

https://dspace.org/

Perceived barriers to digitalization by small-scale farmers Gauteng

Choguya, Donald

2022
University of the Witswatersrand, Johannesburg
https://hdl.handle.net/10539/38471

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

Perceived barriers to digitalization by small-scale farmers Gauteng Province

Donald Choguya

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

Johannesburg, 2022

ABSTRACT

Digitalization in the fourth industrial revolution era has transformed many industries across the board. However, there are some that have been affected more than the others as depicted in the digital vortex. Lagging is the agricultural sector. This study was a quantitative research study that utilized a sample of 40 small-scale farmers to be representative of the Gauteng Province small-scale farmers. The research related the perceived barriers to digitalization and its impact to the agricultural activities of small-scale farmers in Gauteng Province. The data was analysed using the multiple regression analysis and correlation coefficient.

Analysis of the results showed a massive gap between small-scale farmers and commercial farmers on the adoption of digitalization. Further analysis indicated that small-scale farmers were less likely to be impacted by digitalization to adopt technological utilization. It was also found that small-scale farmers were contributors to food production. Finally, it was also discovered that small-scale farmers were less established to adapt and adopt to digitalization in their agricultural activities due to various barriers.

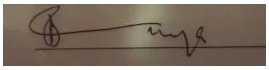
The recommendations were that there was need to do more research to find ways to bridge the gap to digitalization between small-scale farmers in Gauteng Province and commercial farmers. So that small-scale farmers in Gauteng Province especially the small-scale farmers in rural areas could also be exposed to the digitalization of operations to enable them to improve production.

KEYWORDS

South Africa, Gauteng Province, Small-scale farmers, Digitalization, Food security, Perceptions, Gross Domestic Product, Stakeholders.

DECLARATION

I, Donald Choguya, declare that this research report is my own work except as indicated in the references and acknowledgements. It is submitted in partial fulfilment of the requirements for the degree of Master of Management in the field of Digital Business at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in this or any other university.

Name: Donald Choguya Signature: 

Signed at South Hills

On the 20th day of February 2023

********** DEDICATION **********

This thesis is dedicated to my late father Charles Titus Choguya, who passed on when I was at my tender age without a clue of what life was. I also dedicate this thesis to my mother, Betty Choguya who was recently diagnosed with Parkinson's Disease who has been there for me in the absence of my father. I also dedicate this thesis to my wife, Sindiso Dube who continuously encouraged me to push until the end. I also dedicate this thesis to my children Donavan Panashe and Sibusisiwe Mitchel Choguya as an inspiration to them to aim high in life despite any obstacles that they may encounter. This Master of Management in the field of Digital Business degree would not have been complete without such a source of support. I thank you.

**********ACKNOWLEDGEMENTS**********

“Thank you, God,”

I express my gratitude to my supervisor Professor Pius Oba whose guidance made it possible for me to achieve this lifetime academic achievement.

I also acknowledge the program manager Senteni Nsibande for the unwavering support throughout this journey for always being there to assist in every minute hurdles that I faced in my academic journey.

Finally, I convey my appreciation to my Research Methodology lecturers Ayanda Magida and Dr Jabulile Galawe “Dr J.” Without your efforts I would have not known what research was?

TABLE OF CONTENTS

LIST OF TABLES x

LIST OF FIGURES xi

LIST OF ACRONYMS xiii

CHAPTER 1. INTRODUCTION 13

1.1 STATEMENT OF PURPOSE 14
1.2 BACKGROUND OF THE STUDY 15
1.3 RESEARCH PROBLEM 19
1.4 RESEARCH OBJECTIVES 26
1.5 RATIONALE 27
1.6 DELIMITATIONS OF THE STUDY 29
1.7 DEFINITION OF TERMS 30
1.8 ASSUMPTIONS 36
1.9 CHAPTER OUTLINE 37

CHAPTER 2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK 39

2.1 INTRODUCTION 39
2.2 DEFINITION OF TOPIC OR BACKGROUND DISCUSSION 41
2.3 FIRST RESEARCH OBJECTIVE LITERATURE REVIEW HEADING 43
2.3.1 SUB-HEADING 1 43
2.3.2 SUB-HEADING 2 44
2.3.3 HYPOTHESIS 1 AND 2 46
2.4 SECOND OBJECTIVE LITERATURE REVIEW HEADING 47
2.4.1 SUB-HEADING 1 52
2.4.2 SUB-HEADING 2 55
2.4.3 HYPOTHESIS 3 AND 4 57
2.5 ANALYTICAL FRAMEWORK 58
2.5.1 THEORETICAL FRAMEWORK 58
2.5.2 CONCEPTUAL FRAMEWORK 60
2.6 CONCLUSION OF LITERATURE REVIEW 61
2.6.1 HYPOTHESIS 1 AND 2 62
2.6.2 HYPOTHESIS 3 AND 4 62

CHAPTER 3. RESEARCH METHODOLOGY 64

3.1 RESEARCH APPROACH 64
3.2 RESEARCH DESIGN 64

3.3 DATA COLLECTION METHODS 65
3.4 POPULATION AND SAMPLE..... 65
3.4.1 POPULATION 65
3.4.2 SAMPLE 66
3.4.3 SAMPLING METHOD 66
3.5 THE RESEARCH INSTRUMENT 67
3.6 PROCEDURE FOR DATA COLLECTION 67
3.7 DATA ANALYSIS STRATEGIES AND INTERPRETATION 68
3.8 POSSIBLE LIMITATIONS AND CHALLENGES OF THE STUDY 69
3.9 QUALITY ASSURANCE..... 70
3.9.1 EXTERNAL VALIDITY OR TRANSFERABILITY 70
3.9.2 INTERNAL VALIDITY OR CREDIBILITY 70
3.9.3 RELIABILITY OR DEPENDABILITY..... 70
3.10 ETHICAL CONSIDERATIONS..... 71

CHAPTER 4. PRESENTATION OF FINDINGS 73

4.1 INTRODUCTION.....73

4.2 RESULTS PERTAINING TO HYPOTHESES 1 AND 2.....75

4.3 RESULTS PERTAINING TO HYPOTHESES 3 AND 4.....79

4.4 SUMMARY OF RESULTS.....82

CHAPTER 5. DISCUSSION OF THE RESULTS.....85

5.1 INTRODUCTION.....85

5.2 DISCUSSION PERTAINING TO HYPOTHESES 1 AND 3.....86

5.3 DISCUSSION PERTAINING TO HYPOTHESES3 AND 4.....89

5.4 CONCLUSION.....92

CHAPTER 6. CONCLUSION & RECOMMENDATIONS.....99

6.1 INTRODUCTION.....99

6.2 CONCLUSION REGARDING OBJECTIVES1 AND 2.....99

6.3 CONCLUSIONS REGARDING OBJECTIVES3 AND 4.....102

6.4 RECOMMENDATIONS.....106

6.5 SUGGESTIONS FOR FURTHER RESEARCH.....107

REFERENCES 116

APPENDIX A 122

APPENDIX B.....123

LIST OF TABLES

Table 1: The Quarterly Labour Force Survey……25

Table 2: Exemplary Concepts for Digitization and Digitalization…….....30

Table 3: Digital AVC vertical integration and available technology

Services ……42

Table 4: Targeted Sample size……...66

Table 5: Actual Sample Size……74

Table 6: Hypothesis 1, Regression Statistics……76

Table 7: Hypothesis 2, Regression Statistics……78

Table 8: Hypothesis 3, Regression Statistics……79

Table 9: Hypothesis 4, Regression Statistics……81

Table 10: Alternative and Null Hypothesis Results……..83

LIST OF FIGURES

Figure 1: Modified Digital Vortex…….20

Figure 2: Agricultural Products…….23

Figure 3: Industry Performances…….24

Figure 4: Analytical Framework……58

Figure 5: Theoretical Framework…….59

Figure 6: Conceptual Framework……61

Figure 7: Hypothesis 1, Correlation Plot……...77

Figure 8: Hypothesis 2, Correlation Plot……78

Figure 9: Hypothesis 3, Correlation Plot……80

Figure 10: Hypothesis 4, Correlation Plot…….82

LIST OF ACRONYMS

ACRONYM	DESCRIPTION
AI	Artificial Intelligence.
ASC	Agriculture Supply Chain.
AVC	Agriculture Value Chain.
DAFF	Department of Agriculture Forestry and Fisheries.
FAO	Food and Agriculture Organization
4IR	Fourth Industrial Revolution.
GDP	Gross Domestic Product.
GHI	Global Hunger Index.
GPS	Global Positioning System.
HIC	High Income Countries.
ICT	Information and Communication Technology.
IoT	Internet of Things.
IT	Information Technology.
IS	Information Systems.
m-Agric services	mobile agriculture services.
NDP	National Development Plan.
QES	Quarterly Employment Statistics.

QLFS	Quarterly Labour Force Survey.
RPA	Robotics Process Automation.
SC	Supply Chain.
SDGs	Sustainable Development Goals.
SSA	Sub Saharan Africa.
Stats SA	Statistics South Africa.
UAV	unmanned aerial vehicles.
UN	United Nations.
USD	United States Dollars.
WEF	World Economic Forum.

CHAPTER 1. INTRODUCTION

According to McFadden, Casalini, Griffin, and Antón, (2022) there are a lot of advantages on the introduction of digitalization to the agricultural sector. Some of these advantages have a high possibility to avert labour shortfalls, with a long-term redress on sustainability coupled with risk management and the improvement of productivity growth (McFadden, Casalini, Griffin & Anton, 2022). These elements will have an impact on food security and any economy's Gross Domestic Product (GPD). Some believed that despite the era of the fourth industrial revolution most disciplines have been affected with technological changes, and the farmers' perceptions towards crop robotics have been hardly studied (Spykman, Gabriel, Ptacek, & Gandorfer, 2021).

Pestryakov, Sbrodova, & Titovets, (2021) postulates that digitalization can be a pillar in the economic and public places developmental regimen, hence it can act as a fortification factor to the economic security. Pestryakov, Sbrodova and Titovets, (2021) have in their study investigated the relationship between digitalization and crop production as a fortification element to the economic security of the Sverdlovsk region. Nasirahmadi and Hensel, (2022) posits that there was a massive impact on agricultural and food production by digitalization through the utilization of available information from the existing agricultural assets. This has had a hand in helping in resolving challenges of food security, protection of climate and the optimal management of resources (Nasirahmadi & Hensel, 2022).

Jarial, (2022) also states that numerous male and female farmers abandoned the agricultural profession due to the execution of unsustainable practices. However, there was light to sustainable agriculture that was precision agriculture through the utilization of the Internet of Things (IoT), from the emerging technologies of the Fourth Industrial Revolution (4IR) (Jarial, 2022). The utilization of sensors has had an impact to most of the activities that enhanced the quality of life of mankind (Kayad, Paraforos, Marinello, & Fountas, 2020). Kayad et.al, (2020) alludes that the utilization of these sensors has not spared the agricultural sector and these sensor applications have also changed the lives

of agrarian stakeholders. (Viziteu, Brezuleanu, Leonte, VÎNtu, & Micu, 2017) adds that to ensure efficiency in the agricultural sector and the adoption of digitalization on managerial activities as a global trend, this may enhance productivity through innovation in organizational and informatics systems.

However, there were some factors that some stakeholders perceived towards the digitalization of operations in the agricultural sector. (Kumar et al., 2021) posits that despite the high level of globalization and digitalization with most agricultural organizations adopting the technological changes, there were some challenges that digitalization of operations posed towards the level of technological adoption. Kumar et al., (2021) alludes that some of those challenges, through investigations and research could be beneficial for the strategic deployment of digitalization to the agricultural supply chain stakeholders.

Annosi, Brunetta, Capo and Heideveld, (2020) further cements that despite the possible significant contributions digitalization may have had in the agri-food industry and the possibility of its high-level improvement towards sustainable development. Digitalization and its possibility to redress socio-economic challenges in societies and communities, it would all be to the onus of the people who utilized the technologies themselves that may positively and or negatively impact the other stakeholders (Annosi et al., 2020). The level of human resources trainability and availability especially in the Information Technology (IT) has been mentioned as a stumbling block to smooth agricultural digitalization transition by some researchers (Aleshina, Serdobintsev, & Novikov, 2021).

1.1 Statement of purpose

This quantitative research seeks to investigate the:

“Perceived barriers to digitalization by small-scale farmers within the agricultural sector in Gauteng Province and its impact to the food production thereon’’.

The digital technologies that will be considered will include anything that is part of the technological advancement in the fourth industrial revolution (4IR). These

will include Big Data, Artificial Intelligence (AI), cloud computing, Robotics Process Automation (RPA), Augmented Reality, sensors and actuators, Internet of Things (IoT) etc.

1.2 Background of the study

The Fourth Industrial Revolution (4IR) has brought the level of digitalization in most industries to the foremost, to this effect the agricultural sector has also not been spared. The digitalization of operations in the agri-food industries has promoted sustainability development and workable safe environments to agricultural workers through the utilization of technological innovations (Aiello, Catania, Vallone, & Venticinque, 2022).

The ergonomics and safety in the agricultural industry has also been a priority since the era of digitalization, to not only increase productivity but to enable the prevention of work-related illnesses to the operators of machinery to improve productivity (Aeillo et. al, 2022). Aeillo et. al, (2022) posits that inventions have been introduced to exploit the digitalization of technologies that interacted with humans in the agri-food industries to improve health and viz a viz increase production.

Despite the utilization of multi-robots, human-robots collaboration, reimaging of the aerial images and the sensors that are ground based Shamshiri, Weltzein, Hameed, Yule, Grift, Balasundram, Pitonakova, Ahmad and Chowdhary, (2018) states that there will be no prospective future developments were a farm will be entirely run by robots. Shamshiri et al., (2018) further alludes that there was pressure on modern farms to increase yields to carter for the ever-increasing population which may reach 9.8 billion by 2050. However, these targeted yields will not be realistically achievable with the utilization of the labour force available,

hence the need for the implementation of digital farming that utilizes agricultural robots to boost productivity (Shamshiri et al., 2018).

Crop farming and livestock farming, through technological utilization have a potential to be sustainably intensified, and these technologies could be the key driver to the agricultural systems (Kayad et al., 2020). Global warming has been a global burning issue hence there was need to introduce new equipment and technologies that had a potential to increase productivity of labour, energy and resources that are efficient, effective, and saving, and the reduction of pollution (Golubev, 2021).

Approximately there was 1.3 billion tons of food that went to waste which costed approximately united states dollars (USD) 2.6 trillion, of which that amount of money could be used to feed approximately 815 million people worldwide (Kumar et al., 2021). Kumar et al., (2021) postulates that approximately 14% of those losses were incurred during the transportation and storage after harvesting in the agricultural supply chain (ASC).

Yadav et al, (2020a) as cited in Kumar et al., (2021) posits that there was an increased transition of ASC through digitalization and the adoption of advanced digital technologies. Smart technologies integration was the enablement of digitalization in the supply chain (SC) (Lasi et al, 2014, Oesterreich & Teuteberg, 2016 as cited in Kumar, 2021). These actions allowed for the enhancement of product quality (Tortorella and Fettermann, 2017 as cited in Kumar, (2021) and decentralization of decision making to ensure green flexibility (Moeuf et al., 2017 as cited in Kumar, 2021).

The technological and digitalization enhancements in the SC improved visibility and transparency and enhanced real-time data capturing (Hofmann & Rusch, 2017 as cited in Kumar et al., 2021). Casado-Vara et al, (2018) as cited in Kumar et al., (2021) states that trackability in the ASC could be made possible by those technologies. Banerjee, (2019) as cited in Kumar, (2021) cements this that IoT and block chain technology adoption could bring harmony to the ASC in the redress of trackability, farmer availability and authentication.

All those global trends in the digitalization of operations in agri-food industry, to improve productivity could be applied in any continent, including Africa which relies heavily on agricultural activities to improve not only its food security but also the GDP of most of the countries within the African continent. Data extrapolated from the latest World Economic Forum (WEF) postulates that approximately 70% of African countries depended on agricultural activities for their livelihoods (Ayim, Kassahun, Addison, & Tekinerdogan, 2022). Ayim et al., (2022) alludes further those agricultural activities were the backbone of most African countries, however there was the presence of decreased productivity and food insecurity was rife in the Africa continent.

Due to the factors affecting productivity in the African continent agricultural sectors, there has been some latest development to employ the existing Information and Communication Technology (ICT) infrastructures to curb decreased productivities and improve the food security statuses (Ayim et al, 2022). Some of the technologies employed included but were not limited to only those, text, and voice-based services for the distribution of information through mobile technologies (Aleshina, Serdobintsev, & Novikov, 2021).

However, there were some barriers to the implementation of those measures (Ayim et al., 2022). Those limitation to properly exploit technological innovations included were limited to those inappropriate technological infrastructure, were policy makers' poor formulation and implementation of conducive policies, and inadequate skills by the end users, especially the farmers resulted in negative effects (Ayim et al., 2022).

Given the African context of digitalization in the agricultural sectors, South Africa has not been spared as it also relies heavily on agricultural activities to improve its food security and GDP. However, Daff, (2016) as cited in Smidt and Jokonya, (2021) states that there were still some land redressing issues that were pending in South Africa. The issues were from the past Colonialist and Apartheid rule to small-scale farmers that resulted from the past land injustices ownership policies (Daff, 2016 as cited in Smidt & Jokonya, 2021).

Thamaga-Chitja and Morojele, (2014) as cited in Smidt and Jokonya, (2022) posits that the South African agricultural sector could be classified as a dual system. This dual system had the privileged white commercial farmers who owned vast arable lands that were well equipped and developed on one side (Thamaga-Chitja & Morojele, 2014 as cited in Smidt & Jokonya, 2022). On the other side were the black subsistence farmers, less equipped and improperly developed, with small pieces of land on the other side (Thamaga-Chitja & Morojele, 2014 as cited in Smidt & Jokonya, 2022).

Mtshali and Jili, (2022) states that with the advent of the 1st to the 4th industrial revolutions the utilization of technology to operations has been critical to improve productivity and the reduction of cost. Despite those developments (Mtshali & Jili, 2022) postulates that the small-scale farmers in the South African economy have always been side-lined from most of the technological developments.

Mtshali and Jili, (2022) asserts that small- scale farmers still face socio-economic challenges, drought, poverty, and hunger despite the latest technological developments in the agricultural sector of South Africa. However, there are high prospects to redress socio-economic and racial inequalities through agricultural digitalization and automation through the suspension of traditional farming practices and the introduction of 4IR technology (Mtshali & Jili, 2022).

The increased coverage of ICT globally has enabled the ease of information sharing and enabled communications despite geographic limitations (Nkambule & Agholor, 2021). South Africa has also made considerable strides when it comes to improved ICT infrastructures, (Maumbe & Okello, 2013 as cited in Nkambule & Agholor, 2021). Armstrong and Gandhi, (2012) as cited in Nkambule and Agholor, (2021) asserts that there was a considerable increase in the utilization of digital technologies amongst South African farmers and other stakeholders in sharing of agricultural information.

New technological innovations and global market trends accessibility have been made easier despite limitations to geographical locations to those literate farmers who have access to ICT (Nkambule & Agholor, 2021). Wolf, (2001) as cited in Nkambule and Agholor, (2021) posits that despite the latest developments

farmers in the rural areas are still disadvantaged due to inadequate network connectivity and inadequate electricity supply.

The purpose of this study is to investigate the perceived impact the digitalization in the agricultural sector of South Africa and the perceived barriers to adoption of the digital technology by the small-scale farmers. This study will also address some of the perspectives the small-scale farmers may have on the issues related to the digitalization in the South African agricultural sector. These will be the small-scale farmers from the Gauteng Province.

1.3 Research problem

Digitalization of operations in the agricultural sector has been lagging according (Armstrong & Lee, 2019). However, the agricultural sector has a considerable number of workforces in the South African working class (Stas SA, 2013). Food and Agriculture Organization, (2011) as cited in Farayola, Adebisi, Akilapa, and Gbadamosi, (2020) asserts that developing countries considers agriculture as the back-bone of sustainable development, poverty eliminator and the enhancer of food security.

The digital vortex as modified by (Armstrong & Lee, 2019) Figure 1, indicated that agriculture was at the last position of the technological vortex. However, with the speed at which digitalization is moving agriculture will soon be at the mouth of the technological vortex or might even be swallowed in the next 20 to 30 years (Armstrong & Lee,2019).

Modified Digital Vortex by Armstrong, (2019).

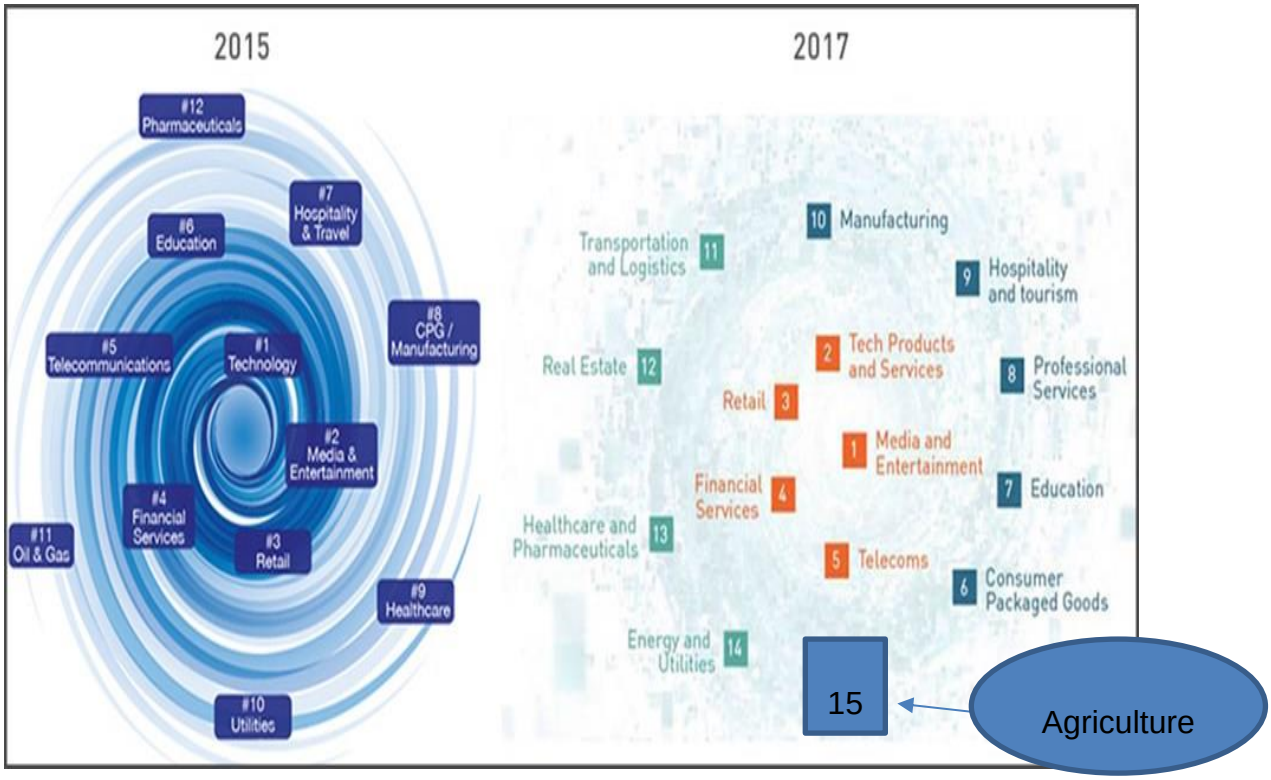


Figure1. Source: Adapted from Tech Fundamentals Notes, (2019). Inspiration source: Global Centre for Digital Business Transformation, Digital Vortex, 2017 (Modified by Armstrong, 2019), (Udovita, 2020).

