerson, R. W. (2015). Convenience sampling, random sampling, and snowball sampling: How does sampling affect the validity of research? *Journal of Visual Impairment & Blindness, 109*(S), 164-`68.

Elasha, B. O., Elhassan, N. G., & Ahmed, H. (2005). Sustainable livelihood approach for assessing community resilience to climate change: case studies from Sudan. Sudan: AIACC Working Papers.

Esmeijer, J., Bakker, T., Ooms, M., Kotterink, B., 2015. Data-driven innovation in agriculture: a case study for the OECD KBC2-programme. TNO Report TNO 2015 R1015

Frey, B.B. 2018. *The SAGE encyclopaedia of educational Research, Measurement and Evaluation.* New York: SAGE

FOA. (2018). The State of Food Security and Nutrition and in The World: Building Climate Resilience for Food Security and Nutrition. Rome: Food and Agriculture Organization of the United Nations Policy Review, 36(1), 35-50.

Garg, B. 2018. Research methodology approaches and techniques. Delhi: Amiga Press Inc

Gathorne-Hardy, A. (2016). The sustainability of changes in agricultural technology: The carbon, economic and labour implications of mechanisation and synthetic fertiliser use. Ambio, 45(1), 885–894.

Georgakopoulos, D., & Jayaraman, P. P. (2016). Internet of things: from internet scale sensing to smart services. *Computing, 98*(10), 1041-1058.

Gillwald, A., Calandro, E., Sadeski, F., & Lacave, M. (2019). Unlocking the potential of the fourth industrial revolution in Africa. Accessed: 14 March 2023, from https://4irpotential.africa/wpcontent/uploads/2019/10/4IR_SOUTHAFRICA_V01PRINT.pd

Gilpin, L., 2015a. How Big Data is Going to help feed nine billion people by 2050. How Big Data Is Going to Help Feed Nine Billion People by 2050. Accessed: 14 March 2023, from: http://www.techrepublic. com/article/how-big-data-is-going-to-help-feed-9-billion-people-by-2050/

Glopp. (2008). *DFID's Sustainable Livelihoods Approach and its Framework.* Globalization and Livelihood Options of People Living in Poverty.

Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). Case Study Research: Foundations and Methodological Orientations. *In Forum Qualitative Sozialforschung/Forum: Qualitative Social Research. 18*, p. 17. DEU.

Heale, R., & Noble, H. (2019). Integration of a theoretical framework into your research study. Evid Based Nur, 22(2), 36-37.

Jayaraman, P. P., Yavar, A., Georgakopoulos, D., Morshed, A., & Zaslavsky, A. (2016). Internet of Things Platform for Smart Farming: Experiences and Lessons Learnt. Sensors, 16(10), 1884.

Jere, N., & Maharaj, M. (2017). The role of information and communications technology in improving food security in Kwazulu Natal. *South African Journal of Information Management, 19*(1), 745.

Khanal, S., Kushal, K.C., Fulton, J.P., Shearer, S., & Ozkan, E. (2020). Remote sensing in agriculture—accomplishments, limitations, and opportunities, Remote Sens. 12 (22) 3783.

Klein, H. K., & Myers, M. D. (1999). Set of Principles for Conducting and Evaluating Interpretive Field Studies in Information Systems. MIS Quarterly, 23(1), 67-93.

Kirsten, J. F., & van Zyl, J. (1998). Defining Small-Scale Farmers in the South African Context. *Agrekon, 37*(4), 551-562.

Kivunja, C., & Kuyin, A. B. (2017). Understanding and Applying Research Paradigms in Educational Contexts. *International Journal of Higher Education, 6*(5), 26-41

Krantz, L. (2001). *The Sustainable Livelihood Approach Livelihood Approach.* Stockholm: Swedish International Development Cooperation Agency.

Lesser, A., 2014. Big Data and Big Agriculture. Gigaom Research, p. 11.

Li, X., Chen, S., Guo, L., 2014. The technological innovation of agricultural information service in the age of Big Data. J. Agric. Sci. Technol. 16, 10–15.