By the year 2050 the United Nations (UN) perceives that the total world population would have reached 9.8 billion which would promote increased agricultural activities to boost production, however the United Nations' perceived prediction is that the land would be limited (Sadiku, Ashaolu, & Musa, 2020).

Nasirahmadi and Hensel, (2022) adds that with perceived future increase of global population to around 10 billion by 2050, there will be need to utilize the availability of technology especially the ICT, big data, AI, IoT etc, to improve agriculture.

Sadiku et al., (2020) posits that to adapt to those perceived future statuses of increased populations and the limited availability of land, advanced technologies should be adopted to curb the catastrophic consequences of food insecurity. Sadiku et al. (2020) further postulates that the agricultural sector has gone through various revolutions stemming from the industrial to the green to the biotechnology and the most recent being big data revolutions.

The advent of big data has been rapidly transforming traditional agriculture into digital and data driven agriculture (Sadiku et al., 2020). However the transformations have been central to the need for Big Data Analytics to extrapolate the information generated and improve productivity (Sadiku et al., 2020). Jellason, Robinson, and Ogbaga, (2021) however, argues that the utilization of digital technologies in the agricultural sector has been concentrated to the higher-income countries (HIC) as compared to the Sub-Saharan Africa (SSA) countries.

The limitations to the common utilization of the digital technologies in the SSA countries was noted as scalability, financial availability, technological leapfrogging, institutional governance and the educational and skills availability (Jellason et al., 2021). Jellason et al., (2021), however asserts that despite the gaps due to the scarcity of knowledge, skills availability, financial availability, and underdeveloped infrastructure in SSA the adoption of agricultural digitalization is possible.

Mtshali and Jili, (2022) asserts that the South African context had most of its prior studies on 4IR, less concentrated to the small-scale farmers. Most of the small-scale farmers in the South African agricultural context were affected by the inability to access technological information, accessibility to the market and the availability of capital to pursue their agricultural activities (Mtshali & Jili, 2022). Global warming has had an adverse effect on the climate change worldwide,

however there have been some technological innovations that have been introduced thereof to address these effects (Ojakorotu, Olajide, & Dunmade, 2020)

Ojakorotu et al., (2020) posits that the digital technologies could help improve human sustainability and improve the food basket. Stats SA, (2015) states that the South African agricultural sector was hit hard with a severe drought that had never been seen since in the past 23 years since 1991 to 2014. The severe drought influenced the food basket of South Africa; hence the GDP was affected negatively (Stats SA, 2015). Ojakorotu et al., (2020) postulates that there is need to act according to the effects of climate change viz a viz the use of state-of-the-art equipment technology. Van der Velden, (2018) as cited in Ojakorotu et al., (2020) adds that the utilization of digitalization could be the answer to the sustainable development of humanity to the redress of climate change.

According to Stats Sa, (2020) agricultural products contributed a considerable part to the GDP of South Africa, and this could be depicted in Figure 2.

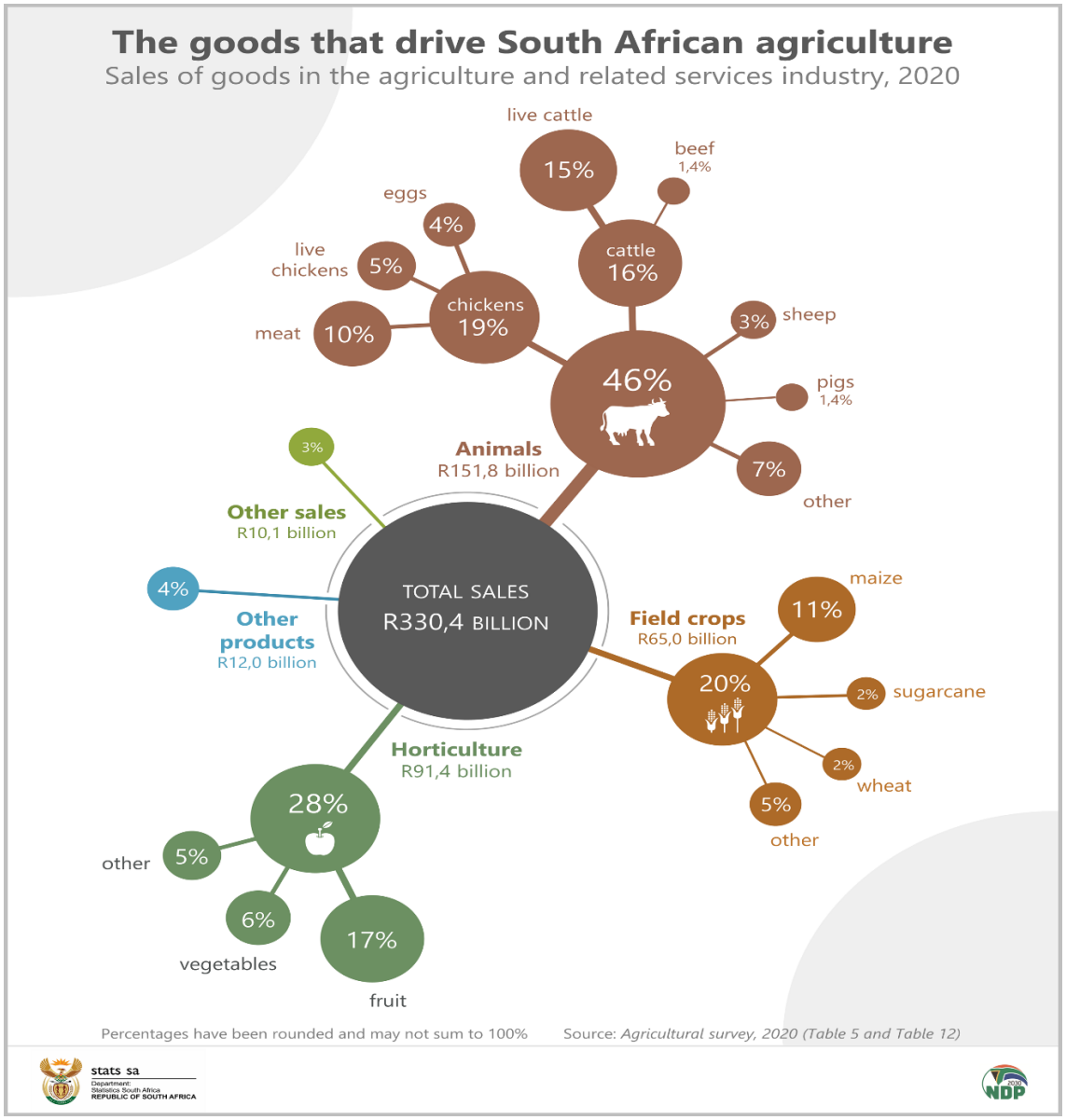


Figure 2. Source: Adapted from stats sa, (2020). Agricultural Products.

Despite the contraction of the GDP in 2020, third and fourth quarters by -1.4% and -0.8% respectively the agricultural activities however did shine with a 0.5% boost to the GDP (Stats SA, 2020). Stats SA, (2020) postulates the boost to the GDP was from the increased agricultural activities by 27.8% from the increased crop production, horticulture products and animal products that increased the exports (Figure. 3). Agricultural activities are vital to the South African economy

as there was a previous depiction of a boost to the GDP of South Africa by an increase of 38.7% and 44.2% in production within the agricultural sector in the second and fourth quarters of 2017 respectively (Stats SA, 2017).

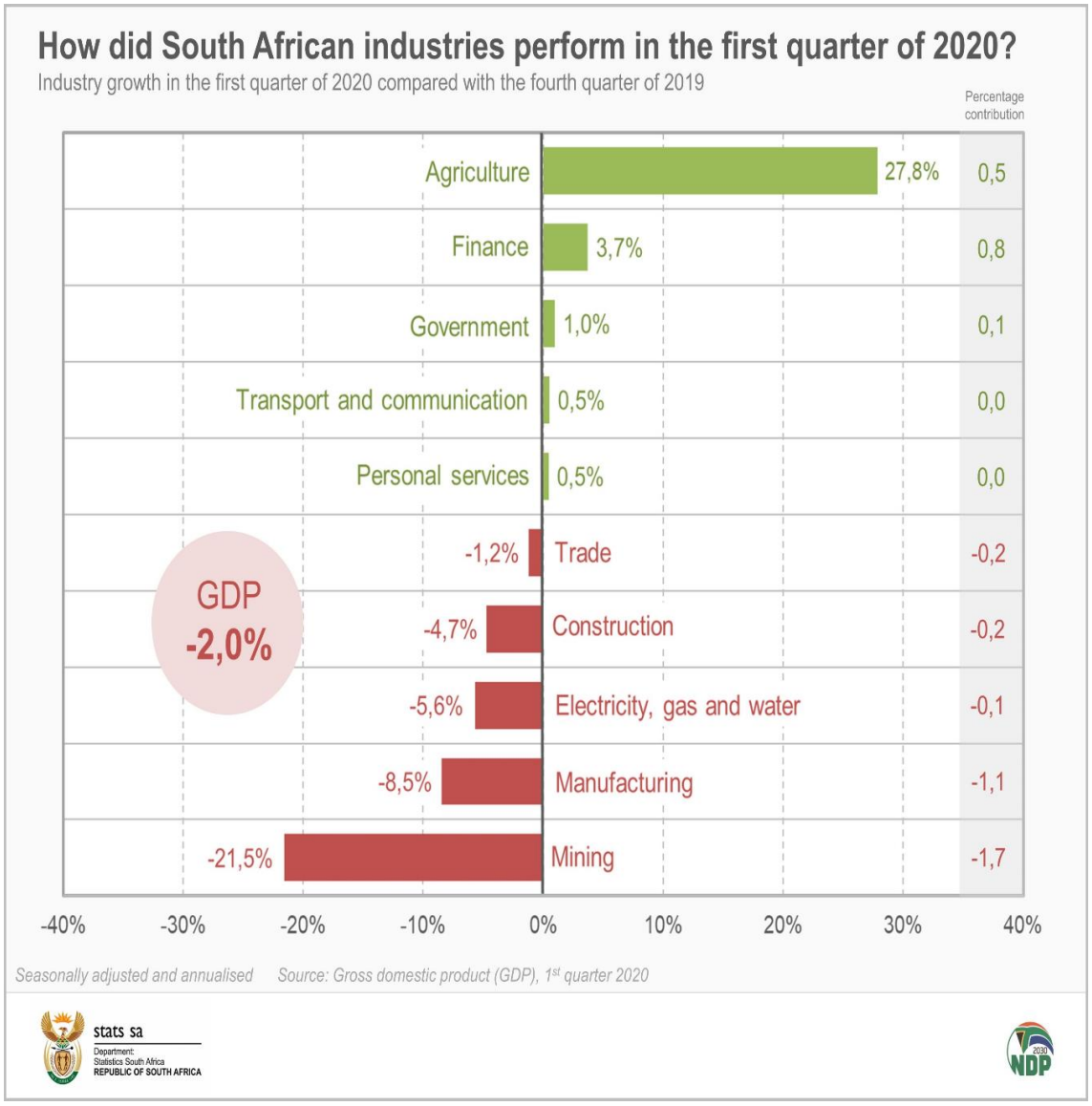


Figure 3. Source: Adapted from Stats SA, (2020). Industry performances.

The commercial agricultural activities that are of vital importance to South Africa are mostly located in the smaller geographical areas of the country, prompting risky exposure to the agricultural sector in the event of catastrophic disasters (Stats SA, 2020). Stats SA, (2013) released the employment by industry statistics where the agricultural sector of South Africa showed a substantial number of people who were dependent on the agricultural activities as a form of employment during the fiscal year 2012-2013, (Table 1., Stats SA 2013).

Employment by Industry. The Quarterly Labour Force Survey (QLFS).

Industry	Jul-Sep 2012	Apri-Jun 2013	Jul-Sep 2013	Qtr-to-qtr change	Year-on-year change	Qtr-to-qtr change	Year-on-year change
Total	1000					%	
	13645	13721	14021	308	383	2.2	2.8
****Agriculture**	**661**	**712**	**706**	**-6**	**45**	**-0.9**	**6.8**
Mining	349	374	389	15	40	4.1	11.3
Manufacturing	1727	1735	1667	-68	-60	-3.9	-3.5
Utilities	105	115	129	14	24	12.3	22.9
Construction	1046	1083	1081	-2	34	-0.2	3.3
Trade	2962	2906	3007	100	45	3.4	1.5
Transport	834	832	861	29	27	3.5	3.2
Finance and other business services	1811	1818	1910	92	99	5.1	5.4

Community and social services	3025	3050	3145	96	120	3.1	4.0
Private households	1124	1093	1132	39	8	3.6	

Note: Total include other industry.

Mining very clustered industry, hence the industry might not have been captured by the QLFS sample.

For more robust mining estimates, please use Quarterly Employment Statistics (QES).

Due to rounding, numbers do not necessarily add up to totals.

Table 1. Source: Adapted from Stats SA, (2013).

1.4 Research objectives

Main Objective: The research will seek to investigate the perceived impact of digitalization within the agricultural sector and the perceived barriers to the adoption of the digital technologies by the small-scale farmers and commercial farmers in Gauteng province. The study will also seek to investigate the perceived impact to improved food production by the small-scale farmers within the agricultural sector of Gauteng Province.

Sub Objective 1: To establish the perceived barriers of digitalization by small-scale farmers in Gauteng Province.

Sub Objective 2: To compare the gaps to the adoption of digitalization between the small-scale farmers and commercial farmers in Gauteng Province.

Sub Objective 3: To relate the level of adaptation of digitalization by small-scale farmers in Gauteng Province.

Sub Objective 4: To describe the improved food production, from improved farming activities, through digitalization by small-scale farmers in Gauteng Province.

1.5 Rationale

During the year 2017, the South African GDP saw agriculture as a major contributor towards the South African GDP in the third quarter with a 44.2% input that accounted for a 0.9% contribution towards the GDP (Stats SA, 2017). Despite having the small share of nominal GDP of 3%, in the third quarter of 2017 agriculture employed quite several citizens and its contributions did influence the South African food security and the GDP (Stats SA, 2017).

Food and Agriculture Organisation in collaboration with FAD et al., (2018) as cited in Stats SA, (2019) postulates that the envisioned Sustainable Development Goals (SDGs) objectives which includes the eradication of hunger will not be achievable by the year 2030. The statistics globally indicated that approximately 821 million people were undernourished in 2017, and this was echoed by IFPRI, (2017) as cited in Stats SA, 2017 that the Global Hunger Index (GHI) indicated the indication of either seriously or extremely alarming hunger in 52 out of 119 countries, (Stats, SA, 2019).

To counter these adverse effects in South African, the government had some measures in place to improve food security and monitor international indicators on food security (Stats SA, 2019). To improve economic growth, job creation, reduction of poverty and food security redressing there was recognition of agricultural activities and rural development through the National Development Plan (NDP) by the South African government (Stats SA, 2019). The South African

constitution guarantees that every citizen has the right to food, this is stated in Section 27(1)(b) of the constitution (Stats SA, 2019).

This right is further supported by Section 27(b) of the constitution which states that the government has an obligation to make reasonable provisions, to avail means for the provision of food and water to its citizens (Stats SA, 2019). Hence there is need for the development of agricultural policies by the Department of Agriculture, Forestry and Fisheries (DAFF), that could enable the South African citizens to produce their own food and reduce food shortages (Stats, SA, 2019).

According to some previous studies done there were indications of synergies on food security, unemployment, poverty, and inequality (FAO, 2017, Wight et al., 2014 as cited in Stats SA, 2019). The NDP however echoed the same sentiment that there was a nexus between food insecurity and poverty (Stats Sa, 2019). Bhorat and Kanbur, (2006) as cited in Stats SA, (2019) adds that the perceived inequalities, discriminations, and the patterns of unsustainable settlements were attributed to the apartheid regime.

According to COGTA, (2018) as cited in Stats SA, (2019) there have been some endeavours however to redress these adverse factors to those who were marginalised by the apartheid regime through the Spatial Planning and Land Use Management Act, Act 16 of 2013. This act seeks to provide accessibility of land to the previously disadvantaged and to ensure protection of the prime agricultural land and the environmental resources (Stats Sa, 2019).

Despite other challenges that were synthetic, that contributed to food insecurity there were some that were inevitable to humanity as they were an act of God. One of such factors is drought. According to Masante et al., (2018) as cited in Stats SA, (2019) postulates that some parts of South Africa especially the Western Cape experienced extreme drought in the year 2018. The drought severely affected the agricultural activities, and this had a negative effect on the GDP (Stats Sa, 2019). Stats Sa, (2019) asserts that between 2011 and 2016 there was a 6.1% decline of people involved in agricultural activities due to drought, in 2011 there was approximately 2.9 million, 19.9% people involved in agriculture. However, in 2016 there were approximately 2.3 million 13.8% people

involved in agricultural activities across all the provinces in South Africa, (Stats SA, 2019).

Seebens, (2009) as cited in Stats SA, (2019) posits that 52.8% of households involved in agricultural activities were headed by women compared to 47.2% households which were headed by men. The provinces that were high in agricultural activities included Limpopo (25%), Eastern Cape (20%) and KwaZulu Natal (20%) with the least dependent on agriculture provinces being Northern Cape (1%) and Western Cape (2%) (Stats SA, 2019).

The national food harvest and inequality is a sensitive and crucial issue to the South African socio-economic dimension. The purpose of this study was hence to explore perceived ways to bridge the gap between the perceived barriers to digitalization by the small-scale farmers and improve ways to help ease pressure on the food basket through the exploration of how the digitalization in the agricultural sector could mitigate problems within this sector.

The trends that will be investigated by the study would be the global proven trends in the technological innovations in the agricultural sector and the perceived perceptions across the board of all the stakeholders involved. This research will contribute to the local phenomenon on the perceived importance of agricultural activities to the South African economy on both the food production issues and the inequality issues.

1.6 Delimitations of the study

The study will not focus on the digitalization of operations in the other provinces' agricultural sector and their effects and influences as to how they promote and or affect the food production and the perceived barriers to the adoption of digital technology by small-scale farmers thereof in the Republic of South Africa. The study will not make any comparisons on the level of adaptation and adoption of digital technologies by small-scale farmers outside of Gauteng Province.

1.7 Definition of terms

The words listed below will form part of this research's key words and they have been defined as to how they will be referred to in the research.

1.7.1 Digitalization

The term digitalization came about from the inventions back dated to the year 1937, were Konrad Zuse a German engineer invented The Z1 that could utilize binary digits, zeros, and ones to execute calculations (Encyclopaedia Britannica, Inc., 2021 as cited in Frenzel & Muench, 2021). The basis for Zuse's invention influenced all the technological developments that followed as they all utilized the same principle of binary digits utilization viz a viz the evolution of digitalization as it is known today (Frenzel & Muench, 2021).

However, the digitalization phenomenon was first discovered by Shannon in 1948, who discovered that information could be stored in binary digits, which was a conversion from analogue to digital signals, (Frenzel & Muench, 2021).

In this research however due to the noise within the definition of these terminologies there were three definitions explained from (Frenzel and Muench, 2021) to try and understand the closest possible meaning of these words in Table 2.

Source(s)	Concept for digitization/digitalization.	Derived understanding.

Legner et al., (2017)	**Digitization:** “[…] the technical process of converting analog signals into a digital form, and ultimately into binary digits.” (p. 301) **Digitalization:** “[…] the manifold sociotechnical phenomena and processes of adopting and using these technologies in broader individual, organizational, and societal contexts.” (p. 301)	□ Preliminary existence of physical carriers □ Digital information is derivate of analog information. □ Explicit difference between digitization and digitalization
Lyytinen et al., (2016)	**Digitization/digitalization:** "[...] processing, storing and communicating [...] matter, energy and information comprising our world, using strings of ones and zeroes." (p. 49)	□ Innovative character of digitization/digitalization □ No explicit difference between digitization and digitalization
Sandberg et al., (2020)	**Digitization:** "[...] change in a firm’s organizing logic by instilling new properties into product platforms." (p. 130)	□ Digitization influences product architectures □ Final stage of digitization is a platform-ecosystem

Table 2. Source: Adapted from Frenzel and Muench. (2021). Exemplary Concepts for Digitization and Digitalization.

This research however adopted the definition by (Legner et al., 2017 as cited in Frenzel & Muench, 2021).

1.7.2 South Africa.

According to Oliver and Oliver, (2017) South Africa was officially colonized in the year 1652, along with other African countries in the 15th century by the Europeans. Despite the colonization being executed from the South of the African continent, South Africa also experienced some massive migration by people from the north of the continent, (Oliver & Oliver, 2017). Approximately 2000 years ago people from the North Africa especially the farmers and the metal workers moved southwards through Cameroon and eastern Africa (Meyer 2012:32 as cited in Oliver & Oliver, 2017).

In the other parts of the African continent, especially Cameroon, farming was already developed, hence people moved from these areas to the northern and north-eastern parts of Africa which is South Africa today about 1700 years ago (Giliomee & Mbenga 2007:22 as cited in Oliver & Oliver. 2017). South Africa attained its democracy in 1994 with Dr Nelson Mandela as its first black president, however due to the history behind apartheid and the struggle with the reconciliation that followed Archbishop Desmond Tutu referred South Africa as the rainbow nation given its inclusivity culture (Oliver & Oliver, 2017).

1.7.3 Stakeholders.

Miles, (2012) as cited in McGrath and Whitty, (2017) posits that the terminology stakeholder has been viewed by many as to be at the centre of business. However, there seems to lack a consensus on the meaning of this term. McGrath and Whitty, (2012) postulates that the stakeholder management has been linked to ethics and management since the advent of Freeman (1984). Since 1984, there was an increase in the utilization of the word, (Fassin, 2009 as cited in McGrath & Whitty, 2017).

This has led to some intense argument on the definition of the stakeholder terminology (Eskerod & Huemann, 2013; Littau et al., 2010; Mainardes et al., 2011; Miles, 2012 as cited in McGrath & Whitty, 2017). McGrath and Whitty, (2017) however posits that stakeholders were those parties that would in a degree be impacted and or impact, directly and or indirectly, primarily and or secondarily, legitimately and or derivatively from any given scenario.

1.7.4 Perceptions.

Perreault and McCarthy, (2005) as cited in Amodu, (2006) states that perception is attributed to the way people view the world and their interpretation to the world view based on their mental models. Jobber, (2004) As cited in Amodu, (2006) agreed to the definition by Perreault and McCarthy, (2005) as cited in Amodu, (2006) that there is a chronological order from when people view the world, how they interpret and act on their interpretation based on their view of the world. Jobber, (2004) as cited in Amodu, (2006) however alludes that the interpretation of the world view is influenced by the information gathered by the individual concerned. The information gathered is sensory in nature which is evoked by outside stimuli and needs to be processed and given a meaning (Santrock, 2003 as cited in Amodu, 2006).

1.7.5 Food security.

According to Peng and Berry, (2019) food security is the situation were by people have accessibility to sufficient safe and nutritious food, socially, physically, and economically, that meets the health dietary requirements and food preferences that are deemed to be for an active and healthy lifestyle. Peng and Berry, (2019) further alludes that for a full food security to be achieved there are 4 dimensions that needs fulfilment.

These dimensions included the availability of food nationally, the accessibility to food sources per household, the utilization of the available food by individuals and the stability of food sources (Peng & Berry, 2019). However, Peng and Berry, (2019) adds that there was a fifth dimension that was added which was sustainability of the food source. The notion of food security stems from production to consumption, through distribution to processing and this could be recognized in several domains as opposed to the 4 pillars (Peng & Berry, 2019).

There were varying factors to determine food security and food insecurity, and both are situational as they are dynamic, reciprocal and time bound (Peng & Berry, 2019). The definition of food security has however been flexible depending

on research and policy usage (Peng & Berry, 2019). This notion was echoed by (Maxwell and Smith, 1992 as cited in Peng and Berry, 2019) that even the last two decades since their publication the term was used contextually depending on the feature of the definition and it had approximately 200 definitions.

However, the most recent accepted definition of food security is when people all the time have physical, social, and economic access to sufficient, safe, and nutritious food for their dietary needs that could fulfil a healthy and active lifestyle (FAO, 2002 as cited in Peng & Berry, 2019). Berry et al., (2015) as cited in Peng and Berry, (2019) states that the availability and price stability of basic food due to the extreme volatility of the agricultural commodity prices and the turbulence in economic activities was the measure used to determine the food security status. As a result, food security does not have a specific definition as it was discovered to be contextual specific, that were dependent to technical perspectives marred by policy issues due to its multidimensional and multifaceted nature (Peng & Berry, 2019).

1.7.8 Gross Domestic Product.

According to (Leamer, 2009) gross domestic product (GDP) was the total output from the market activities of goods and services produced per year within a certain geographic area, especially a country. The GDP has been the reference that has been used to measure how any country's performance could be evaluated in a given period especially with a year (Leamer, 2009). Leamer, (2009) posits that big and or growing are deemed good and or positive while on the other hand small and or shrinking are bad and or negative for any country in question.

The issue of GDP is around outcomes rather than processes, as many people are normally ignorant about how the goods and services are derived, and most people overlook what they consume (Leamer, 2009). Leamer, (2019) asserts that GDP normally excludes what is valuable and includes what is unwanted, in short despite unintended consequences from any activities it will still be captured by the GDP, so all activities good and or bad are included.

1.7.9 Small-scale farmers.

According to Kirsten and Van Zyl, (1998) there are basically two categories of farmers in the South African context, and these are subsistence farmers and commercial farmers. Subsistence farmers are mainly the black population that emanate from the rural homeland areas while the commercial farmers are mainly the white community (Kirsten & Van Zyl, 1998).

In the South African context small-scale farmers are categorized as the backward, non-productive, non-commercial, subsistence agriculture that is found mainly in the homeland and is practiced mainly by black people (Kirsten & Van Zyl, 1998). On the other hand, Kirsten, and Van Zyl, (1998) postulates that white farmers are described as commercial farmers due to their ability to utilize modern and advanced farming techniques through advanced technologies exploitations. However, Kirsten and Van Zyl, (1998) dispute these claims as they indicated that 25% in white commercial farming covers land smaller than 200ha while almost 5% covers land less than 10ha, despite their contributions towards the South African GDP.

Kirsten and Van Zyl, (1998) perceives that there is no certainty as to the classification of commercial viability of small-scale farmers. This uncertainty emanates from who to look at be it emerging farmers, subsistence farmers, farmers in the homeland, black farmers, small-scale white farmers, previously disadvantaged farmers, farmers on small pieces of land or farmers with a small turnover (Kirsten & Van Zyl, 1998)? Coetzee, (1998) as cited in Kirsten and Van Zyl, (1998) further cements the dilemma associated with the difficulty in the small-scale farmer classification from individual to individual given the vast number of various categories found in this sector.

Kirsten and Van Zyl, (1998) posits that due to the confusion in the classification of what a small-scale farmer is, there is a very serious repercussion on policies that would improve small-scale farming in South Africa. According to Kirsten and Van Zyl, (1998) size should not define the farm scalability, but the turnover or rather the level of farm net income. Kirsten and Van Zyl, (1998) posits that the

definition of small-scale farmers is of importance to the government for policy formulations hence the definition should be:

‘’A small-scale farmer is one whose scale of operations is too small to attract the provision of the services he/she needs to be able to significantly increase his/her productivity’’.

1.7.10 Gauteng Province.

Landau and Gindrey, (2008) states that Gauteng is the centre of South Africa, with the responsibility of close to 10% of the Sub-Saharan Africa’s GDP as it connects people and businesses around the continent and beyond. It has a well-connected mode of transportation which includes road and air transport system that most immigrants and the South African citizens alike utilizes everyday of their lives (Landau & Gindrey, 2008).

1.8 Assumptions

Small-scale farmers who will answer the questions provided will come as a mixture of individuals, there might be a gap in the level of education as some of the small-scale farmers might not have proper understanding of the topic in question. However, their contribution will be valuable as it will help to make sense of how different small-scale farmers view this issue of digitalization hence this might help with future policy review and policy implementation to promote inclusivity.

Since there was little attention given to this topic around digitalization in agriculture the issue under investigation might not have many small-scale farmers to interview and or assess, however the research will carry on with the available data gathered to help with future references.

Some of the data used in the study was secondary data from Statistics South Africa, it was assumed that the data was correct and accurate for the study. The

data was however selected with description as to how relevant it was to the study, and it was in accordance with the research objectives and or the research questions that were addressed.

1.9 Chapter Outline

The research followed the presented model below from the start to the end.

Chapter One.

In chapter one the purpose of the study was divulged, as to what the study would seek to achieve. The terminology was also explained in this part of the study. This section also indicated what was excluded from this study. The list of topics which were included in the first chapter included: The Introduction, Definition of Terms, Assumptions, Delimitations.

Chapter Two.

In this chapter the literature was be critiqued. The literature involved was that from various previous authors with whom have contributed towards the topic in question. Some of the hypotheses were introduced and critiqued as well.

Chapter Three.

In this chapter of the research report, the methodology was explained. The methodology indicated which method was adopted in conduction of the research.

Chapter Four.

In chapter four the results were presented. The results were derived from the correlation coefficient and regression based on the data gathered.

Chapter Five.

Chapter five was discussion of the results based on the findings according to the results interpretations.

Chapter Six.

Finally, in chapter six the conclusions were drawn from the findings of the research study. Recommendations closed the research study with some suggestions.

CHAPTER 2. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

2.1 Introduction

Digitalization of operations has been one of the hot topics in the advent of the 4IR, in most of the sectors. Agriculture has not been spared from the disruption that this 4IR came along with, despite those changes being less aggressive in the agricultural sector, a change in the agricultural sector has been prevalent. Yueh, Chen, and Chen, (2013) posits that in the agricultural sector there was need to continuously engage the utilization of computer-controlled technologies and automated machinery to remain competitive.

However there has been a notable effect on how the agricultural sector was far behind in the technological realm (Hsiu-Ping, Tyz-Ling & Chien-Tso, 2013). Daberkow and Mcbride, (2003) as cited in Annosi et al., (2020) asserts that despite the availability of precision agricultural tools and technologies since 1990 the adoption rate has been slow.

Annosi et al., (2020) postulates that the slow diffusion to the adoption of these technologies were attributed to the lack of preparedness by the users and providers. This was due to the lack of financial commitment to those novel technologies by users who not only did not have to consider purchasing of equipment, but also the availability of skilled personnel to operate the technology (Annosi et al., 2020).

Annosi et al., (2020) also asserts that on the provider side there was the lack of adoption of those technology due to the lack of disruption of the traditional way of operations to the adoption of modern technology by the users. On the organizational levels there were several challenges that reduced the rate of adoption of these agricultural technologies stemming from the expertise availability, accessibility to knowledge and technology (Daberkow & McBride as cited in Annosi et al., 2020), literacy level (Hudson & Hite as cited in Annosi et al.

,2020) and the response to the technological changes (Cochrane, 1993 as cited in Annosi et al., 2020).

Deloitte, (2021) as cited in (Valiyev, Oglu Rustamov, Huseynova, Orujova, and Musayeva, 2022) posits that agricultural activities accounted for approximately 6% of the Azerbaijan's GDP and the entity of the population approximately 40% was dependent on agriculture. This showed how crucial agricultural activities could be to any economy.

This could be supported by the results produced in the third quarter of 2017 in the South African economy were agricultural activities produced 44.2% on its production activities that contributed 0.9% towards the GDP and this was the highest performer for that period (Stats SA, 2017). Valiyev et al., (2022) alludes that for the agricultural sector to perform more effectively and efficiently there will be need to exploit innovative technologies. This was attributed by (Rostec, 2020 as cited in Valiyev, 2022) that approximately 70% of farmers in the developed nations utilized digital technologies for their farming activities.

Sub Objective 1: To establish the perceived barriers of digitalization by small-scale farmers in Gauteng Province.

Sub Objective 2: To compare the gaps to adoption of digitalization between small-scale farmers and commercial farmers in Gauteng Province.

Sub Objective 3: To relate the level of adaptation of digitalization by small-scale farmers in Gauteng Province.

Sub Objective 4: To describe improved food production, from improved farming activities, through digitalization by small-scale farmers in Gauteng Province.

Since the study was based on digitalization in the agricultural sector and how it influences the food production and the GDP the literature review first investigated how other authors have critiqued this view. The second part investigated what the stakeholders thought and how they expressed themselves in as far as the issue of digitalization was concerned in the agricultural sector.

2.2 Digitalization of operations in the Agricultural sector.

Harvard Business Publishing, (2016) as cited in Valiyev et al., (2021) contemplates that agriculture has been lagging in technological application to the digitalization of operations. More so the physical, capital and growth have been rated to be extremely weak in the developing countries as compared to developed countries due to low agricultural investments and productivity (Sabodash et al., 2021 as cited in Mtshali & Jili, 2022). This could be attributed to the political atmosphere, unfavourable regulatory conditions and the exploitation of the natural resources which were at risk of extinction in most developing countries (Mtshali & Jili, 2022).

However there has been an upward trend in the subject matter of digitalization in the agricultural sector (Harvard Business Publishing, 2016 as cited in Valiyev et al., 2021). Subeesh and Mehta, (2021), Vasiljeva et al., (2020); Figueiredo et al., (2019); Nguyen and Tuyen, (2021); Megits, Neskorodieva and Schuster, (2020) as cited in Valiyev et al., (2021) echoes this sentiment that there has been quite several research done to address the constraints that have hindered the fast implementation of digitalization in the agricultural sector.

The advent of industrialization in the agricultural sector in developing nations was to improve their food baskets from increased production, help in the alleviation of unemployment and improvement of the GDP (Barlow, 2018 as cited in Mtshali & Jili, 2022). Food security could be improved by the upgrading of small-scale farmers and achieve some of the Sustainable Development Goals (SDGs) as set out in the 2030 Agenda for Sustainable Development, 2015 set out by the United Nations (UN) targeting the socio-economic and environmental factors (SDSN, 2015; FAO, 2015 as cited in Shmit & Jokonya, 2021). Pessce et al., (2019) as cited in Smidt and Jokonya, (2021) as indicated in Table 3 showed the relevancy of technological utilization in the Agriculture Value Chain (AVC) and some of the stakeholders who could reap from the utilization of some of the technologies available.

Farmer's Suppliers (Input supply Industry)	Farmers/Producers	Processing post-harvest and storage	Distribution and Retail	Consumers
Technology Service Providers				
AI and IoT Big Data Collection and Analysis				E-business
GNSS precision agriculture			Blockchain traceability	
Smart farming and Smart irrigation				
ICT digitalized Communication (Broadband)				
Robotics Automation				
Block chain smart contracts				

Table 3. Digital AVC vertical integration and available technology services. Source: Adapted from Pesce et al. (2019) as cited in Shmit and Jokonya, (2021).

2.3 The perceived barriers to digitalization by small-scale farmers in the agricultural sector in Gauteng Province.

Since 1994 South Africa has shown an annual growth rate of 7.5% from the registered commercial farmers approximately 40% being crop farmers and approximately 60% being livestock farmers who have utilized the ICT technology (DAFF, 2018 as cited in Nkambule et al., 2021). Naude, (2018) as cited in Nkambule et al., (2021) posits that only 4% of the commercial farmers were the only ones who contributed to the economy. Despite the contribution of 25% of the total agricultural production to the GDP by small-scale farmers, it has proven to be difficult to integrate them to the export channels and for them to reap the benefits of their challenging work (Mtshali & Jili, 2022).

However approximately 75% of the farmers were rural farmers who were dependent on farming for their upkeep (Nkambule et al., 2021). This sentiment was echoed by Jellason et al., (2021) that agriculture was practiced by small-scale farmers who lacked the resources to properly execute production. Rotz et al., (2019) as cited in Mtshali and Jili, (2022) postulates that there could be a risk of socio-economic and racial inequalities if the traditional way of farming could entirely be replaced with the agricultural digitalization and automation through the utilization of the 4IR technologies.

2.3.1 Small-scale farmers versus digitalization in Gauteng Province.

Hajiyeva, (2021) as cited in Valiyev et al., (2021) alludes natural causes as the risk factors to productive agricultural activities, while Aliyev, (2019) as cited in Valiyev et al., (2021) echoes that fabricated factors were also contributory factors to poor agricultural productivity. Agriculture was an important part of the economic growth for the Azerbaijani economy with a 36% ranking on the importance ranking rating index (Deloitte, 2020 as cited in Valiyev et al., 2021). Portulans Institute, (2020); E-Governance Academy, (2022) as cited in Valiyev, (2021) confirmed the tightness of the casual relationship between GDPs per capita, Network Readiness Index and GDP per capita, Digital development in 130 countries. The findings found that less developed countries lacked the affordability to implement

digital solutions to their agricultural activities with correlation coefficients of 0.66 and 0.74 respectively which was statistically significant at p=0.05 (Cunningham, Weathington & Pittenger, 2013 as cited in Valiyev, 2021).

The South African GDP has been pegged much lower at approximately 0.7% compared to United Arab Emirates approximately 1.3%, Brazil approximately 1.26%, China approximately 2.19%, Japan approximately 3.36%, the Republic of Korea approximately 4.81% and Israel approximately 4.95% (Malomane, Musonda & Okoro, 2022 as cited in Mtshali and Jili, 2022). These differences according to Malomane, Musonda and Okoro, (2022) as cited in Mtshali and Jili, (2022) were attributed to the highly effective implementation of 4IR to economic activities to those countries' economies, agriculture included better than the South African economic activities that contributed to the GDP.

DAFF, (2013) as cited in Mtshali and Jili, (2022) asserts that the small-scale farmer who participated in horticulture were liable of 25% of the total agricultural activities' contribution towards the GDP of the South African economy. NAHF, (2017) as cited in Smidt and Jokonya, (2021) posits that according to the South Africa's National Development Plan (NDP) that was launched in 2012, there were prospects of future employment creation from the expansion of irrigated land, cultivation of underutilized land and the facilitation of commercial production.

2.3.2 Improved food production versus digitalization by small-scale farmers in Gauteng Province.

Nkambule et al., (2021) argues that there is still a grey area on the issue of ICT utilization which dates back from 1996 to the current era which needs to be redressed to increase productivity. However, despite the need to address future food security issues that stem back from the first industrial revolution up to the latest 4IR, (King, 2017), there were numerous possible 4IR technologies that could be utilized (Berendt, Littlejohn, & Blakkemore, 2020; Lele & Goswami, 2017; Lune & Berg, 2017; Smit & Jokonya, 2017 as cited in Mtshali & Jili, 2022). Hekkert, Suurs, Negro, Kuhlmann and Smidt, (2007) as cited in Mtshali and Jili, (2022) posits that there would be need to consider the global socio-economic, political shift to address the digitalization issues in the agricultural realm.

However, the advent of 4IR was not a new phenomenon, but a continuation of the past three revolutions (Allal-Cherif, Simon-Moya & Ballester as cited in Mtshali & Jili, 2022). The basis of 4IR was viewed as the integration of networks through digitalizing them and utilizing big data, artificial intelligence, IoT and other digital technologies to improve business transactionality (Mtshali & Jili, 2022). The 4IR has however shown some threats to the human-labour due to the availability of technologies that have shown more ability to interact and perform tasks meant for humans much better that the humans themselves (Xu, David & Kim, 2018 as cited in Mtshali & Jili, 2022).

Kozma and Vota, (2014) mentioned the importance of ICT utilization, one of them being agriculture. The utilization of ICT in the agricultural space in Africa was noted to be on the rise (Avgerou, 2010, Heeks, 2002, Heeks & Future, 2014, Walsham, 2017 as cited in (Emeana, Trenchard, & Dehnen-Schmutz, 2020). There was a notable evolution from the traditional methods of agricultural activities to the modern ways (FAO, 2019; Zyl, Alexander, Graaf & Mukherjee, 2014; Chavula, 2014; Ajani, 2014; Ajani & Agwu, 2012; Karugia & Ndokweni, 2007 as cited in Emeana et al., 2020).

GDP and unemployment of a country could be addressed by the venturing of citizens into agricultural activities (Nkambuke et al., 2021). Chhachhar et al., (2014) as cited in Nkambule et al., (2021) posits that the utilization of advanced technology in agriculture and constant improvements could address food insecurity issues, help with the reduction of poverty, and enable the improvement of environmental sustainability.

Food and Agriculture Organization, (2011) as cited in Farayola, Adebisi, Akilapa and Gbadamosi, (2020) posits that even in Nigeria, food insecurities, sustainable development and growth were supported by agriculture, hence innovation has been on the fore front (Avsar & Avsar, 2014 as cited in Farayola et al., 2020). Despite the 4IR benefits to improve food security, it might be a challenge to fully understand how it operates given that there were still lack of understanding of the other three past revolutions (Agbehadji, Awuzie, & Ngowi 2021 as cited in Mtshali & Jili, 2022).

However, ITU, (2016) as cited in Shmit and Jokonya, (2021) posits that the development of agriculture through the Agriculture Value Chains (AVC) could be crucial in poverty alleviation. The utilization of digital technology thereof in the agricultural realm could improve the effectiveness and efficiency of AVC and this could have an impact on the food production hence enhanced food security (Heeks, 2018 as cited in Shmidt & Jokonya, 2021).

Given the higher demand for food needs in SSA and the accelerated rate at which ICT is developing, there would be chances for small scale farmers to grow (Jellason et al., 2021) and there could be more job prospects in the agricultural sector (Tompkins 2020 as cited in Jellason et al., 2021). Tompkins, (2020) as cited in Jellason et al., (2021) adds that this could improve profits for the farmers and improve the food basket of the SSA countries. Jellason et al., (2021) postulates that if Africa would be missed by the technological evolutions brought by the 4IR there could be prospects that it will be dependent to the high-income countries (HIC) for its food supplies for an exceptionally long time and there would be a danger to utilize the abundant natural resources Africa has.

2.3.3 Impact of barriers to digitalization on small-scale farmers' production and its effects to the food production in Gauteng Province.

2.3.3.1: Alternative Hypothesis

- Digitalization in the agricultural sector could improve food production in the Gauteng Province for small scale-farmers.

- Barriers to digitalization could affect the agricultural activities of small scale-farmers in the Gauteng Province.

H1. Small-scale farmers in Gauteng Province are of importance towards the contribution to food production through digitalization.

H2. Small-scale farmers are not well established to adopt and adapt to digitalization of operations in Gauteng Province.

2.4 The perceived barriers to digitalization by small-scale farmers in Gauteng Province.

Aker et al., (2016) as cited in Nkambule et al., (2021) believed the usage of ICT in the rural areas would help in the rural-urban connectivity, which would in turn connect the rural areas to the rest of the globe. Buseth, (2021); Phiri et al., (2020) as cited in Mtshali and Jili, (2020) alludes that 4IR technologies will enable the disadvantaged farmers to compete locally and internationally.