Liu, D., Zhou, J., Mo, L., 2012. Applications of the Internet of Things in food and agri-food areas. Nongye Jixie Xuebao = Transactions of the Chinese Society for Agricultural Machinery 43, 146–152.

Liu, Z., Chen, Q., & Xie, H. (2018). Influence of the Farmer's Livelihood Assets on Livelihood Strategies in the WesternMountainous Area, China. *Sustainability, 10*(3), 875.

Loeper, W. v., Musango, J., Brent, A., & Drimie, S. (2016). Analysing challenges facing smallholder farmers and conservation agriculture in South Africa: A system dynamics approach. *South African Journal of Economic and*m*Management Sciences, 19*(5)., Lombardo, S., Sarri, D., Corvo, L., & Vieri,

Lombardo, S., Sarri, D., Corvo, L., & Vieri, M. (2017). Approaching the Fourth Agricultural Revolution: Analysis of Needs for the Profitable Introduction of Smart Farming in Rural Areas. Proceedings of the 8th International Conference on Information and Communication Technologies in Agriculture, Food and Environment (pp. 521- 532). Chania: In HAICTA.

Lowe, L., & Schilderman, T. (2001, May). *The impact of policies institutions and processes in urban up-grading.* Bourtonon-Dunsmore: International Workshop on Regulatory Guidelines for Urban Upgrading.

Lowder, S. K., Skoet, J., & Raney, T. (2016). The Number, Size, and Distribution of Farms, Smallholder Farms, and Family Farms Worldwide. World Development, 87, 16-29.

Madhuri, T. H. (2014). Livelihood vulnerability index analysis: An approach to study vulnerability in the context of Bihar. *Journal of Disaster Risk Studies, 6*(1), 1-13.

Makoza, F., & Chigona, W. (2010). Application of Sustainable Livelihood Approach in assessing the impact of ICT use in microenterprises in developing countries. *Semantic Scholar.*

Murambadoro, M. D. (2009). How the sustainable livelihoods framework can contribute towards sustainable social development: where are we going? *Council for Scientific and Industrial Research*.

Mwangi, M., & Kariuk, S. (2015). Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries. *Journal of Economics and Sustainable Development, 6*(5), 2222-1700.

Norton, A., & Foster, M. (2001). *The Potential of Using Sustainable Livelihoods Approaches in Poverty Reduction Strategy Papers.* London: Overseas Development Institute.

Noyes, K., 2014. Big Data Poised to Change the Face of Agriculture. Fortune Data. http://fortune.com/2014/05/30/cropping-up-on-every-farm-big-data-technology/ (Accessed: 14 April 2023).

Pienaar, L., & Traub, L. N. (2015). Understanding the smallholder farmer in South Africa: Towards a sustainable livelihood's classification. International Conference of Agricultural Economics (p. 36). Milan, Italy: Int. Conf. Agric. Econ

Pour, M. D., Barati, A. A., Azadi, H., & Scheffran, J. (2018). Revealing the role of livelihood assets in livelihood strategies: Towards enhancing conservation and livelihood development in the Hara Biosphere Reserve, Iran. *Ecological Indicators, 94*(1), 336-347.

Poppe, K.J., Wolfert, J., Verdouw, C.N., Renwick, A., 2015. A European perspective on the economics of Big Data. Farm Policy Journal 12, 11–19.

Qwabe, N., & Machete, C. (2014, May). Lending to small-scale farmers in South Africa: A case for best practices in formal institutions. Doctoral dissertation, University of Pretoria, 1-103.

Rehman, A. A., & Alharthi, K. (2016). An Introduction to Research Paradigms. *International Journal of Educational Investigations, 3*(8), 51-59.

Ricciardi, V., Ramankutty, N., Mehrabi, Z., & Jarvis, L. (2018). How much of the world's food do smallholders produce? *Global food security, 17*, 64-72.

Robinson, J.P. Shaver, P.R. Wrightsman, L.S. (2014) Criteria for scale selection and evaluation. Meas Pers Soc Psychol Attitudes 1(3):1–16

Rose, D. C., & Chilvers, J. (2018). Agriculture 4.0: Broadening Responsible Innovation in an Era of Smart Farming.*Frontiers in Sustainable Food Systems, 2*(87), 1-7.