Nkambule et al., (2021) posits that there would be need for the policymakers to understand the rural living conditions and how they operated before they could channel developmental initiatives to the rural farmers. The understanding could help program planners develop suitable programs for the rural farmers and there could be strong nexus between the program designers and the beneficiaries (Nkambule et al., 2021).

The utilization of ICT to the farming sector could be seen as a unifier between the rural and urban farmers (Ugboh & Tibi, 2007 as cited in Nkambule et al., 2021). The rural farmers through the utilization of ICT technology will be able to access credit and banking facilities (Nkambule et al., 2021), with the ability for the farmers to have latest information on agricultural activities (Agholor & Ogujiuba, 2021 as cited in Nkambule 2021). Wamboye, Tochkov, Sergi and Technology, (2015) as cited in Jellason et al., (2021) asserts that there has been a great deal of improvement on the ICT infrastructure in the Sub-Saharan Africa (SSA) that has been for the past a catapult to increased agricultural digitalization.

The pioneering of platforms such as M-Pesa has enabled farmers especially the small-scale farmers to transition from subsistence farming to commercial farming through the ease of transactional advantages from such platforms (Maree,

Piontak, Omwansa, Shinyekwa & Njenga, 2013 as cited in Jellason et al., 2021). Annan, Dryden, and Conway, (2018); Baumuller, (2017); Schwab, (2016) as cited in Emeana et al., (2020) asserts that the accessibility to the agricultural information enabled by the ICT, contributed to the increased uptake of digital technologies by most African farmers.

DAFF, 2015 as cited in Nkambule et al., (2021) asserts that there was need for commercial farmers and rural farmers collaboration to create employment and improve on food security. Mtshali and Jili, (2022) argues that there were prospects that both commercial farmers and small-scale farmers had the prospects of losing employment especially due to the heavy reliance on 4IR technology which could not be compared by previous technologies.

This notion was attributed to issues that surrounded the decision-making hierarchy, were government in the South African context was the one responsible for decision making and not the farmers themselves (Mtshali & Jili, 2022). CTA, (2019); Joffre, Poortvliet and Klerkx, (2019) as cited in Jellason et al., (2021) suggested that there could be need for clustering of famers to improve scalability as there could be better manageability of clusters of farmers compared to individual farmers from the agricultural 4.0 service providers.

Tembo and Maumbe, (2011) as cited in Nkambule et al., (2021), postulates that most commercial farmers utilized the ICT technologies such as drones and satellites because they knew the benefits it came with. Jellason et al., (2021) adds that the utilization of unmanned aerial vehicles (UAV), through smartphone sensor application and the global positioning systems (GPS) in soil mapping (Klerkx, Jakku & Labarthe, 2019; Barret & Rose, 2020; De Clercq, Vats & Biel, 2020; Rose, Wheeler, Winter, Lobley & Chivers, 2021 as cited in Jellason et al., 2021) has also been beneficial to the agricultural activities in the SSA.

Mtshali and Jili, (2022) acknowledges the sentiments of the utilization of advanced robotics, 3D printing and the IoT which has been in use for the collaboration of things like data and drone operations. Despite having approximately 80% of smallholder farmers in Sub Sahara Africa, digitalization has been concentrated to the few commercial farmers (Jellason et al, 2021).

The farmers have, however been engaging in taking initiatives to replace their old equipment to the latest and recent 4IR technologies to boost their production levels and improve efficiencies (Soffel, 2016 as cited in Mtshali & Jili, 2022). Kariuki, (2011), Collier and Dercon, (2009) as cited in Jellason et al., (2021) attributed this to the perception held by other stakeholders that despite their numbers, small-scale holder farmers utilized unconventional methods of farming which were less sustainable for economic purposes of a country. The perception of how small-scale farmers were perceived to be of less value has led to limited support for the small-scale farmers to the adoption of modern technologies and that has had a negative effect on production, in Africa and especially the South African small-scale farmers (Lele & Goswami, 2017 as cited in Mtshali & Jili, 2022).

Gillwald et al. (2019) as cited in Nkambule et al., (2021) cited the past colonial imbalances were the causes of rural farmers' struggles due to the agricultural policies that disadvantaged the black farmers and affected land ownership. This was supported by (Schut, van Asten, Okafor, Hicintuka, Mapatano, Nabahungu, Kagabo, Muchunguzi, Njukwe and Dontsop-Nguezet, 2016 as cited in Jellason et al., 2021) that the rights to land ownership have hampered the sustainable development for the smallholders' farmers to take advantage of the agriculture 4.0 in Africa.

Gillward et al., (2019) as cited in Nkambule et al., (2021) postulates that the utilization of ICT technologies by the commercial farmers was for the maximization of production and not for the replacement of the farmworkers. However, World Health, (2017) argues that despite the augmentation of by artificial intelligence and robotics in pursuit of working conditions improvement, some jobs will become redundant in the service sector and the labour-intensive industries.

Due to the developments that were brought by the 4IR in the agricultural sector with the utilization of drones, electronics, tractors, and several unlimited 4IR technologies, human labour has been rendered irrelevant to some of tasks (Mtshali & Jili, 2022). This was cemented by Lele and Goswami, (2017) as cited in Msthali and Jili, (2022) as they stated that the interaction between technology

and humans have some effects positive and or negative at some point in their lifetime.

Even some of the most qualified personnel will be at risk of having some and or all their jobs replaced by automation and robotics (Mtshali & Jili, 2022). This has prompted the government to be discouraged in the encouragement of 4IR utilization by small-scale farmers, due to the fear of job redundancy in the sector that has a considerable number of people depending on it (Moloi & Marwala, 2020 as cited in Mtshali & Jili, 2022). However, there are possibilities of the formation of a new educational system where current labour will have to upskill and work with robots (Etikan, Musa & Alkassim, 2016 as cited in Mtshali & Jili, 2022) and this might influence the median earnings of most of the workforce (Mtshali & Jili, (2022).

The accessibility to digitalization of agricultural activities is dependent on the number of factors which includes accessibility to the internet services, data, and proper technology (Nkambule et al., 2021). There was a notable digital divide between the rural and urban farmers (Nkambule et al., 2021). However South Africa's 53% of the population has access to internet which has been found to be the highest number of internet users in the Sub-Saharan Africa (Nkambule et al., 2021).

Nkambule et al., (2021) asserts that despite approximately 85% of South Africans having access to a mobile device only approximately 47% owns a smart phone which supports digitalization. They echoed that the digitalization has been viewed to be the backbone of agribusiness in the 4IR era (Nkambule et al., 2021).

There has been a notable number of citizens who had no access to the internet, approximately 47% (Nkambule et al., 2021). Some of the contributory factors noted were cost of the internet, high illiteracy, lack of training and skills to utilize the technology and misinformation (Nkambule et al., 2021). Hansos and Heeks, (2020) as cited in Nkambule et al., (2021) states that despite the digital divide in South Africa, farmers were utilizing some of the latest digital technologies in agriculture.

Those technologies have been used to promote transparency and to hold farmers to account on ecological and ethical issue on their agricultural activities (Gbetibouo & Ringler, 2009 as cited in Nkambule et al., 2021). Acker, (2011) as cited in Nkambule, (2021) alludes that were digital technology was utilized through extension services and information systems both small scale-holder farmers and commercial farmers benefited.

Antwi and Seahlodi, (2011) as cited in Nkambule et al., (2021) states that those digital technologies were directed to commercial, large farmers who had the capability to afford them. Jellason et al, (2021) posits that some of the small-scale holder farmers were exposed to adverse conditions that they lacked financial backup marred by their high illiteracy rate and limited access to financial means to improve production. Mtshali and Jili, (2022) adds that there was a limited number of farmers who had access to financial accessibility to support their digital agricultural activities.

Barret and Rose, (2020) as cited in Jellason et al., (2021) however argued that the digitalization of agricultural activities was perceived as a high capital-intensive exercise and as result it has disadvantaged many small-scale holder farmers to financial accessibility. Lele and Goswami, (2017), Xing and Marwala, (2017) as cited in Mtshali and Jili, (2022) alludes this that there was need to financially include the farmers who were behind to the notion of the 4IR and hasten their accessibility to internet connectivity and the notion of renewable energy. (Nkambule et al., (2021) argues that if those technologies were also accessible to small-scale farmers, they would have a greater impact as the number of these disadvantaged farmers was large.

The utilization of technology in agriculture in the African continent has a possibility of environmental protection, environmental sustainability, and climate change awareness benefits (Cotter, Asch & Editorial, 2020, De Clerq et al., 2020 as cited in Jellason, 2021). CTA, (2019) as cited in Jellason et al., (2021) posits that those technologies have the capability to allow SSA countries achieve Sustainable Development Goals (SDGs) through the reduction of the carbon footprint while there would be an increase in productivity.

Some of those climatic changes have brought water shortages and droughts in most parts of South Africa (Banwell, Rutherford, Mackey & Chu, 2018 as cited in Mtshali & Jili. 2022). Mtshali and Jili, (2022) states that the utilization of drones, satellite, in-field sensors, and mobiles has had an impact on soil monitoring, the management of water, animal and crop monitoring that resulted in less effects of the climate change.

Despite the availability of the technological applications that could boost production there was some scepticism to the readiness of Africa to harness these development (Jellason et al., 2021). Dosso, Nwankwo and Travaly, (2021) as cited in Jellason et al., (2021) alludes that there were less investments channelled towards the digitalization of operations in the African agriculture sector. However, Zantsi, Greyling and Vink, (2019) as cited in Mtshali and Jili, (2022) postulates that there were considerable strides in the South African context towards the improvements of agricultural activities since 1994 to assist both the commercial and small-scale farmers.

In those endeavours to improve agricultural activities for the South African commercial and small-scale farmers, (Calicioglu et al., 2019; Chapman et al., 2016 as cited in Mtshali & Jili, 2022) posits that there was constant formulation of policies for the satisfaction of agricultural activities pursuit needs by government institutions. The departments that have played those crucial roles included the Department of Agriculture, Land Bank, and the Agricultural Research Council (Calicioglu et al., 2019; Chapman et al., 2016 as cited in Mtshali & Jili, 2022).

2.4.1 Digitalization versus technological utilization by small-scale farmers in Gauteng Province.

Ponelis and Holmner, (2015) as cited in Nkambule et al. (2021) postulates that many African countries were being proactive to transition to the global trend of

ICT savvy and transforming into information driven economies. The 2015 data indicated that there was approximately 63% usage of mobile phones in 2103, internet utilization by Africans was at least 16%, the household accessibility to internet was approximately 7% and the accessibility to internet growth per annum was at least 27% per annum (Nkambule et al., 2021).

Nkambule et al., (2021) further asserts that there was an increase of 9% usage of internet between the years 2010 and 2013. Due to the increased penetration of ICT in African countries from the availability of several mobile networks there has been a provision of mobile enabled agricultural services (m-Agric services) (Kleine & Unwin, 2009; Baumuller, 2017; Aker & Mbiti, 2010; World Bank, 2016; Baumuller, 2015; Heeks, 2008 as cited in Emeana et al., 2020).

Due to the increased connectivity, there has been an improvement of accessibility to extension services, agricultural information, and financial services by the rural farmers despite their statuses and or environmental factors (Kleine & Unwin, 2009; Baumuller, 2017; Aker & Mbiti, 2010; World Bank, 2016; Baumuller, 2015; Heeks, 2008 as cited in Emeana et al., 2020).

Maumbe and Okello, (2013) as cited in Nkambule, (2021) states that there was an exponential growth in the ICT sector, this was attributed to the fact that most South Africans had access to a mobile device (Herselman, 2003 as cited in Nkambule et al., 2021). Kyobe, (2011) as cited in Nkambule et al., (2021) however disagreed with the notion of accessibility to mobile communication nationally.

Mtshali and Jili, (2022) posits that the minority of small-scale farmers were the only ones familiar with those agricultural technologies. Nkambule et al., (2021) asserts that due to the increased accessibility most farmers had access to the mobile devices. However, Chetty et al., (2013) as cited in Nkambule et al., (2021) stipulated the inflated cost of data in the African countries versus the world standards as problematic. Despite the availability of the different technological gadgets, (Naicker, 2017 as cited in Mtshali and Jili, 2022) posits that some of the technology was only beneficial to commercial farmers as opposed to small-scale farmers. The argument was based on technologies like genetics and intelligent

irrigation which would need to be practiced on larger scales and that could only be attributable to commercial farmers than small-scale farmers (Naicker, 2017 as cited in Mtshali & Jili, 2022).

The utilization of the ICT gadgets was noted as a helpful channel for farmers to share agricultural information with other stakeholders without the issue of geographic dispensation barriers (Armstrong & Ghandi, 2012 as cited in Nkambule, 2021). Digital utilization was also found to aid in the reduction of gaps and aided in the suppression of inefficiencies such as information sharing, market accessibility, financial accessibility, traceability and trackability for the small-scale farmers (El Bilali & Allahyari, 2018; FAO, 2013; FAO & ITU, 2017; GSMA, 2018; OECD, 2019 as cited in Shmidt & Jokonya, 2021). OECD, (2019) as cited in Shmidt and Jokonya, (2021) further asserts that the technologies that could be used for traceability for supporting the exports by small-scale farmers would be AI and blockchain.

The ease of access to important agricultural information to farmers was cited as an advantage to those farmers who were literate enough to use the ICT technologies without the geographic distribution barriers (Nkambule et al., 2021). The availability of effective and efficient ICT was noted as solution to the lack of information accessibility to farmers (Jayathilake et al., 2010 as cited in Nkambule et al., 2021). Hekkert et al., (2007) as cited in Mtshali and Jili (2022) postulated that the utilization of Network and Information Learning foundations was critical to improve farmers' connectivity.

Mtshali and Jili, (2022) attributed this to the Ghana example were the farmers utilized the social media to link to each other for latest technological advancement updates. There was noted increase to the farmers' productivity, approximately 88% of the farmers' population, and those results were driven by information sharing from ICT channels (Weir & Knight, 2000 as cited in Mtshali & Jili, 2022). The group of farmers with whom they lacked the ability to transmit and receive agricultural information, were small-scale farmers (Pretty, 2018 as cited in Mtshali a& Jili, 2022).

2.4.2 Small-scale farmers on the issues pertaining to digitalization adaptation in Gauteng Province.

These issues stemming from traditional farming to the technologically driven changes in the agricultural realm could affect the disadvantaged (Qiang et al., 2012 as cited in Nkambule et al., 2021). However, the Green Revolution tried to address the adverse challenges to the disadvantaged, and those challenges since the Green Revolution's inception in the 1990s (Pingali, 2012 as cited in Nkambule et al., 2021).

Despite the inception of the Green Revolution farmers still experienced huge losses (Bruinsma, (2003), hence Nkambule et al., (2021) asserts that there was need for farmers to get most relevant information and innovative ideas. Fagerlind and Saha, (2016) as cited in Nkambule et al., (2021) echoes that to address some of the challenges in the agricultural sector, education would be the starting point.

The education would be directed to the farmers for them to be able to access the relevant information required such as weather information, market information, pest control information etc (Munyua et al., 2009 as cited in Nkambule et al., 2021). Syiem and Raj, (2015) as cited in Nkambule, (2021) adds that despite the potential benefits connected to the usage of ICT, the trend to utilize this technology was still new in the African context.

Nkambule et al (2021) states that despite the advent of ICT, most rural farmers lacked accessibility to this technology. However small-scale farmers were viewed as laggards in general to the technological innovations in the agricultural activities (King, 2017 as cited in Mtshali & Jili, 2022). Fuglie, Gautam, Goyal, and Maloney, (2020); Jellason, Conway and Baines, (2020) as cited in Jellason et al., (2021) adds that there could also be resistance to the adoption of the technological innovations from the users due to lack of knowledge.

This could be exacerbated by the low literacy levels, inability to communicate and reluctancy of rural farmers to shift from the traditional to the newer technological methods of farming (Abdullah & Samar, 2013 as cited in Nkambule, 2021).This sentiment was echoed by (Monteleone, Moraes and Maia, 2019 as cited in

Jellason et al., 2021) who denoted that there was high likelihood that younger farmers were likely to utilize technology in their farming expeditions.

However (Pogorelskaia and Varallyai, 2020 as cited in Jellason, 2021) noted that ICT skills were a prerequisite to fully exploit agricultural activities by the farmers in general. Gassner et al., (2019) as cited in Msthali and Jili (2022) adds that small-scale farmers however did not have the technological expertise to harness the digitalization of operations and improve production for self-sustenance. Jellason et al., (2021) juxtaposed the nexus between illiteracy and the skills in the management of data gathered as an obstacle to agriculture 4.0 adoption.

However, there could be some ways that could be used to address such issue. Jellason et al., (2021) posits that the policymakers, academia, technological suppliers, and manufacturers will need to educate the African population at large of the benefits of those technologies stressing the points that they are for environmental and social enrichment despite productivity and efficiency. Mtshali and Jili, (2022) alludes those technological innovations would have a great deal of contributory factors to societal issues. Mtshali and Jili, (2022) adds that due to the digitalization of operations in the agricultural sector it has prompted a noticeable improvement to the environment and the farmers' working conditions.

However, Barret and Rose, (2020) as cited in Jellason et al., (2021) argues that this move could be problematic as most of those technologies were not spread evenly across the globe making it difficult for other stakeholders especially the disadvantaged small-scale rural farmers to understand them. The applicability of cheap equipment however has enabled advanced analytics to the digitalization of agriculture due to the 4IR, bringing the IoT in the sector through ICT utilization for those farmers who have implemented it (Calicioglu, Flammini, Bracco, Bellu & Sims as cited in Mtshali & Jili, 2022).

Language barrier could be another drawback to the utilization of ICT since most of the services were facilitated in English were in the rural areas as most of the rural farmers were familiar with their native languages (Best & Mier, 2007 as cited in Nkambule et al., 2021). Despite the language barrier there were other challenges that the rural areas were faced with to effectively and efficiently

access ICT which were infrastructural i.e., roads, electricity, network availability etc (Phiri et al., 2019; Munyua et al., 2009 as cited in Nkambule et al., 2021).

The developmental gap between the rural and urban areas was noted as problematic especially the rural areas where not much developmental attention was channelled (Nwagwu, 2006 as cited in Nkambule, 2021). Fielke, Garrard, Jakku, Flemming, Wiseman, and Taylor, (2019) as cited in Jellason et al., (2021) asserts that those technologies have a possibility of bringing negative effects despite the intended application to improve food security and improve agricultural sustainability.

2.4.3 Perceived relationship between barriers to digitalization by small-scale farmers' and the adoption and adaptation gaps in Gauteng Province.

2.4.3.1: Alternative Hypothesis.

-There could be a notable gap between the adoption of digital technologies by commercial farmers and small-scale farmers in the in Gauteng Province.

-There could be a positive impact on agricultural harvest through the adaptation of digital technologies by small-scale farmers in Gauteng Province.

H3. There is a notable gap of digitalization for the small-scale farmers compared to commercial farmers in Gauteng Province.

H4. Digitalization has a positive impact on agricultural harvest for small-scale farmers in Gauteng Province.

2.5 ANALYTICAL FRAMEWORK

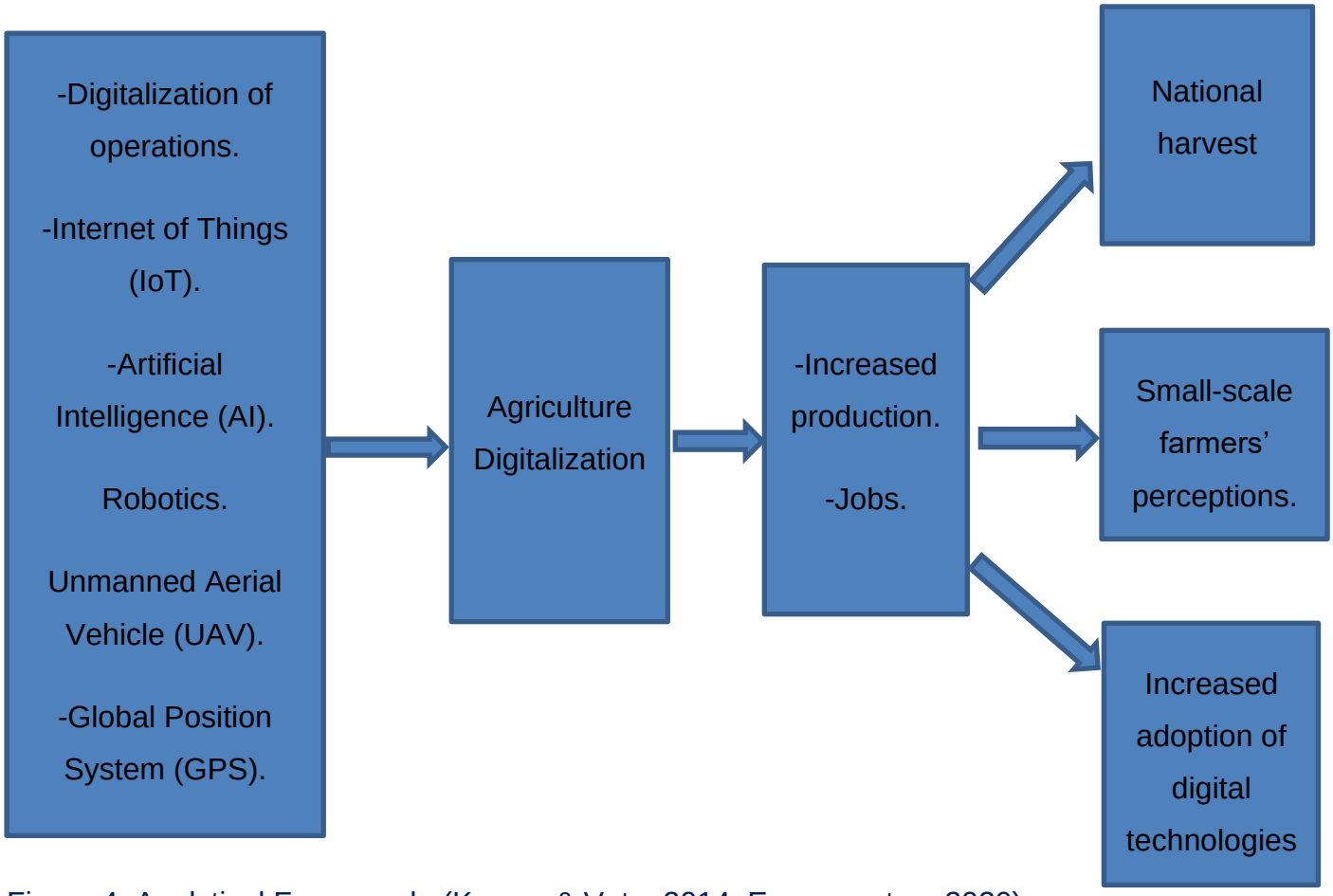


Figure 4. Analytical Framework. (Komza & Vota, 2014. Emeana et a., 2020).