Rusere, F., Mkuhlani, S., Crespo, O., & Dicks, L. V. (2019). Developing pathways to improve smallholder agricultural productivity through ecological intensification technologies in semi-arid Limpopo, South Africa. *African Journal of Science, Technology, Innovation and Development, 11*(5), 543-553.

Rotz, S., Gravely, E., Mosby, I., Duncan, E., Finnes, E., Horgan, M., . . . Fraser, E. (2019). Automated pastures and the digital divide: How agricultural technologies are shaping labour and rural communities. Journal of Rural Studies, 68(1), 112-122.

Sanyang, S., Sibiri , T. J.-B., Kuiseu, J., Coulibaly, N., & Konaté, L. (2016). A paradigm shift in African agricultural research for development: the role of innovation platforms. *International Journal of Agricultural Sustainability, 14*(2), 187-213

Saunders MN, Saunders M, Lewis P, Thornhill A (2011) Research methods for business students, 5th edition. Pearson Education India.

Schneider, K., & Gugerty, M. K. (2011). Agricultural productivity and poverty reduction: Linkages and pathways. Libraries Test Journal, 1(1), 56-74.

Serrat, O. (2017). Knowledge Solutions. In The Sustainable Livelihoods Approach (pp. 21-26). Singapore: Springer.

Sibhatu, K. T., & Qaim , M. (2017). Rural food security, subsistence agriculture and security. *PLOS One, 12*(10). Accessed: 14 March 2023, from: https://doi.org/10.1371/journal.pone.0186406

Sileyew, K.J. (2019). “Research Methodology”, In: Text Mining - Analysis, Programming and Application, IntechOpen, pp. 1-12

Slater, J., & Yeudall, F. (2015). Sustainable Livelihoods for Food and Nutrition Security in Canada: A Conceptual Framework for Public Health Research, Policy, and Practice. *Journal of Hunger & Environmental Nutrition, 10*(1), 1-21.

Sundmaeker, H., Verdouw, C., Wolfert, S., & Freire, L. P. (2016). Internet of Food and Farm 2020. In Digitising the Industry - Internet of Things connecting physical, digital and virtual worlds (pp. 129-151). River Publishers.

Statistics South Africa. (2019a). Towards measuring the extent of food security in South Africa: An examination of hunger and food adequacy (No. 03-00–14). Statistics South Africa.

Teherani, A., Martimianakis, T., Stenfors-Hayes, T., Wadhwa, A., & Varpio, L. (2015). Choosing a qualitative research approach. Journal of graduate medical education, 7(4), 669-670. Accessed: 14 March 2023, from: https://doi.org/https://doi.org/10.4300/JGME-D-15-00414.1

Tennant, J. (2018, January 2). SA’s key economic sectors. Brand South Africa. https://www.brandsouthafrica.com/investmentsimmigration/business/investing/economicsectors-agricultu

Thanh, N. C., & Thanh, T. T. (2015). The Interconnection Between Interpretivist Paradigm and Qualitative Methods in Education. *American Journal of Educational Science, 1*(2), 24-27.

Tracy, S. J. (2010). Qualitative Quality: Eight “Big-Tent” Criteria for Excellent Qualitative Research. *Qualitative Inquiry*, *16*(10), 837-851. Accessed: 14 March 2023, from: https://doi.org/10.1177/1077800410383121

Wallian, N. (2011). *Research Methods the basics.* Abingdon: Routledge.

Whittington, R., Regner, P., Angwin, D., Johnson, G., & Scholes, K. (2020). *Exploring strategy (12th Ed.) Pearson.*

Wolfert, S., Ge, L., Verdouw, C., & Bogaardt, M.-J. (2017). Big Data in Smart Farming – A review. Agricultural Systems, 153, 69-80.

Yahya, N. (2018). Agricultural 4.0: Its Implementation Toward Future Sustainability. Springer: Singapore.

Yang, C., 2014. Big Data and its potential applications on agricultural production. Crop, Environment & Bioinformatics 11, 51–56

Yang, L., Liu, M., Lun, F., Min, Q., Zhang, C., & Li, H. (2018). Livelihood Assets and Strategies among Rural Households: Comparative Analysis of Rice and Dryland Terrace Systems in China. *Sustainability, 10*(7), 2525.