2.5.1 Theoretical Framework

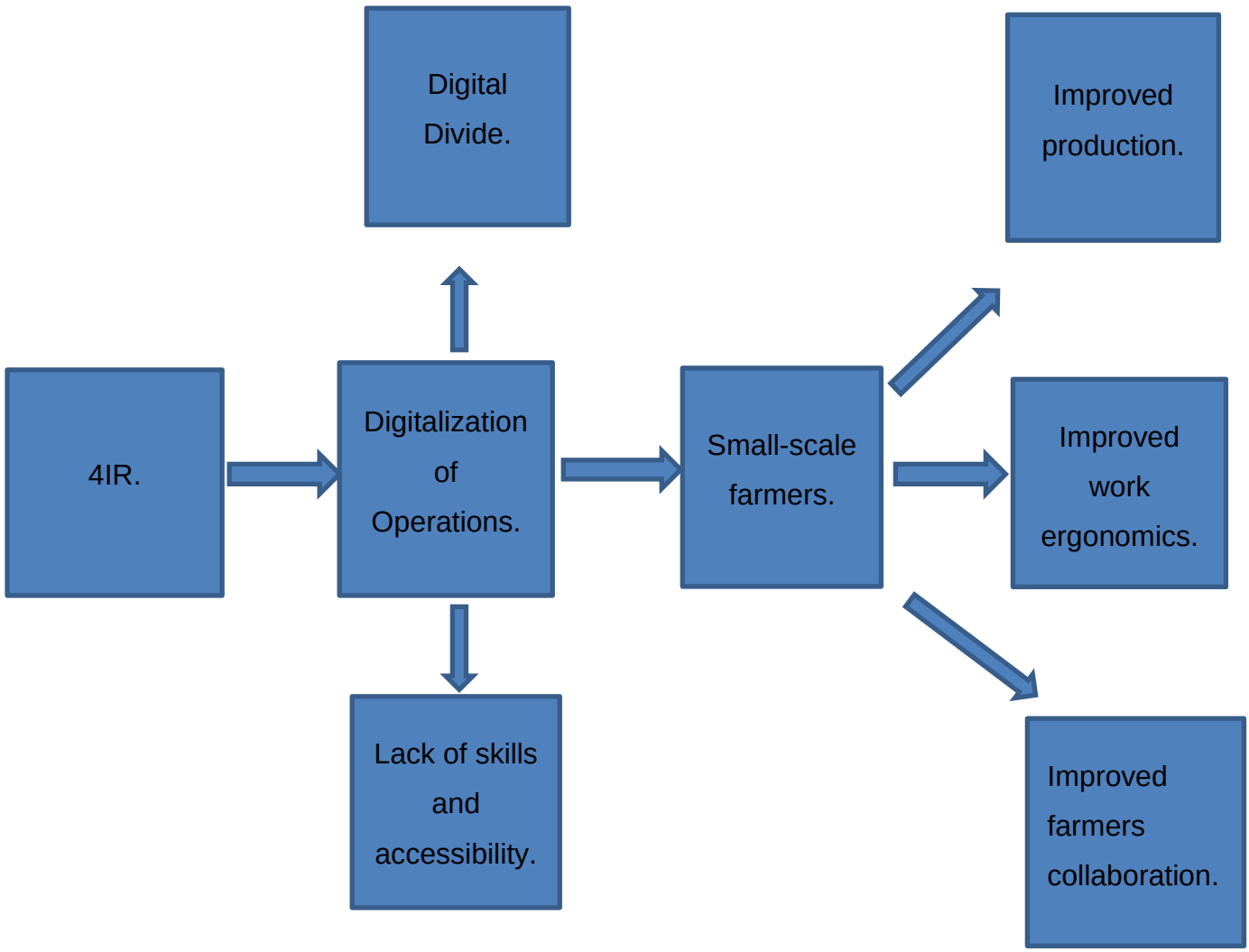


Figure 5. Theoretical Framework (Nkambule et al., 2021, Jellason et al., 2021, Mtshali & Jili, 2022).

2.5.2 Conceptual Framework

Depicted below in Figure 4 is the conceptual framework that shows the hypotheses for the study.

The framework gives a brief overview of what the study will be looking into, and the perceived impact of digitalization and the barriers to adoption of the digital technologies by the small-scale farmers in Gauteng Province.

The perceived impact of digitalization to food production and the perceived adaptation by small-scale farmers on the digitalization in the agricultural sector in Gauteng Province, socio-economic and political sphere.

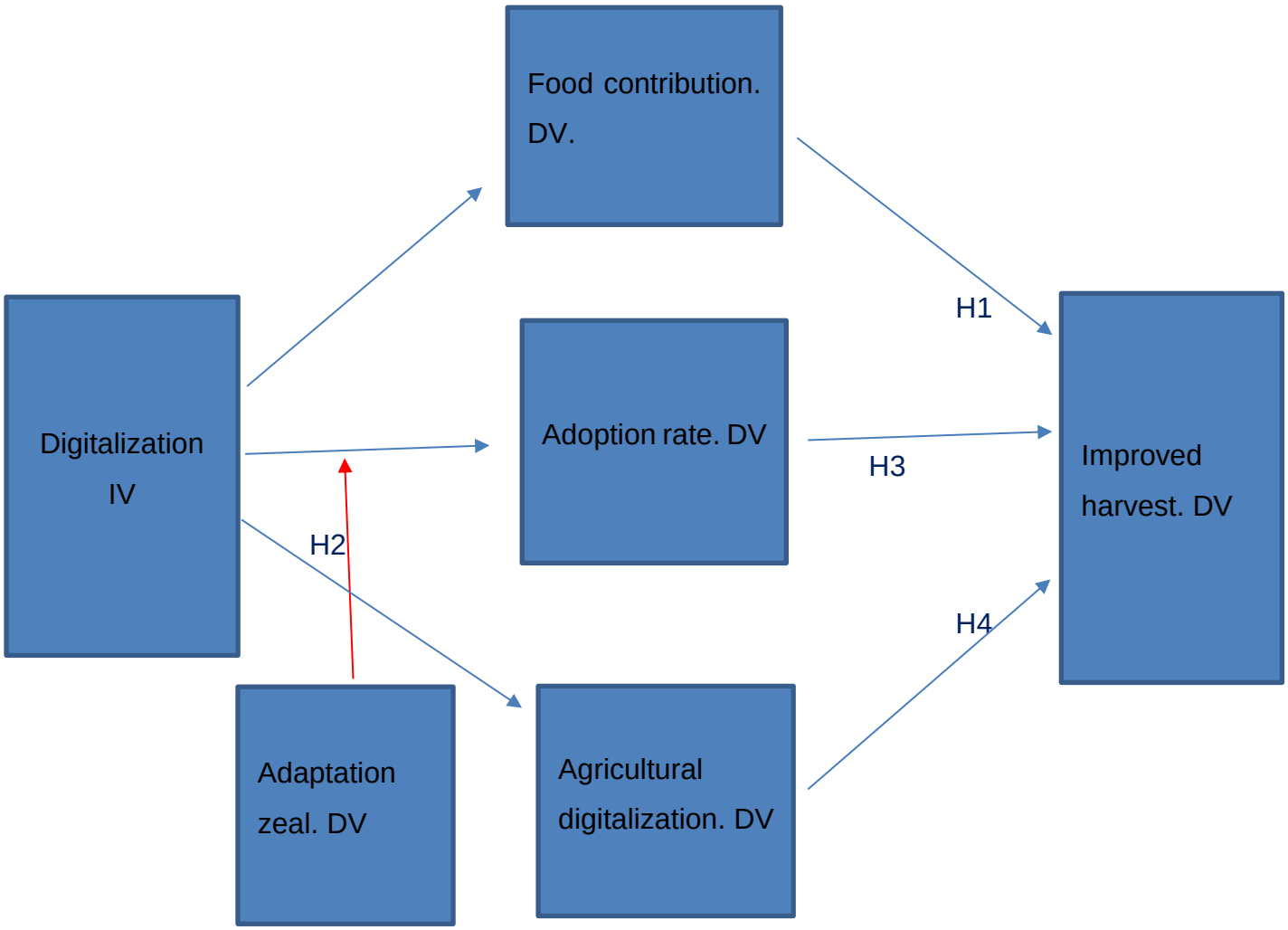


Figure 6. Conceptual framework.

2.6 Conclusion of Literature Review

Despite being a laggard in the 4IR era, in the agricultural sector there has been quite a considerable improvement in the utilization of 4IR technology. There has been a considerable utilization of technologies like robotics, IoT, big data analytics, automation, 3D etc. The trend showed that there was an element of correlation to digitalization and the boost of production. The boost of production contributed to the food basket of any country involved in the digitalization of

operations of its agricultural activities. There were some pronounced elements of digital divide amongst the stakeholders, which ranged from lack of accessibility to the technology, inability to harness the technology due to the level of education, lack of infrastructure to support the technology etc.

Most researchers have shown some degree of agreement to the issue of digitalization and thereof the contribution to the food production viz a viz food security improvements. However, there was not much literature that indicated that the digitalization in agriculture had an impact on the GDP. However, given the definition of GDP utilized in this research, it was assumed that an increased efficiency and or effective agricultural production due to digitalization of operations, within the agricultural sector, to that effect will be attributed to the GDP positivity and vice versa.

The small-scale farmers' views were noted as a melting pot, as some had shown positive feedback towards digitalization while some showed negative perceptions. Based on the literature reviewed there were more positive feedback towards digitalization in the agricultural sector compared to the negative feedback. However, the stakeholders with whom were most negatively affected were the small-scale farmers, despite their massive participation in the agricultural sector.

After some due diligence, the following research questions were formulated in an endeavour to address some of the challenges found within the agricultural sector.

2.6.1 Hypothesis

H1. Small-scale farmers in Gauteng Province are of importance towards the contribution to food production through digitalization.

H2. Small-scale farmers are not well established to adopt and adapt to digitalization of operations in Gauteng Province.

2.6.2 Hypothesis

H3. There is a notable gap of digitalization for small-scale farmers compared to commercial farmers in Gauteng Province.

H4. Digitalization has a positive impact on agricultural harvest for small-scale farmers in Gauteng Province.

CHAPTER 3. RESEARCH METHODOLOGY

Outlined in this chapter was the how the research was conducted from data collected and sampled through the questionnaire. This was done by the application of research approach and research design coupled with the limitations of the study.

3.1 Research approach

A quantitative research methodology was utilized for this research. The data was therefore nominal and ordinal data; hence the research utilized the questionnaire with a Likert-Scale that had seven responses (Josh et al., 2015). Ranging from strongly agree to strongly disagree.

The method that used was correlational research to try and establish the relationships between the digitalization versus the perceived barriers and the digitalization versus the improvement of food production (Ratner, 2009). Descriptive research was utilized to establish the small-scale farmers' adoption and adaptation rates towards the digitalization in the Gauteng agricultural sector.

This research was utilized as it tried to establish factual correlations between the subjects that were being investigated. Quantitative research methodology is based on the objectivity of the matter under investigation hence that was the chosen methodology.

3.2 Research design

This research adopted the descriptive research method as it was able to accurately portray the small-scale farmers' characteristics (Akhtar,2016). This portrayed the small-scale farmers' characteristics towards the digitalization in the agricultural sector. However due to the limitations of the descriptive methodology from its inability to explain the nexus between variables (Akhtar, 2016).

The theory- grounded was used for fortification of the research to try and establish the nexus between digitalization of operations versus improved harvest and digitalization versus perceived barriers (Akhtar, 2016). According to literature and previous studies it has been proven that descriptive research is the best in accurate portrayal of stakeholders' characteristics. Hence descriptive research was utilized for this research to get as accurate results as possible for the research.

3.3 Data collection methods

Secondary data was utilized to analyse the impact of agricultural activities to the food production of South Africa. The secondary data was accessed from the Stats Sa, from previously gathered data.

Primary data was also utilized from the questionnaires that were distributed to the research respondents. The primary data included information collected from the small-scale farmers. This information was in the form of responses from the statements on the questionnaires. This research investigated subjects that were in Gauteng hence the distribution of questionnaires was feasible and data collection was a little bit easier.

3.4 Population and sample

3.4.1 Population

The population that was included in this research included small-scale farmers who were currently actively participating in the agricultural activities.

3.4.2 Sample

The sample will be composed of small-scale farmers. The sample that will receive the questionnaires will be at least 200 to 300 respondents. The sample will be part of the small-scale farmers in the Gauteng region who will be actively participating in the agricultural activities.

Table 4. below indicates the sample to be analysed to try and establish relevant results from the study.

Designation of participants.	Number of respondents.
Small-scale farmers	200 - 300

Table 4. Targeted Sample Size.

3.4.3 Sampling method

Due to the nature of the study which will be geographically dispersed, the cluster sampling will be utilized. Davis, (2005) as cited in Taherdoost, (2016) asserts that cluster sampling could be utilized to subjects that are widely geographically distributed as this could save money and time.

Clusters sampling will allow the population to divided into clusters thereof samples will be collected from those clusters (Wilson, 2010 as cited in Taherdoost, 2016). This method will be used as it will be suitable for the set up under investigation given that the farming activities within Gauteng context is quite dispersed geographically.

3.5 The research instrument.

The questionnaire will be utilized as an instrument for this research. It will be a 7 Scale-Likert questionnaire. The questionnaire will include the following responses strongly disagree, disagree, somewhat disagree, either agree or disagree, somewhat agree, agree, and strongly agree (Josh et al., 2015).

The questionnaire will include questions pertaining to the accessibility of small-scale farmers in Gauteng province to any ICT infrastructures. Ability to utilize digital technologies to activities that involve small-scale farmers 'daily activities in Gauteng Province. Level of understanding from small-scale farmers in Gauteng province to operate the latest digital technologies in their agricultural activities.

Since some of the participants will include small-scale farmers who will be illiterate, some provision will be put in place to explain to them what they will be required to do and why they will be doing it in their familiar language. This will be facilitated by the other stakeholders who will help with interpretations if necessary. The other stakeholders who are literate will receive their questionnaires via the internet through emails.

This instrument will be utilized as the subjects under investigation are geographically dispersed and questionnaires will be easier to distribute, hence this instrument will be utilized.

3.6 Procedure for data collection

The data for this study will be collected by the utilization of a questionnaire. Some questionnaires will be distributed to all the participants via email, while the others will be distributed manually. The questionnaires will be distributed via the Google Forms or Qualtrics to the intended participants who will be presumed to be literate enough to respond via emails.

After the distribution to those questionnaires the small – scale farmers who will be presumed to be illiterate, will be helped to understand the information on the

questionnaires. This information will be explained to them, and they will be helped to answer the questionnaires through interpretation and help in their language of choice.

The procedure will be done as transparent as possible to try and get the most honest answers from the participants, especially from the participants that will require help on the interpretation of the questionnaires. This method will be utilized as it will be easier to reach out to the small-scale farmers that will be subject to the research.

3.7 Data analysis strategies and interpretation

The data for this study will be analysed using the correlation coefficient and the regression methodologies.

3.7.1 Correlation Coefficient

Ratner, (2009) posits that the correlation coefficient was invented by Karl Pearson in the year 1896. Despite the formula being so ancient it is still relevant in the 21st century it is widely used by many researchers (Ratner, 2009). The correlation coefficient intervals range from +1 to -1, where it indicates the relationships between two variables in a linear format (Ratner, 2009).

The interpretations of the correlation coefficient are that 0 shows no relationship (Ratner, 2009). Ratner, (2009) states that +1 shows absolute linear correspondence depicted by the increase in one variable its effect causes the other variable to increase in the exact same direction. Contrary -1 shows the opposite as one variable increases the other decreases parallel to the other variable in the opposite direction (Ratner, 2009).

Ratner, (2009) alludes that 0 and 0.3 (0 and -0.3) depicts a weak positive (negative) relationship, 0.3 and 0.7 (0.3 and -0.7) depicts a moderately strong positive (negative) link, while 0.7 to 1 (-0.7 to -1) shows a positive (negative) interconnection. However, the relationship between the variables needs to be

linear to give more accurate results, and if not linear the results maybe inconclusive or nonetheless worthless (Ratner, 2009).

3.7.2 Linear Regression Analysis

According to Tranner, Murphy, Elliot and Pampaka, (2020) the estimation link between two variables where y is the response variable and x is the explanatory variable is termed regression. Tranner, Murphy, Elliot and Pampaka, (2020) posits that linear regression is a tool that researchers can utilize to make predictions through data analysis from modelled data. In linear regression an equation is used to make predictions between variables plotted on a scatter graph with x-axis and y-axis (Tranner, Murphy, Elliot & Pampaka, (2020).

3.8 Possible limitations and challenges of the study

The study will investigate the Gauteng situation the small-scale farmers.

-The study will utilize the primary data to interpret the perceived barriers to digitalization in the agricultural sector by small-scale farmers of Gauteng.

- English will be used as a medium of communication and this will affect the interpretation due to the level of understanding from the other small-scale farmers who will need help in the interpretation of the questionnaire.

-The study will investigate the small-scale farmers who will be actively participating in agricultural activities.

- The study will not be able to reach the rest of the South African areas due to other constraints that will be beyond this study’s reach.

3.9 Quality Assurance

According to Storey, Briggs, Jones, and Russell, (2011) the acceptable status of a service, product and or result after planned and systemic action could be attributable to quality assurance. ISO, (1994) as cited in Storey et al., (2011) adds that those activities will be the total required to achieve that specific standard which will be deemed as acceptable. This study will utilize the external validity, reliability, and internal consistency from previous research to establish its quality assurance for this study.

3.9.1 External validity

The Gauteng case will be compared to the other cases in the similar context, for external validity based on the literature reviewed. The generalisability will be maximized through the utilization of several of the cases that were like the Gauteng case. Examples will include Alzerbaijani case (Valiyev et al., 2021). Given the other proven cases prior this study, this study will fulfil its required determination.

3.9.2 Internal validity

To enable internal validity the questionnaires will be utilized across board without taking into consideration of literacy levels. This will enable honest responses based on the understanding of the concept under investigation from the various small-scale farmers involved.

3.9.3 Reliability

The reliability of the study will be tricky to establish. This will be due to bias from respondents, level of understanding of the questions from the questionnaires

especially from the respondents who will require interpretation. However, to achieve a near reliability for the study respondents will be given a chance to freely ask questions, and this will be achieved by encouraging the respondents to ask any question without fear of embarrassment. In short no question from the respondents will be taken as a silly and or foolish. All the questions will be treated with the same weight of importance.

3.10 Ethical considerations

-All small-scale farmers will sign consent forms to give consent to participate in the research.

_ This research will be used by other researchers in future to further what it will seek to establish and or to critique it for the betterment of the topic in question, and this will happen without any party facing victimization from the researcher.

-The respondents will be given provision to withdraw at any time when if they will no longer be interested in participating in the research and they will be given assurance that their withdrawal from the study will not incur any punishable penalty.

-The respondents will be assured of confidentiality of their information and that the information gathered will be solely used for this research only.

-This research will not utilize any form of experimentation that will affect life of any kind be it animals or humans.

-This research will respect all forms of stakeholder involvement and any negative impact to any organization and or individual will be withdrawn.

-The researcher will reference all the work utilized in this research to prevent plagiarism and the research will be submitted via turn it in to check for any form of plagiarism and a plagiarism declaration form will be signed.

- The information for all the respondents will be kept confidentially and not distributed to third parties for any other use besides the research in question.

-The researcher will not utilize the collected data for monetary benefits besides its intended use for this research only.

CHAPTER 4. PRESENTATION OF RESULTS

4.1 Introduction

Chapter four of the research report shows the breakdown of results to test the hypotheses formulated to confirm. The results for the first and second hypotheses were be presented, followed by the third and fourth hypotheses presentations. The summary of results followed the hypotheses testing.

4.2 Demographic profile of respondents

4.2.1 Sample size

The sample size that was targeted initially for the study was 300 small-scale farmers in and around Gauteng Province. The questionnaire was distributed to over 400 small-scale farmers using emails, however there was poor response from the small-scale farmers. Only 42 responded and out of the 42, 1 was not a small-scale farmer and did not reside in Gauteng Province and the other 1 did not complete the questionnaire completely, hence only 40 responses in total were used for the study.

While gathering data, it was noted that some of the small-scale farmers did not have any email addresses. This was attributed to illiteracy, old age, lack of infrastructure and other outskirts places difficult to reach in Gauteng Province among other things. According to age group percentages of participants 18-24 years was 2.3%, 25-34 years was 26.19%. 35-44 years was 42.85%, 55-54 years was 23.8% and 65 years and above was 4.76%.

The age of the sample was dominated on the first position by 35-44 years old, second position 55-54 years old, third 25-34 years old, fourth 65 years and older and fifth 18-25 years old.

The age groups that responded to the questionnaire are depicted in the below table.

Table 5. Actual Sample Size.

AGE GROUP	NUMBER OF PARTICIPANTS
18-24 Years.	1
25-34 Years	11
35-44 Years	18
55-54 Years	10
65 Years +	2

According to Louangrath, (2017) sample size is a crucial component of any research as it is responsible for the fair representation of the population as well as a well-organized way of population studies. Memon, Ting, Cheah, Thurasamy, Chuah and Cham, (2020) further cements the need to have sufficient sample to have meaningful results that will be a representation of the entire population. Fair representation reduces bias while well-organized sample saves material for research, (Louangrath, 2017). According to Freiman et al., (1986) and Thornley and Adam, (1998) as cited in Louangrath, (2017) there is a risk of having a Type I and or Type II error due to insufficient sample.