Zambon, I., Cecchini, M., Egidi, G., Saporito , M. G., & Colantoni, A. (2019). Revolution 4.0: Industry vs. Agriculture in a Future Development for SMEs. *Processes, 7*(36), 2-16

Appendix A – This is a research instrument for a small-scale farmer

These interview questions are derived from the Sustainable Livelihood framework. The questions are prepared as per layout of the framework as follows: Vulnerability context, livelihood Assets, structures policies and organisations, and livelihood Outcomes.

Question 1: Age Category

a. 14 – 21	
b. 22 – 35	
c. 36 – 60	
d. 61+	

Question 2: Education level

a. Grade 5 to 12	
b. Diploma	
c. Degree	
e. Honours +	

Question 3: Sex

a. Male	
b. Female	
c. Other	

Question 4: Marital Status

a. Single	
b. Married	
c. Widowed	
d. Divorced	

Question 5: Land ownership

a. Own	
b. Leased	
c. Other	

Question 6: Land size

a. 1 – 5ha	
b. 6 – 15ha	
d. 16 – 20ha	
e. 21+	

Question 7: Commodity

a. Dairy	
b. Vegetables	
c. Livestock	
d. Other	

Question 8: Farming experience

a. 1 – 10 years	
b. 11- 20 years	
c. 21 – 30 years	
d. 30 – 60 years	

Question 9: Annual revenue

a. R0 – R50 000	
b. R51 000 – R100 000	
c. R100 001 – R 500 000	
d. R500 001 – R 1 000 000	

Question 10: Town

a. Butterworth	
b. Centane	
c. Nqamakwe	
e. iDutywa	

Vulnerability Context
Q1. Has your farm ever been affected by a natural disaster (Floods, Draught etc) or economic shocks?

Q2. If yes, could you have prevented the event from happening and damaging your property?
Q3. How did you manage to recover from the damage and who assisted you?

Livelihoods Assets
Q1. What are the top three things you need to successfully run your operations?
Q2. Do you have the right skills, knowledge, mentorship, and labour to run the business successfully?

Q3. Are you part of any farmer association network?
Q4. Do you have access to financial support services from government and private sector?

Transforming structures
Q1. What institutions do you think help you get what you need to run the business?
Q2. Does the current government legislation and policies make it easy to get what is needed to run the business?

Q3. Can you depend on government and private sectors for quick assistance?

Livelihoods Outcomes
Q1. What is your goal or vision would you like to achieve for your farm?
Q2. Can new technologies assist in achieving your vision?
Q3. Can your farm contribute meaningfully to the economy of your area?

Q4. Can new technology improve your production efficiencies?

Annexe B: Research questions directed to Authorities in public and private sector. Again, the SLA was used as point of reference as the following questions were designed around it.

Question 1: Education level

a. Grade 5 to 12	
b. Diploma	
c. Degree	
d. Honours +	

Question 3: Sex

a. Male	
b. Female	
c. Other	

Question 5: Occupation

a. Government employee	

b. Private sector employee	
c. Entrepreneur.	

Question 7: Commodity

a. Dairy	
b. Vegetables	
c. Livestock	
d. Other	

Question 8: Farming experience

a. 1 – 10 years	
b. 11- 20 years	
c. 21 – 30 years	
d. 30 – 60 years	

Question 10: Town/City

a. Butterworth	
b. Centane	
c. Nqamakwe	
d. iDutywa	
e. Other	

Question 11: General Questions

What do you specialise in?	
Are farmers using any technology to improve production in your farm?	
How do farmers keep safe from natural disasters?	
What impact do new technologies have on farm performance?	
How and where do farmers secure these new technologies?	
Please share your opinion of small-scale farmers using new technology.	