Amongst researchers there are various opinions about how big a sample should be. According to Yamane, (1967) as cited in Louangrath, (2017) 83-400 would be sufficient, while (Kish, 1967 as cited in Louangrath, 2017) suggests that 30-200 will work, and on the other hand (Sudman, 1976 as cited in Louangrath, 2017) states that 100 will be good enough.

According to Roscoe, (1975) as cited in Memon et al., (2020) a sample size greater than 30 and equal to or less than 500 should be sufficient. This was supported by Kreft, (1996) as cited in Memon et al., (2020) that a 30/30 rule with a sample of 30, should derive relevant results from a study. Kline, (2005) as cited in Memon et al., (2020) states that a sample of 100 would be small, while 100-200 would be medium and over 200 would be too large.

According to Budiu and Moran, (2021) in quantitative research a sample of 40 should be enough to get the representation of the population that a researcher is looking into. Field, (2009,2103) as cited in Galawe, (2017) posits that 10-15 participants would be enough for analysis, while (Kass & Tinsley, 1979 as cited in Galawe, 2017) alludes that 10-15 participants per variable would suffice, however they add that this number could reach up to 300. On the other hand, Hair, Anderson, Tatham and Black, (1995) as cited in Galawe, (2017) states that a researcher can utilize the 20:1 ratio.

4.3 Results pertaining to Hypothesis 1 and Hypothesis 2

Hypothesis 1.

Small-scale farmers in Gauteng Province are of importance towards the contribution to food production through digitalization.

Regression Statistics	
Multiple R	0,98297389
R Square	0,96623766
Adjusted R Square	0,96226562
Standard Error	2,21482931
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	4773,214058	1193	243,26	1,67707E-24
Residual	34	166,7859415	4,905		
Total	38	4940			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept		-8,10329922	1,211521701	-6,689	1,1E-07	-10,5654075	-5,641191	-10,565408	-5,6411909
	1	3,48181197	0,837858897	4,156	0,00021	1,779077824	5,184546	1,77907782	5,18454611
	1	1,95971284	0,899650249	2,178	0,03641	0,131403561	3,788022	0,13140356	3,78802212
	1	2,40385373	0,621389451	3,869	0,00047	1,14103843	3,666669	1,14103843	3,66666903
	1	-1,29438946	0,97394338	-1,329	0,19269	-3,27368055	0,684902	-3,2736806	0,68490162

Table 6. Hypothesis 1, Regression Statistics.

According to the results R Square was 0.966 which indicated that 96% of the data explained the model that was utilized. The observations were greater than 30 that made the study significant. The probability value was 0.000 which was less than the alpha value of 0.05. The alternative hypothesis was supported based on the results that were produced, therefore small-scale farmers do contribute towards the food production through digitalization.

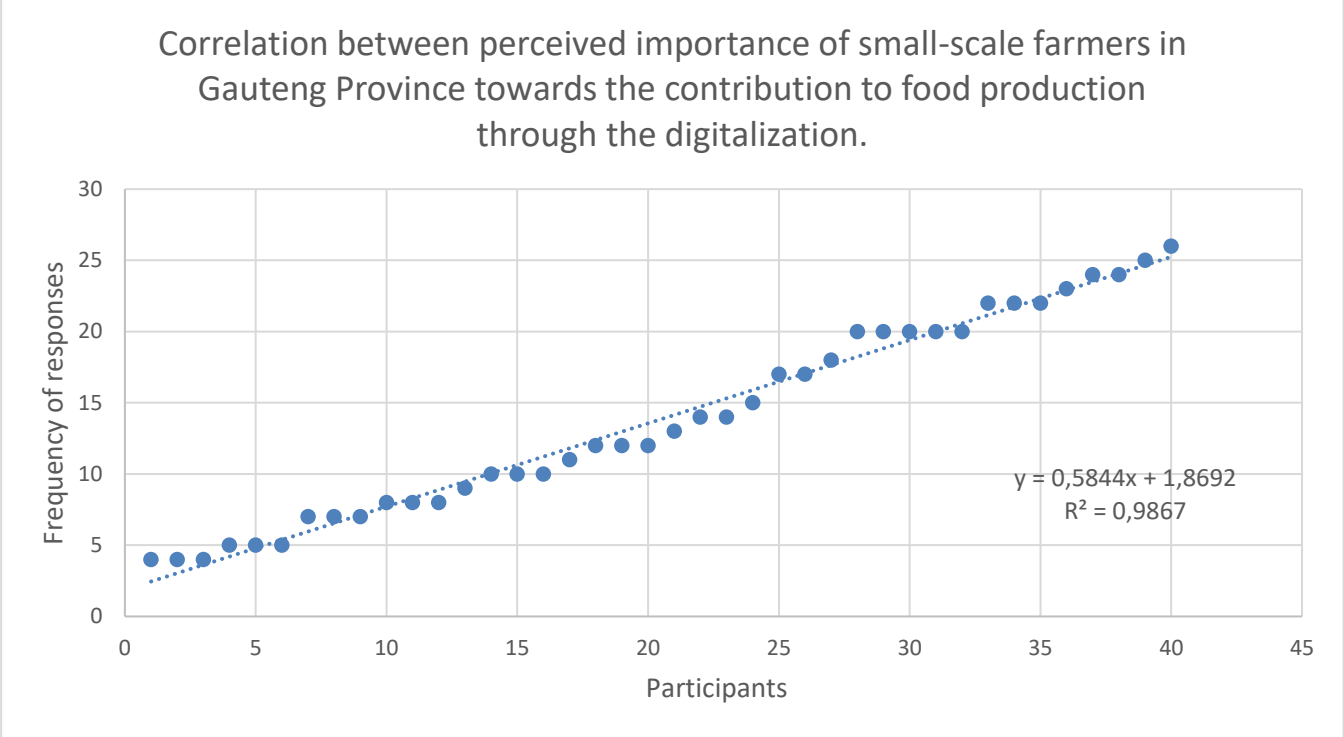


Figure 7. Hypothesis 1, Correlation Plot.

The correlation that was depicted by the above results was r = 0.99. This according to the Pearson correlation coefficient indicates that there is a very strong correlation between the variables under scrutiny. The points on the trendline were close to the points plotted on the correlation graph hence the correlation resembled almost a true correlation.

Hypothesis 2.

Small-scale farmers are not well established to adopt and adapt to digitalization in Gauteng Province.

Regression Statistics	
Multiple R	0,99482958
R Square	0,98968589
Adjusted R Square	0,98847246
Standard Error	1,22416486
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*

Regression	4	4889,048294	1222	815,61	3,02E-33
Residual	34	50,95170636	1,499		
Total	38	4940			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept		-2,9778252	0,506578248	-5,88	1E-06	-4,007316	-1,948334	-4,0073161	-1,9483343
	1	2,3082002	0,428594198	5,386	5E-06	1,437192	3,179208	1,43719199	3,1792084
	1	2,09147059	0,53192646	3,932	0,0004	1,010466	3,172475	1,01046596	3,17247521
	1	1,63723137	0,38855305	4,214	0,0002	0,847597	2,426866	0,84759657	2,42686617
	1	0,5475052	0,567354711	0,965	0,3414	-0,605498	1,700509	-0,6054983	1,70050869

Table 7. Hypothesis 2 Regression Statistics.

The results depicted above showed R Square 0.98 which indicated that 98% of the data represented what the model tested for, hence the model used was good enough. The number of observations was 39 variables above the 30 variables recommended when a researcher utilizes the quantitative methodology. The probability value was 0.000 smaller than the alpha value of 0.05, hence the alternative hypothesis was endorsed. This was depicted by how the dependent variable which was the adaptation zeal was influenced by the independent variable which was digitalization.

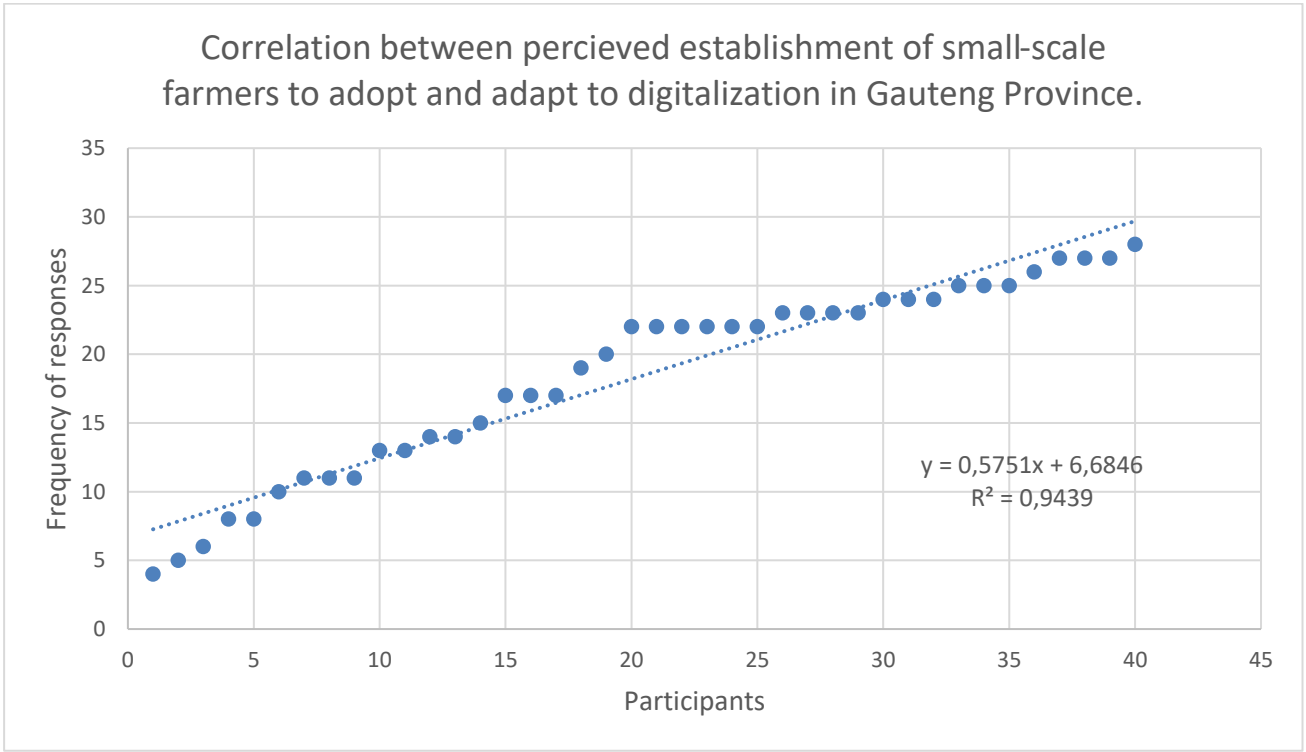


Figure 8. Hypothesis 2, Correlation Plot.

The correlation depicted above was r = 0.97. This was a positive very strong correlation relationship between the variables that were under investigation. However, the trendline did not touch all the other points plotted on the graph so the correlation was not a true reflection of correlation.

4.4 Results pertaining to Hypothesis 3 and Hypothesis 4

Hypothesis 3.

There is a notable gap of digitalization for small-scale farmers compared to commercial farmers in Gauteng Province.

Regression Statistics	
Multiple R	0,9924948
R Square	0,9850459
Adjusted R Square	0,9832866
Standard Error	1,4740211
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	4866,126906	1216,5	559,91	1,6596E-30
Residual	34	73,87309407	2,1727		
Total	38	4940			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept		-4,630659	0,91197788	-5,078	1E-05	-6,48402095	-2,777297	-6,484021	-2,7772969
	1	1,5739806	0,584416323	2,6933	0,0109	0,386303741	2,7616575	0,3863037	2,76165747
	1	2,3610208	0,481252457	4,906	2E-05	1,382998156	3,3390435	1,3829982	3,33904348
	1	2,1631986	0,415174541	5,2103	9E-06	1,319462399	3,0069348	1,3194624	3,00693476
	1	0,2162024	0,616017026	0,351	0,7278	-1,0356948	1,4680996	-1,0356948	1,46809964

Table 8. Hypothesis 3, Regression Statistics.

Based on the results displayed above the R Square was 0.98 which indicated that 98% of the data was indeed tested by the model, making the model suitable

for the test conducted. The probability value was 0.000 and this value was less than the alpha value of 0.05, this notion supported the alternative hypothesis to be true. The observations were above the 30 variables mark which is normally the recommended number for quantitative research methodology. This was supported by the impact the independent variable which was digitalization displayed towards the dependent variable which was the adoption rate.

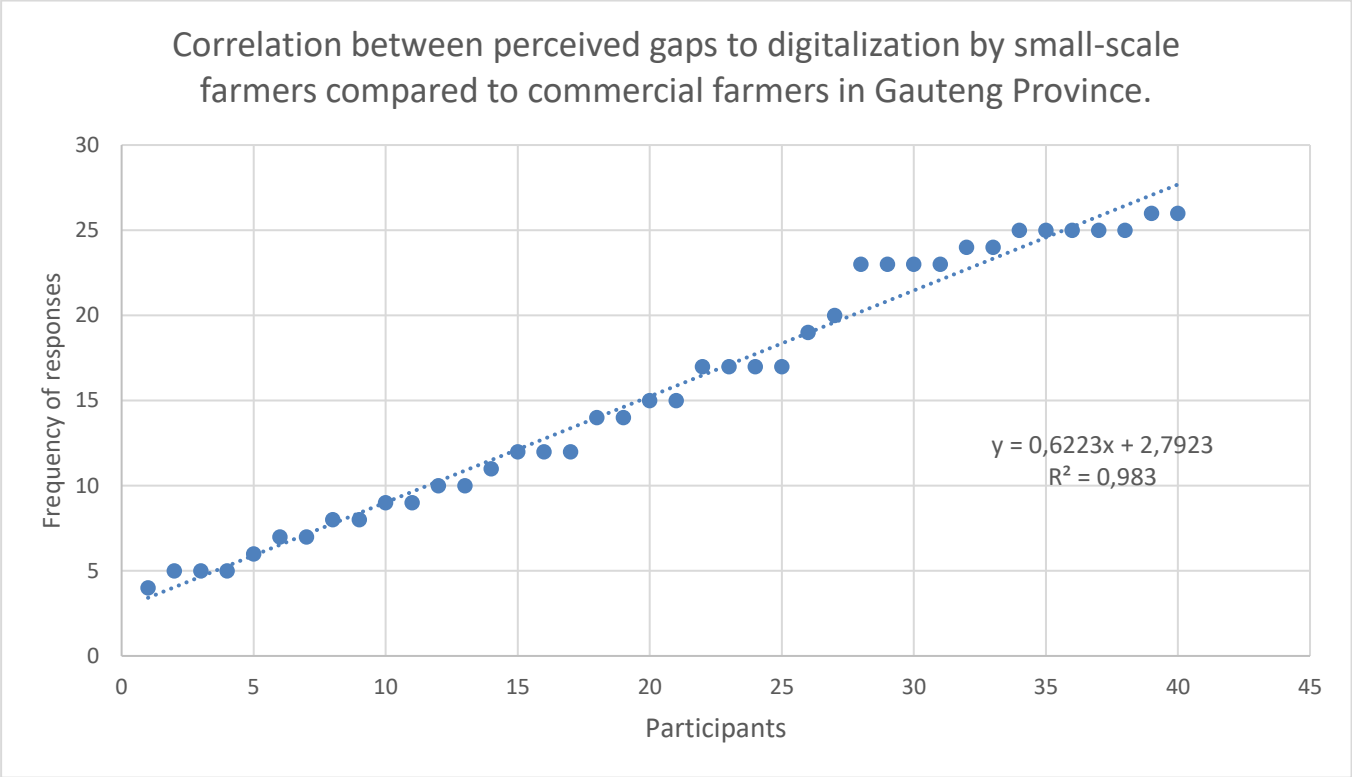


Figure 9. Hypothesis 3, Correlation Plot.

The correlation coefficient indicated above was r = 0.99. This result was a very strong correlation according to the Pearson correlation coefficient scale. The plotted dots on the graph were close to the trendline hence this indicated that the depicted results were a true reflection of the correlation displayed.

Hypothesis 4.

Digitalization has a positive impact on the agricultural harvest for small-scale farmers in Gauteng Province.

Regression Statistics	
Multiple R	0,9829257
R Square	0,9661429
Adjusted R Square	0,9621597
Standard Error	2,2179343
Observations	39

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	4	4772,746092	1193,187	242,56	1,75872E-24
Residual	34	167,2539084	4,919233		
Total	38	4940			

		Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95,0%*	*Upper 95,0%*
Intercept		0,6488299	1,384034253	0,468796	0,6422	-2,16386607	3,461526	-2,1638661	3,46152596
	1	3,0694955	1,366938761	2,245525	0,0313	0,29154172	5,847449	0,29154172	5,8474493
	1	0,4278801	0,265529143	1,611424	0,1163	-0,11173999	0,9675	-0,11174	0,96750029
	1	-0,3218849	0,292862338	-1,0991	0,2794	-0,91705274	0,273283	-0,9170527	0,27328302
	1	2,2402544	1,380720119	1,622526	0,1139	-0,56570645	5,046215	-0,5657064	5,04621531

Table 9. Hypothesis 4, Regression Statistics.

The above results depicted the R Square of 0.96 an indication that 96% of the data represented the model that was used to test the hypothesis. An observation of 39 variables was noted which is above the 30 variables as recommended. The probability value was 0.000 less than the alpha value of 0.05, hence the alternative hypothesis was supported. The independent variable which was digitalization described the relationship towards the dependent variable which was agricultural digitalization.

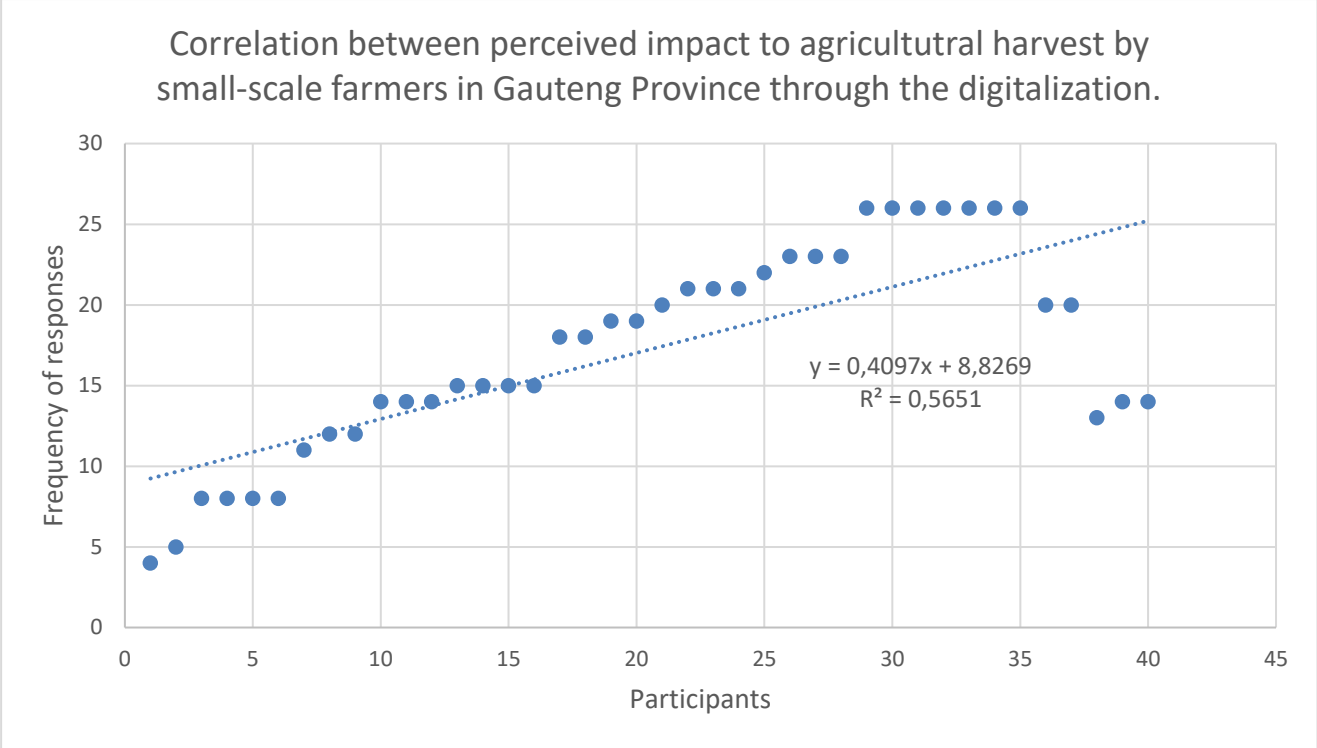


Figure 10. Hypothesis 4, Correlation Plot.

The results depicted in the above correlation graph was r = 0.74. The correlation depicted was a positive strong correlation. The trendline and the plotted dots were not in line, hence the correlation of these results were questionable.

4.5 Summary of the results

According to the results portrayed above, the alternative hypotheses have been proved to be true. It should however be noted that based on the correlation coefficient results even though they mainly ranged from strong to very strong there was no evidence that correlation was because of causation. However, there is some evidence that digitalization does have an effect in the way most small-scale farmers employed their agricultural techniques.

The study utilized 40 variables from the questionnaire that were distributed, however when data analysis was conducted the tests picked 39 observations.

This was attributed to the random missing data in the data that was collected, and as a result the 39 observations were utilized.

During data collection it was noted some of the small-scale farmers did not have email addresses, hence the small-scale farmers that mainly answered the questionnaire were the one in proximity to towns within Gauteng Province. Some of the small-scale farmers were illiterate that they did not understand anything about digitalization and the 4IR concept. Unfortunately, these small-scale farmers could not be included in the study.

The respondents who participated in the study supported all the hypotheses as depicted in the table below. These results depicted below mainly shows the inputs of those small-scale farmers who were close to towns in and around Gauteng Province.

Table 10. Alternative Hypotheses Results.

Number	Alternative Hypothesis	Results
1	Small-scale farmers in Gauteng Province considered are of importance towards the contribution to food production through the digitalization.	Supported
2	Small-scale farmers are not well established to adopt and adapt to digitalization in Gauteng Province.	Supported
3	There is a notable gap of digitalization for small-scale farmers compared to commercial farmers in Gauteng Province.	Supported

4	Digitalization of operations has a positive impact on the agricultural harvest by small-scale farmers in Gauteng Province through the digitalization.	Supported

CHAPTER 5. DISCUSSION OF THE RESULTS

5.1 Introduction

This study investigated the perceived barriers to digitalization by small-scale farmers in Gauteng Province. The study's aim was to establish the digital divide between small-scale farmers and commercial farmers. The study's objective was also to relate the perceived contribution of small-scale farmers to the food production through digitalization.

The study' objective was to investigate the impact of digitalization to the way small-scale farmers in Gauteng Province conducted their farming activities. Finally, the study's objective was to prove that the rate of adoption and adaptation of these digital technologies by the small-scale farmers in Gauteng Province was impacted by digitalization.

This chapter summarized the findings of the results from the study that was conducted. These findings were matched to the hypotheses formulated. The hypotheses formulated were matched to the literature reviewed based on the outcomes of the results from the study that was conducted. These hypotheses were investigated each separately and matched to the literature reviewed.

The demographics of the participants was also investigated. Lastly everything was summed up and conclusions were drawn up according to the findings from the study conducted and the literature reviewed.

5.2 Discussion pertaining to Hypothesis 1 and Hypothesis 2

5.2.1 ***Hypothesis 1:*** *Small-scale farmers in Gauteng Province are of importance towards the contribution of the food production through the digitalization.*

According to the findings from the results portrayed above based on the questionnaire that the participants responded to most small-scale farmers believed they were of importance to the national food security. Despite how small-scale they were, most small-scale farmers postulated that their produce was not only used for their consumption (Schut, van Asten, Okafor, Hicintuka, Mapatano, Nabahungu, Kagabo, Muchunguzi, Njukwe and Dontsop-Nguezet, 2016 as cited in Jellason et al., 2021).

The small scale-farmers stated that they also sold some of their produce to big retailers like any other commercial farmers. This they stated that it contributed to the national food basket and the GDP (Deloitte, 2021 as cited in Valiyev, Oglu, Rustamov, Huseynova, Orujova & Musyeva, 2022), (Berendt, Littlejohn, & Blakkemore, 2020; Lele & Goswami, 2017; Lune & Berg, 2017; Smit & Jokonya, 2017 as cited in Mtshali & Jili, 2022).

As a developing country in Africa, South Africa's agriculture has been at the top of GDP improvements and a source of food production. Gauteng Province small-scale farmers were part of that population of farmers who also produced some of the agricultural products that were a source of food (Ayim, Kassahun, Addison, & Tekinerdogan, 2022), Hekkert, Suurs, Negro, Kuhlmann & Smidt, (2007) as cited in Mtshali & Jili, (2022), (Avgerou, 2010, Heeks, 2002, Heeks & Future, (2014), Walsham, (2017) as cited in Emeana, Trenchard, & Dehnen-Schmutz, (2020)

These sentiments were echoed by Food and Agriculture Organization, (2011) as cited in Farayola, Adebisi, Akilapa, & Gbadamosi, (2020). Gauteng Province small-scale farmers were also of the opinion that they did not only promote food security. They believed they also created employment that helped to curb unemployment in the province Stats SA, (2017), Tompkins (2020) as cited in Jellason et al., (2021), supported these claims.

In the South African economy agricultural activities were amongst the top contributors of the GDP and these agricultural activities included the activities conducted by the small-scale farmers (Stats SA, 2017), (Nkambuke et al., 2021). According to the study it was depicted that food security was an urgent issue that needed attention and small-scale farmers were part of the solution to address some of those issues (SDSN, 2015, FAO, 2015 as cited in Shmit and Jokonya, 2021). To combat food insecurities small-scale farmers in Gauteng Province were adamant that they were also counted amongst producers within the province (Sadiku et al., 2020).

Most small-scale farmers alluded that they were dependent on farming as a way of living Chhachhar et al., (2014) as cited in Nkambule et al., (2021). This was stated in literature where it was stated that 75% of farmers were rural farmers which are seen as small-scale farmers in the South African context (Nkambule et al., 2021). Small-scale farmers in Gauteng Province alluded that they also fed the population of South Africa just like any other commercial farmers (Shamshiri et al., 2018). The population issue was viewed as a global incident (Sadiku, Ashaolu, & Musa, 2020, Nasirahmadi & Hensel, 2022).

5.3.2 Hypothesis 2: *Small-scale farmers are not well established to adopt and adapt to digitalization in Gauteng Province.*

Based on the findings of the study from the small-scale farmers it was found that small-scale farmers lacked the resources to adapt and adopt to digitalization. The lack of resources to adapt and adopt to these digital technologies has been a global trend as most farmers were not familiar with the current digital technologies (Hsiu-Ping, Tyz-Ling & Chien-Tso, 2013) , (King, 2017 as cited in Mtshali & Jili, 2022), (Fuglie, Gautam, Goyal, and Maloney, 2020; Jellason, Conway and Baines, 2020 as cited in Jellason et al., 2021).

Financial constraints were also found to be a cause of concern to most of the small-scale farmers and this was also noted in literature (Annosi et al., 2020). The

skills to operate these sophisticated technologies was also a deterrent to utilize them (Annosi et al., 2020), cemented by the illiteracy prevalence within the small-scale farming community (Hudson & Hite as cited in Annosi et al., 2020), (Pogorelskaia and Varallyai, 2020 as cited in Jellason, 2021). Most small-scale farmers lacked the skills and knowledge to adapt and adopt with some of the digital technologies (Aleshina, Serdobintsev & Nevikov, 2021).

Despite the lack of skills to utilize these digital technologies a few small-scale farmers believed they were qualified enough to utilize them (Berendt, Littlejohn, & Blakkemore, (2020); Lele & Goswami, (2017); Lune & Berg, (2017); Smit & Jokonya, (2017) as cited in Mtshali & Jili, 2022).

However, some small-scale farmers believed these technologies would take their jobs and replace them (Mtshali & Jili, 2022). These sentiments were posited by (Jellason et al., 2021), who asserted that Africa had the capacity to utilize digital technologies like any other continent. However, (Mtshali and Jili, 2022) postulated that South Africa's investment to technological innovations was less concentrated to small-scale farmers.

The inability to adopt and adapt to digital technology was attributed to the level of development with the South African context as a developing nation (Cunningham, Weathington & Pittenger, 2013 as cited in Valiyev, 2021). However, those small-scale farmers who were privileged enough utilized it and the results they got they were satisfied (Kayad, Paraforos, Marinello & Fountas, 2020). Some of the small-scale farmers in Gauteng Province utilized the sensors for animal tracking which they were comfortable with, and this was postulated in literature (Kayad et al., 2020).

Some small-scale farmers that were close to some towns within Gauteng Province asserted that they had access to some digital technologies, and they utilized them (Nkambule & Agholor, 2021). This sentiment was echoed in literature by Armstrong & Gandhi, (2012) as cited in Nkambule and Agholor, (2021). Due to the improved infrastructure in Gauteng Province some of the small-scale farmers were lucky to be in proximity to these infrastructures.

Being close to these infrastructures made it easier for them to access the digital technologies through well-established ICT infrastructure etc. Armstrong and Gandhi, (2012) as cited in Nkambule and Agholor, (2021).

However, those far away from the infrastructure were not so luck especially those in the outskirts of Gauteng Province (Wolf, 2001 as cited in Nkambule and Agholor, 2021). Some of the small-scale farmers believed that these technologies were not cut for African countries but rather for the developed countries in Europe and America (Jellason, Robinson, & Ogbaga, 2021).

5.3 Discussion pertaining to Hypothesis 3 and Hypothesis 4

5.3.1 ***Hypothesis 3:*** *There is a notable gap of digitalization by small-scale farmers compared to commercial farmers in Gauteng Province.*

The findings from the study depicted that the small-scale farmers believed the commercial farmers were given more attention than them. Most small-scale farmers believed they lagged with issues of digitalization not just as Gauteng Province but as the whole of South Africa (Harvard Business Publishing, 2016 as cited in Valiyev et al., 2021). Armstrong and Lee, (2019) postulated the same sentiments of lagging within the agrarian realm and these were alluded by the previous studies as well Subeesh and Mehta, (2021), Vasiljeva et al., (2020); Figueiredo et al., (2019); (Nguyen and Tuyen, (2021); Megits, Neskorodieva and Schuster, (2020) as cited in Valiyev et al., 2021).

According to the small-scale farmers the gap was exacerbated by the lack of resource allocation and support from some relevant authorities (Sabodash et al., 2021 as cited in Mtshali & Jili, 2022). Despite a small number of commercial farmers that contributed to the economy (Naude, 2018 as cited in Nkambule et al., 2021), with most small-scale farmers contributing more to the GDP it has been found to be difficult to integrate the small-scale farmers into the export channels (Mtshali & Jili, 2022). However, some small-scale farmers in Gauteng Province

believed digital technologies would help improve food security. Ojakorotu et al., (2020) supported these sentiments.

Despite their contribution to the GDP small-scale farmers believed they lacked the resources to improve productivity (Rotz et al., 2019 as cited in Mtshali & Jili, 2022). Small- scale farmers felt that they were side lined from most of the technological innovations which only privileged the commercial farmers (Mtshali and Jili, (2022), (Schut, van Asten, Okafor, Hicintuka, Mapatano, Nabahungu, Kagabo, Muchunguzi, Njukwe and Dontsop-Nguezet, (2016) as cited in Jellason et al., 2021). Small scale farmers in Gauteng felt that they were still poorer to utilize these technologies than their counterparts the commercial farmers (Mtshali & Jili, 2022).

Most small-scale farmers in Gauteng Province were concerned about how the commercial farmers were given preference over them (Antwi and Seahlodi, (2011) as cited in Nkambule et al., (2021). According to literature this was attributed to the colonial history (Daff, 2016 as cited in Scmidt and Jokonnya, (2021), Bhorat and Kanbur, (2006) as cited in Stats SA, (2019), Gillwald et al. (2019) as cited in Nkambule et al., (2021).

The issue was that there was a division between small-scale farmers and commercial farmers that created a dual system in the agricultural sector Thamaga-Chitja and Morojele, (2014) as cited in Smidt & Jokonya, (2022). Small-scale farmers believed commercial farmers owned vast arable lands while they owned small portions of land that was less fertile (Thamaga-Chitja & Morojele, 2014 as cited in Smidt & Jokonya, 2022).

Small-scale farmers in the outskirts of Gauteng province stated that they felt that if the digital technology reached them, it was going to be beneficial to them. They mentioned that especially the ICT infrastructure that was vital for them to at least be in touch with the rest of Gauteng Province if not the rest of South Africa viz a viz the rest of the world. This was supported by literature as other researchers were of the same views (Ugboh & Tibi, 2007 as cited in Nkambule et al., 2021), (Agholor & Ogujiuba, 2021 as cited in Nkambule 2021).

5.3.2 ***Hypothesis 4:*** *Digitalization has a positive impact on agricultural harvest for small-scale farmers in Gauteng Province.*

The adoption of digitalization by small-scale farmers according to the study portrayed that most small-scale farmers thought that it was helpful towards their farming activities. Despite the lack of access and better knowledge of these digital technologies (Annosi et al., 2020). The small-scale farmers who were fortunate enough to be exposed to the digital technologies confirmed how they reaped the results (Valiyev et al., 2022). This notion was supported by (McFadden, Casalini, Griffin & Anton, 2022) were they mention how labour-intensive exercises were made easier by digitalization.

The small-scale farmers in Gauteng Province according to the study knew some of the benefits for the digitalization (Tembo and Maumbe, 2011 as cited in Nkambule et al., 2021). However, they lacked the resources due to its less prevalent uses in this sector (Yueh, Chen & Chen, 2013). Despite the availability of these technologies most small-scale farmers does not have access and the adoption rate has been slow in Gauteng Province (Daberkow & Mcbride as cited in Annosi, Brunetta, Capo & Heideveld, 2020).

The lack of study within the agricultural realm was another factor that small-scale farmers in Gauteng Province were comfortable with their traditional farming methods (Spykman, Gabriel, Ptacek & Gandorfer, 2021). Despite the utilization of digital technologies small-scale farmers in Gauteng were limited to the technological applications they utilized.

Some of the sophisticated digital technology was beyond their reach e.g., aerial mapping using the Global Satellite Positioning techniques (Shamshiri, Weltzein, Hameed, Yule, Grift, Balasundram, Pitonakova, Ahmad & Chowdhary, 2018), (Cotter, Asch & Editorial, (2020), De Clerq et al., (2020) as cited in Jellason, 2021) (Banwell, Rutherford, Mackey & Chu, (2018) as cited in Mtshali & Jili. 2022).

Adoption of digital technologies by small-scale farmers in Gauteng Province was partially influenced by the perceptions by small-scale farmers that they were not given priority just like commercial farmers (Thamaga-Chitja & Morojele, 2014 as cited in Smidt & Jokonya, 2022). However, some of the small-scale farmers

postulated that due to the era of the 4IR it was inevitable for them not to utilize digital technologies (Sadiku, Ashaolu, & Musa, 2020), (Nasirahmadi & Hensel, 2022). This was also alluded by (Sadiku et al., 2020) who reiterated the advent of big data and data analytics brought about the need to embrace these technologies.

The advent of 4IR was however viewed by some of the small-scale farmers as a new phenomenon that was inevitably to replace the traditional way of farming (Soffel, 2016 as cited in Mtshali & Jili, 2022). This was cemented by some studies in literature (FAO, 2019; Zyl, Alexander, Graaf & Mukherjee, 2014; Chavula, 2014; Ajani, 2014; Ajani & Agwu, 2012; Karugia & Ndokweni, 2007 as cited in Emeana et al., 2020). This was influenced with how some of the areas within Gauteng Province were fast changing due to exposure of improved ICT infrastructures (Jellason et al., 2021).

The less value that was invested in small-scale farmers was also a deterrent factor to the adoption of digital technologies by small-scale farmers in Gauteng province. Some of the researchers shared the same views (Lele & Goswami, 2017, as cited in Mtshali & Jili, 2022). Age was noted as the determinant to the adoption of digital technologies as mostly younger farmers in Gauteng were the ones who preferred the digital technologies. These sentiments were echoed in literature by some researchers (Monteleone, Moraes and Maia, 2019, as cited in Jellason et al., 2021).

5.4 Conclusion

5.5.1: Hypothesis 1: *Small-scale farmers in Gauteng Province are of importance towards the contribution of the food production through digitalization.*

According to the interpretation of the results for the above hypothesis a conclusion was drawn that small-scale farmers in Gauteng Province were considered important towards food production contribution, however most of the small-scale farmers lacked exposure to digital technologies. Most small-scale farmers noted that they supplied their produce to the same retailers the commercial farmers supplied, this was noted as proof that small-scale farmers in Gauteng Province were an important part of food security in the province.

Farayola, Adebisi, Akilapa, & Gbadamosi, (2020) asserted that developing countries considered agriculture to be the backbone of their economies and to be a food enhancement catalyst and poverty elimination. Ayim, Kassahun, Addison, & Tekinerdogan, (2022). Ayim et al., (2022) echoed the same sentiments that almost 70% of African nations depended on agriculture for their upkeep. Given these findings about developing nations South African is also amongst them, henceforth agriculture is amongst the economic enhancers and food security guarantor.

Sadiku, Ashaolu, and Musa, (2020), stated the forecasted perceived global population by the year 2050, which was projected at 9.8 billion. Nasirahmadi & and Hensel, (2022) however predicted the world population to be 10 billion by 2050. Due to these population increases the United Nation posited that they will be needed to increase the agricultural production to carter for those growing populations to prevent food insecurities. Given these forecasts it explains the findings of this study's results from the small-scale farmers in Gauteng Province. According to their responses they believed they contributed to the food production by virtue of supplying the same retailers supplied by commercial farmers to feed the nation.

To counter the effects of the increased populations on the issue of food security, some researchers believed technological advancements in the agricultural realm was needed (Sadiku et al., 2020). Ojakorotu et al., (2020) was also of the opinion that the use of digital technology would bring relief to the human sustainability through food production improvements hence boosting the food basket. Stats SA, (2020) from its released results indicated that an increase of 27.8% through crop products, horticulture products and animal products boosted the GDP. These

figures were higher in the previous years with 38.7% and 44.2% in the second and fourth quarter of 2017 respectively (Stats SA, 2017).

Amongst the above figures small-scale farmers in the Gauteng province were included in those statistics. These findings were true according to the research conducted about how the small-scale farmers in Gauteng Province were of importance to the contributions towards the food production. Chhachhar et al., (2014) as cited in Nkambule et al., (2021) asserted that to achieve these objective of poverty reduction, environmental sustainability and food security improvements technological innovations were dire.

5.5.2: Hypothesis 2: *Small-scale farmers are not well established to adopt and adapt to digitalization in Gauteng Province*

Based on the hypothesis above it was summed up that some small-scale farmers in Gauteng had the ability to adapt and adopt the digitalization of operations in Gauteng Province. However, some did not have the capacity to adapt and adopt the digitalization of operations in Gauteng province. Given the number of those who can adapt and adopt to digitalization of operations in Gauteng province the number of those who afforded was outweighed by the number of those who could not afford.

Aleshina, Serdobintsev, & Novikov, (2021) alluded that the availability and trainability of human resources was problematic especially in ICT. Given the number of some small-scale farmers who were illiterate in Gauteng Province, those who could not respond to the questionnaire due to illiteracy, it was not how the other researchers' (Aleshina, Serdobintsev, & Novikov, 2021) was portrayed given the Gauteng Province scenario.

Mtshali and Jili, (2022) posits that besides latest technological developments, most small-scale farmers still were faced with poverty, drought, hunger, socio-economic challenges etc. Most of the small-scale farmers who were in the outskirts of Gauteng Province, were of the same opinion that they did not even have the infrastructural support to utilize these technologies.

Armstrong and Gandhi, (2012) as cited in Nkambule and Agholor, (2021) however denoted that there was a reasonable number of farmers in South Africa who were utilizing the digital technologies to do their farming activities. These findings were like some of the responses found in this study where some small-scale farmers in Gauteng province were utilizing digital technologies to conduct their farming. Mtshali and Jili, (2022) supported these findings that prior studies about 4IR in the agricultural sector was less concentrated within the small-scale farming community.

Seebens, (2009) as cited in Stats SA, (2019) postulated that 52.8% of households were headed by women while 47.2% were headed by men. Annosi et al., (2020) asserted that lack of preparedness were deterrent factors for the inability to adapt and adopt to digital technologies. Most of these households were dependent on agriculture as a source of upkeep, with most of them being small-scale farmers from rural areas (Stas SA, 2019). These findings were relevant to this research because most of the small-scale farmers were not well established to adapt and adopt the digitalization of operations in their agricultural activities given their backgrounds.

5.5.3: Hypothesis 3: *There is a notable gap of digitalization by small-scale farmers compared to commercial farmers in Gauteng Province*

Small-scale farmers in Gauteng Province according to the findings believed there was a considerable gap of digitalization between small-scale farmers and commercial farmers in Gauteng Province. Most scale-farmers in Gauteng province believed commercial farmers were given preferences over them.

Most of the small-scale farmers' perceptions that small-scale farmers were not given preference dates back from the apartheid era. Daff, 2016 as cited in Smidt and Jokonya, (2021) stated that the land redress issue was pending in South Africa. Daff, (2016) as cited in Smidt & Jokonya, (2021) added that the Apartheid Colonial era disadvantaged the small-scale farmers, and this has had an impact on how small-scale farmers conducted their farming activities since then until the present era. These findings were taken to be relevant to the study given the

responses from small-scale farmers in Gauteng Province who responded to the distributed questionnaire.

Thamaga-Chitja & Morojele, (2014) as cited in Smidt & Jokonya, (2022) postulated that commercial farmers owned vast arable lands versus the small and less fertile land that most of the small-scale farmers owned. Thamaga-Chitja & Morojele, (2014) as cited in Smidt & Jokonya, (2022) further state that small-scale farmers were less equipped than their counterparts, the commercial farmers. These were some of the findings that the other researchers found in their research that were like this study. These finding fitted the scenario which most small-scale farmers in Gauteng Province faced.

According to (DAFF, 2018 as cited in Nkambule et al., 2021) since 1994 there was a rise of 7.5% of registered commercial farmers with 40% being crop farmers while 60% being animal farmers who have utilized the ICT technology. However, given this number only 4% were found out to contribute to the economy, (Naude, (2018) as cited in Nkambule et al., 2021) while 25% of small-scale farmers contributed to the GDP (Mtshali & Jili, 2022). (Mtshali & Jili, 2022) further posits that given these figures it was found that integration of small-scale farmers to the export channel was found to be difficult.

These findings were like the study which prompted small-scale farmers in Gauteng Province to state that preference was given to commercial farmers than them despite their contributions. Nkambule et al., (2021) postulated that this was attributed to the grey areas on the usage of ICT on technology to improve productivity and this needed redressing.

5.5.4: Hypothesis 4: *Digitalization has a positive impact on agricultural harvest for small-scale farmers in Gauteng Province*

Given the outcome of the findings, it was found that a few farmers who were educated enough understood the concept of digitalization. These were the small-

scale farmers whose adoption of digitalization was impacted by the digitalization of operations. However, most of the small-scale farmers lacked the knowledge of digitalization and they lacked the resources to utilize the digital technologies in their daily farming activities.

The small-scale farmers who were educated enough to utilize the digital technologies mentioned that they saw its benefits, this was denoted by (McFadden, Casalini, Griffin, & Antón, 2022) postulated the importance of utilizing digital technologies in the agricultural sector. Spykman, Gabriel, Ptacek, & Gandorfer, (2021), however alluded that despite the utilization of digital technologies in most disciplines, the utilization in the agricultural realm was hardly studied. This was however the findings of the study, which showed that most scale farmers in Gauteng province were not familiar with these technologies. (Armstrong & Lee, 2019) reiterated this when they divulged the digital vortex, which illustrated how agriculture was on the outskirts of the vortex.