Appendix C

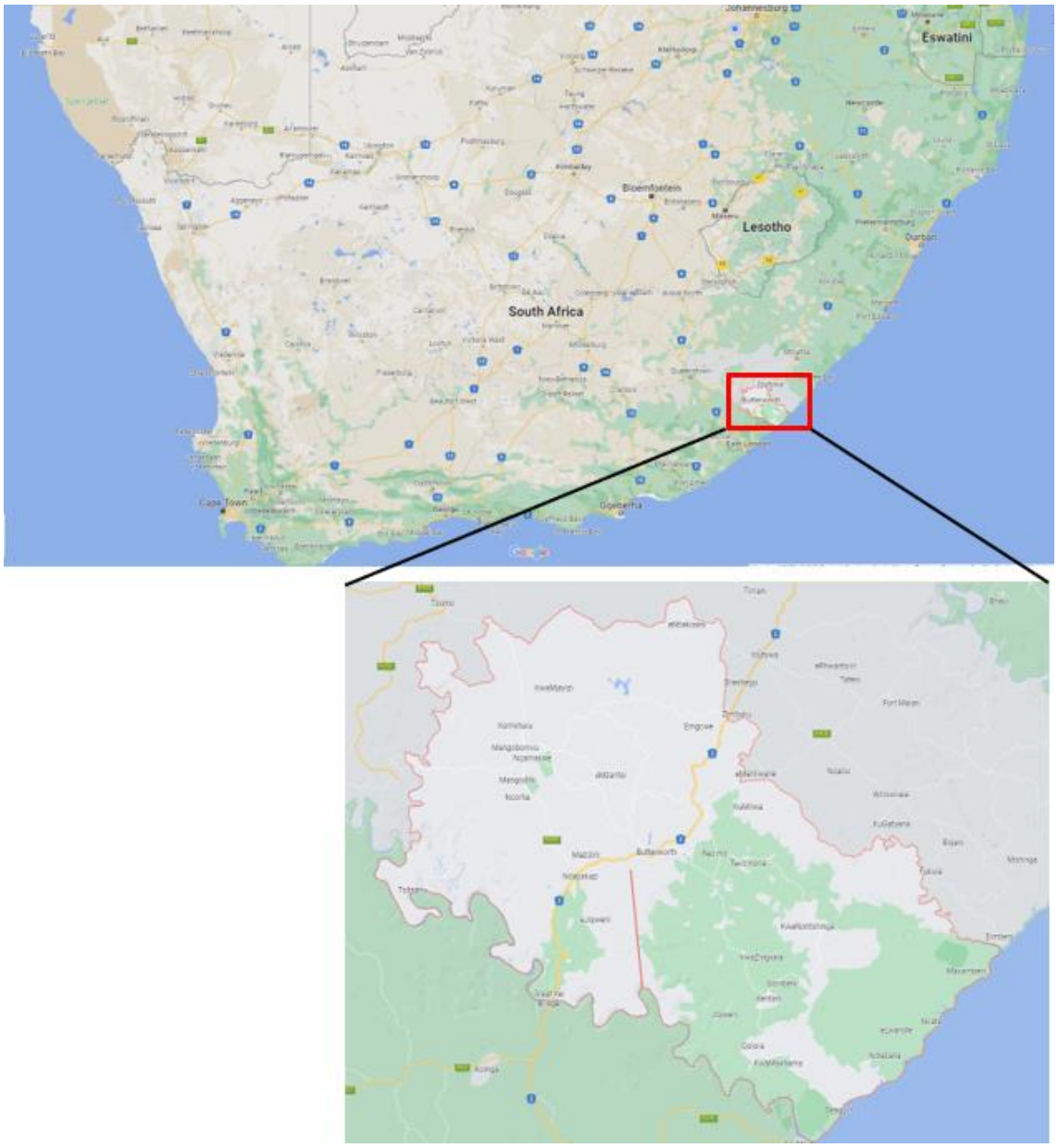


Figure 4: Locality map of Mnquma Municipality (Google maps)

Appendix D

Parameter	Criteria
Age	For the study I will select participates between 18-65+ years.
Education level	All education levels
Sex	Both male and female considered
Marital status	Both married and unmarried considered
Type of land ownership	All forms
Size of land (Ha)	5 - 20Ha
Commodity farmed	All commodities considered
Faming experience	Between 10 - 30years
Annual turnover	R0 to R500k
Geographic location	Mnquma Municipality