Pestryakov, Sbrodova, & Titovets, (2021) on the other hand mentioned how digitalization could be used to strengthen the economy and be used to improve economic and developmental regimen to secure food security. Nasirahmadi and Hensel, (2022) seconded these sentiments as the mentioned how digitalization had a massive impact on agriculture and food production. However, despite the advantages of digital technologies in the agricultural sector its adoption rate was noted by some researchers to be very slow Daberkow and Mcbride, (2003) as cited in Annosi, Brunetta, Capo, & Heideveld, (2020)

These trends of slow adoption to the digital technologies were also picked up by this study from the small-scale farmers in Gauteng Province. The slow reaction to the adoption of these technologies were denoted to high illiteracy levels (Hudson & Hite as cited in Annosi et al., 2020), expertise availability, accessibility to knowledge and technology, (Daberkow & McBride as cited in Annosi et al., 2020), and the response rates to technological evolution (Cochrane, 1993 as cited in Annosi et al., 2020). These trends were amongst some of the challenges faced by small-scale farmers in Gauteng Province that forbade small-scale farmers to reap the benefits that digitalization came with.

CHAPTER 6. CONCLUSIONS & RECOMMENDATIONS

6.1 Introduction

This chapter of the study juxtaposed the nexus between the objectives of this study and the hypotheses that were formulated. These were according to the findings of this research based on comparisons and or similarities made to some of the literature reviewed. Some recommendations were made based on the outcomes of the findings. Finally, suggestions for further research on the topic that was under investigation for further future analysis of this study were given.

6.2 Conclusions regarding research objective 1 and objectives 2.

*6.2.1. **Objective 1:** To establish the perceived barriers of digitalization by small-scale farmers in Gauteng Province*

According to the first objective it was to establish how small-scale farmers in Gauteng Province were not able to utilize the digital technologies in their agricultural activities.

According to the findings it was found that most small-scale farmers in Gauteng Province believed there were not exposed to the digitalization of operations in their farming activities. These findings were consistent to some of the findings which found that there were some barriers to digitalization of operations within the farming realm. Some of the challenges that small-scale farmers in Gauteng Province encountered included language barriers (Best & Mier, 2007 as cited in Nkambule et al., 2021), this was due to high rate of illiteracy within the farming community (Hudson & Hite as cited in Annosi et al. ,2020).

It was found that most of the digital technologies were expressed in English while most of the small-scale farmers were well versed in their native languages

(Nwagwu, 2006 as cited in Nkambule, 2021). These findings were consistent with some of the studies conducted by some research. The level of ICT development also played a major role especially in area that were in the outskirts of Gauteng Province (Ayim et al., 2022).

Some analyses believed agriculture was in the outer space within the digital vortex (Armstrong & Lee, 2019). These findings were consistent with some of the results from this study. However, it was noted by most of the researchers agreed that agriculture was deemed the backbone of most African nations (Food and Agriculture Organization, 2011 as cited in Farayola, Adebisi, Akilapa, & Gbadamosi, 2020).

However, there were a few who believed they were exposed to the digitalization of operations in their farming activities (Wamboye, Tochkov, Sergi and Technology, 2015 as cited in Jellason et al., 2021). This group of small-scale farmers acknowledged the benefits that they reaped from the digitalization of operations with their farming activities. This group of small-scale farmers were the fortunate ones who resided within urban and peri-urban of Gauteng Province were the infrastructure was more developed than the outskirts of Gauteng Province (Aker et al., 2016 as cited in Nkambule et al., 2021).

However, those small-scale farmers who utilized the digital technologies were those that were literate enough to understand the technological benefits brought by 4IR. (Soffel, 2016 as cited in Mtshali & Jili, 2022). However, despite the level of understanding of digitalization of operations most of the small-scale farmers in Gauteng Province believed they were not exposed to financial funding like eSusFarm, AgriBEE etc. (Maree, Piontak, Omwansa, Shinyekwa & Njenga, 2013 as cited in Jellason et al., 2021).

Most small-scale farmers in Gauteng Province agreed that there were some hurdles in the establishment of digitalization as small-scale farmers (Aleshina, Serdobintsev, & Novikov, 2021). Despite these findings it was also found that there were a minority who were well versed with the utilization of digital technologies in their farming activities.

However, the number was insignificant compared to the number of the small-scale farmers that were not well established. Given these findings it was endorsed that small-scale farmers in Gauteng Province faced barriers to digitalization in their farming activities. These findings were consistent with (Nkambule & Agholor, 2021), (Wolf, 2001 as cited in Nkambule and Agholor, 2021), who found that there were barriers to digitalization in farming operations.

6.2.2 Objective 2: *To investigate the perceived gaps to the adoption of digitalization by the small-scale farmers compared to commercial farmers in Gauteng Province*

The second objective for the study was to try and analyse whether the small-scale farmers in Gauteng Province believed there was a difference from how they adopted the digital technologies compared to commercial farmers.

Most of the small-scale farmers in Gauteng Province believed they were not given preference compared to their counterparts the commercial farmers. According to previous research these gaps were attributed from the past colonial apartheid era (Daff, 2016 as cited in Smidt & Jokonya, 2021). Despite the availability of these digital technologies small-scale farmers stated that they did not have the capacities to utilize them due to financial problems. Tembo and Maumbe, (2011) as cited in Nkambule et al., (2021), postulated that most commercial farmers utilized digital technologies. (Jellason et al, 2021), supported this notion that despite 80% small-scale farmers within Sub Saharan Africa only a few commercial farmers utilized the digital technologies.

According to the literature reviewed it was consistent to the findings of this research study. However, there were some findings which contradicted to these claims that there was a gap to the adoption of digital technologies by small-scale farmers compared to commercial farmers (Thamaga-Chitja and Morojele, 2014 as cited in Smidt & Jokonya, 2022). These findings were consistent to some extend as some of the small-scale farmers in Gauteng province believed they utilized these technologies especially those who were educated enough. Aker et al., (2016) as cited in Nkambule et al., (2021) believed the connectivity to the rural and less literate, would help improve rural-urban connectivity.

Most small-scale farmers in Gauteng Province believed policy makers were more inclined to the commercial farmers than small-scale farmers. (Ayim et al., 2022). These findings were found according to the responses that the small-scale farmers gave. It was however found that these responses were consistent with some of the research that were conducted previously (Jellason et al., 2021).

DAFF, (2015) as cited in Nkambule et al., (2021) postulated the importance of collaboration between small-scale farmers and commercial farmers. (Lele and Goswami, 2017 as cited in Mtshali and Jili, 2022) however asserted that due to the less value that was perceived towards the small-scale farmers. This had increased the gap of adoption to digital technologies by small-scale farmers. These findings were consistent with this study.

Based on the findings it was concluded that there was indeed a gap to the adoption of digitalization of operations by small-scale farmers in Gauteng Province and commercial farmers. These results were found to be consistent with some previous studies that supported this notion. However (Annosi et al., 2020) was of a different view as they mentioned that some small-scale farmers in Gauteng province had access to the digital technologies (Mtshali & Jili, (2022), (Armstrong & Gandhi, 2012 as cited in Nkambule & Agholor, 2021).

These findings were also found to be consistent to this study, but the significancy was minor based on the responses (Rotz et al., 2019 as cited in Mtshali & Jili, 2022). With that noted it was concluded that since the majority believed there was a gap, which was the taken conclusion.

6.3 Conclusions regarding research objectives 3 and 4

6.3.1 ***Objective 3*** *To examine the impact of farming harvest through the adaptation of digitalization by small-scale farmers in Gauteng Province*

The third objective was to investigate what impact small-scale farmers in Gauteng Province had through the adaptation of digital technologies in their farming activities.

According to the findings it was found that most small-scale farmers in Gauteng Province did not understand the advantages of digital technologies (Barret and Rose, 2020 as cited in Jellason et al., 2021). As a result, they were comfortable with their traditional methods of farming. These findings were depicted in some of the research that were conducted before this research. These notions were supported by other findings who believed not all farm activities were going to be digitalized any time soon (Shamshiri, Weltzein, Hameed, Yule, Grift, Balasundram, Pitonakova, Ahmad & Chowdhary, 2018).

However, it was postulated that there were some benefits that came with the utilization of the digital technologies in farming activities (McFadden, Casalini, Griffin, & Antón, 2022). Despite improved and increased production levels, there were also benefits like improved working conditions, ergonomics of working, ability to use technologies for predictions and preventative measures etc. (Aiello, Catania, Vallone, & Venticinque, 2022). Some researchers believed the utilization of sensors had not spared the agricultural sector as well. However, it had positive influence in the improvement of food security, protection of the climate and managerial enhancements (Nasirahmadi & Hensel, 2022), (Kayad, Paraforos, Marinello, & Fountas, 2020). Kayad et.al, (2020).

Most of the small-scale farmers who were not influenced by the technology were illiterate and were from the outskirts of Gauteng Province (Aleshina, Serdobintsev, & Novikov, 2021). This was supported by the inability of those small-scale farmers to respond to the questionnaire due to lack of either ICT infrastructure (Phiri et al., 2019; Munyua et al., 2009 as cited in Nkambule et al., 2021) or lack of understanding due to language barriers (Best & Mier, 2007 as cited in Nkambule et al., 2021).

However, there were a few small-scale farmers who were influenced by the advantages the digital technologies came with. Those farmers that were influenced by the adaptation of digital technologies in their farming activities were educated enough to understand the impact that digitalization had (Annan, Dryden, and Conway, 2018; Baumuller, 2017; Schwab, 2016 as cited in Emeana et al., 2020). It was found that these farmers were the ones who resided with urban and peri-urban areas of Gauteng Province were the ones who had

exposure to these digital technologies due to suitable ICT infrastructure (Nwagwu, 2006 as cited in Nkambule et al., 2021).

The study concluded that the adaptation of digital technologies was influenced by the area the small-scale farmers came from within Gauteng Province (Wolf, 2001 as cited in Nkambule & Agholor, 2021). The level of education did play a role as well. (Gbetibouo and Ringler, 2009 as cited in Nkambule et al., 2021). According to the numbers of small-scale farmers that were exposed to the digitalization compared to those who did not have access it was found that the majority were not influenced by the digitalization to adapt it in their farming activities. These findings were supported by (Daberkow & Mcbride, 2003 as cited in Annosi, Brunetta, Capo, & Heideveld, 2020) in their previous studies.

6.3.2 ***Objective 4:*** *To investigate the perceived contribution towards the food production by small-scale farmers in Gauteng Province through digitalization.*

The fourth objective was to investigate the perceived importance small-scale farmers in Gauteng Province had towards the contribution to the food production through digitising operations.

It was found that most small-scale farmers believed they contributed towards the food production. Despite the ways they conducted their farming activities most small-scale farmers responded positively towards the issue of national food basket contribution. These findings were postulated by some studies prior to this study (Ayim, Kassahun, Addison, & Tekinerdogan, 2022), Ayim et al., (2022).

These findings were supported by previous research that mentioned the number of small-scale farmers versus the number of commercial farmers in the African context (DAFF, 2013 as cited in Mtshali and Jili, 2022). Naude, (2018) as cited in Nkambule et al., (2021) asserted that only 4% of commercial farmers contributed to the economy. While 25% of small-scale farmers contributed to the economy including the provision of food to the people (Mtshali & Jili, 2022).

It was found that food security was a crucial issue in the African continent with agriculture on the fore front of food production boosters in many developing nations with 70% dependent on agriculture (Ayim et al., 2022). These findings were consistent to this study as it was found that agricultural activities were deemed to be not only to address food security issues but also to address poverty, unemployment and boost any nations' GDP (Ayim, Kassahun, Addison, & Tekinerdogan, 2022). Most of the small-scale farmers in Gauteng Province insisted that because they also supplied to those retails that commercial farmers also supplied, this was indicative of how their production contribution mattered.

Given the history of South Africa, based on the respondents that answered the questionnaire from the survey that was conducted it showed how small-scale farmers were also contributors towards national food security (Hekkert, Suurs, Negro, Kuhlmann & Smidt, 2007 as cited in Mtshali & Jili, 2022). This was due to the number of respondents who answered ranging from agree to strongly agree. These findings were consistent with some literature from other previous researchers (Allal-Cherif, Simon-Moya & Ballester, 2016 as cited in Mtshali & Jili, 2022).

According to the findings from this study it was concluded that small-scale farmers in Gauteng Province contributed to the food security. These findings were like (Soffel, 2016 as cited in Mtshali & Jili, 2022), who noted that the number of small-scale farmers outweighed the number of commercial farmers. Based on these assumptions it was also noted as an important factor that could support this study. However (Mtshali & Jili, 2022), in their study, they found out that these small-scale farmers were side lined from the export channels. These results were consistent to the findings from this study as most small-scale farmers believed commercial farmers were given preference over them.

6.4 Recommendations

The following stakeholders were identified for recommendations from this study. The identified stakeholders were policy makers, academia and researchers, business executives and corporations.

6.4.1 Policy Makers

The significancy of this study to the policy makers was noted because those were the stakeholders who were law makers and policy formulators. This study will assist the policy makers in making sound policies to help in bridging gaps that small-scale farmers faced. Some of the identified hurdles were lack of proper ICT infrastructures, high level of illiteracy within the farming community, discriminations amongst the small-scale farming community etc. This study will provide the findings to establish what problems the small-scale farmers have based on the research conducted and the literature reviewed.

6.4.2 Academia and Researchers

The researchers and academia would help in the formulation of proper programs that will be tailor-made to suit the affected parties within the small-scale farming communities. These tailor-made programs would be designed according to the level of understanding that these affected parties would be able to absorb. Researchers would conduct further scrutiny on this topic to extrapolate some other relevant information that would help policy makers in future to improving the welfare of the small-scale farmers within Gauteng Province viz a viz the whole of South Africa.

6.4.3 Business Executives

The role of business executives could not be taken lightly, as they were noted to be the leaders within the corporate organizations that were responsible for the disruptive technologies brought by the organizations that they headed. As business executives it was noted that they had a duty to play in the way these digital technologies impacted the small-scale farmers and other stakeholders involved.

The significancy of this study to this group was to guide the business executives with information that would enable them to understand how small-scale farmers felt about the technologies that their organizations produced. With such information they would be able to act responsibly towards the affected stakeholders, in so doing it will improve corporate social governance and corporate social responsibility from the organizations they lead.

6.4.4 Corporations

The significancy of this study towards the corporations' point of view was that since they were the producers of these technological innovations. This study would give the information they might need to innovate good and sound innovations for the betterment of humanity. Through good governance from the corporate leaders these organizations will be able to improve corporate social responsibilities towards the communities they operate from.

6.5 Suggestions for further research

According to this study it was to investigate the barriers to digitalization by small-scale farmers in Gauteng Province. Along the way in trying to establish the nexus that juxtaposed the barriers to digitalization of operations by small-scale farmers in Gauteng Province. Suggestions for further research was found to be on how the barriers to digitalization by small-scale farmers could be addressed. These could be the innovations within applications of these digital technologies, addressing the digital divide, etc.

Table. Consistency table: research questions, propositions, data collection and data analysis

RQ #	Research Question.	Research Objective.	Alternate Hypothesis.	Null Hypothesis.	Data collection details and Literature Reviewed.	Data analysis method.
1	What are the perceived barriers to digitalization by small-scale farmers?	To establish the perceived barriers of digitalization by small-scale farmers in Gauteng Province.	Barriers to digitalization could affect the agricultural harvest by small scale-farmers in		Questionnaire Likert Scale. Questions – 3, 10, 13, 15. Mtshali and Jili, (2022), Barret and Rose, (2020) as cited in Jellason et al., (2021), Fielke, Garrard, Jakku,	Multiple Regression.

RQ #	Research Question.	Research Objective.	Alternate Hypothesis.	Null Hypothesis.	Data collection details and Literature Reviewed.	Data analysis method.
			the Gauteng Province.		Flemming, Wiseman, and Taylor, (2019) as cited in Jellason et al., (2021), (Modified by Armstrong, 2019). (Udovita, 2020) (Aiello, Catania, Vallone, & Venticinque, 2022), .	

RQ #	Research Question.	Research Objective.	Alternate Hypothesis.	Null Hypothesis.	Data collection details and Literature Reviewed.	Data analysis method.
2	What is the extend of the gap between small-scale farmers and commercial farmers in respect to digitalization Gauteng?	To compare the gaps to the adoption of digitalization between the small-scale farmers and commercial farmers in Gauteng Province.	There could be a notable gap between the adoption of digital technologies by commercial farmers and small-scale farmers in the in Gauteng Province.		Questionnaire Likert Scale. Questions – 2, 7, 8, 14, 17. (Calicioglu, Flammini, Bracco, Bellu & Sims as cited in Mtshali & Jili, 2022), (Naicker, 2017 as cited in Mtshali and Jili, 2022) (Daberkow & McBride as cited in Annosi et al., 2020), (Hudson & Hite as	Linear Regression/ Correlation.

RQ #	Research Question.	Research Objective.	Alternate Hypothesis.	Null Hypothesis.	Data collection details and Literature Reviewed.	Data analysis method.
					cited in Annosi et al. ,2020), Bhorat and Kanbur, (2006) as cited in Stats SA, (2019)	
3	To what extent does digitalisation impact the adaptation of digital technology in Gauteng by	To relate the level of adaptation of digitalization by small-scale farmers in Gauteng Province.	There could be a positive impact on agricultural harvest through the adaptation of digital technologies		Questionnaire Likert Scale. Questions – 4, 5, 11, 16. (Best & Mier, 2007 as cited in Nkambule et al., 2021), (Phiri et al., 2019; Munyua et al.,	Factor analysis.

RQ #	Research Question.	Research Objective.	Alternate Hypothesis.	Null Hypothesis.	Data collection details and Literature Reviewed.	Data analysis method.
	small-scale farmers?		by small-scale farmers in Gauteng Province.		2009 as cited in Nkambule et al., 2021), (Cunningham, Weathington & Pittenger, 2013 as cited in Valiyev, 2021),	
4	What impact does small-scale farmers have on the food production output?	To describe the improved food production, from improved farming activities, through digitalization by	- Digitalization in the agricultural sector could improve food		Questionnaire Likert Scale. Questions – 1, 6, 9, 12, (Kleine & Unwin, 2009; Baumuller, 2017; Aker & Mbiti,	Multiple Regression

RQ #	Research Question.	Research Objective.	Alternate Hypothesis.	Null Hypothesis.	Data collection details and Literature Reviewed.	Data analysis method.
		small-scale farmers in Gauteng Province.	production in the Gauteng Province for small scale-farmers.		2010; World Bank, 2016; Baumuller, 2015; Heeks, 2008 as cited in Emeana et al., 2020), (Heeks, 2018 as cited in Shmidt & Jokonya, 2021), (Stats SA, 2017), Ojakorotu et al., (2020), Sadiku et al., (2020), (Nasirahmadi & Hensel, 2022), (Ayim, Kassahun, Addison, &	

RQ #	Research Question.	Research Objective.	Alternate Hypothesis.	Null Hypothesis.	Data collection details and Literature Reviewed.	Data analysis method.
					Tekinerdogan, 2022), (Shamshiri, Weltzein, Hameed, Yule, Grift, Balasundram, Pitonakova, Ahmad & Chowdhary, 2018), Annosi, Brunetta, Capo and Heideveld, (2020), (Aleshina, Serdobintsev, & Novikov, 2021)	

RQ #	Research Question.	Research Objective.	Alternate Hypothesis.	Null Hypothesis.	Data collection details and Literature Reviewed.	Data analysis method.

REFERENCES

Aiello, G., Catania, P., Vallone, M., & Venticinque, M. (2022). Worker safety in agriculture 4.0: A new approach for mapping operator's vibration risk through Machine Learning activity recognition. Computers and Electronics in Agriculture, 193, 106637.

Akhtar, D. M. I. (2016). Research design. Research Design (February 1, 2016).

Aleshina, E. A., Serdobintsev, D. V., & Novikov, I. S. (2021). Formation of the personnel potential of the digital transformation of the agriculture in Russia. Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 21(2), 27.

Amodu, L. O. (2006). Perception: A Determinant for Effective Communication. Sophia: An African Journal of Philosophy, 9(1), 148-153.

Annosi, M. C., Brunetta, F., Capo, F., & Heideveld, L. (2020). Digitalization in the agri-food industry: the relationship between technology and sustainable development. Management decision.

Ayim, C., Kassahun, A., Addison, C., & Tekinerdogan, B. (2022). Adoption of ICT innovations in the agriculture sector in Africa: a review of the literature. Agriculture & Food Security, 11(1), 1-16.

Budiu, R., & Moran, K. (2021). How many participants for quantitative usability studies: A summary of sample-size recommendations. Nielsen Normal Group.

Emeana, E. M., Trenchard, L., & Dehnen-Schmutz, K. (2020). The revolution of mobile phone-enabled services for agricultural development (m-Agri services) in Africa: The challenges for sustainability. Sustainability, 12(2), 485.

Farayola, C. O., Adebisi, L. O., Akilapa, O., & Gbadamosi, F. Y. (2020). Does Innovation Enhance Youth Participation in Agriculture: A Review of Digitalization in Developing Country? International Journal of Research in Agriculture and Forestry, 7(2), 7-14.

Frenzel, A., Muench, J. C., Bruckner, M. T., & Veit, D. (2021). Digitization or digitalization? -Toward an understanding of definitions, use and application in IS research. In AMCIS.

Galawe, N. J. (2017). Endogenous and exogenous risk factors in the success of South African small medium enterprises. Doctoral dissertation, University of the Witwatersrand, Faculty of Commerce, Law, and Management.

Goundar, S. (2012). Research methodology and research method. Victoria University of Wellington.

Jarial, S. (2022). Internet of Things application in Indian agriculture, challenges, and effect on the extension advisory services–a review. Journal of Agribusiness in Developing and Emerging Economies.

Jellason, N. P., Robinson, E. J. Z., & Ogbaga, C. C. (2021). Agriculture 4.0: is sub-Saharan Africa ready? Applied Sciences, 11(12), 5750.

Joshi, A., Kale, S., Chandel, S., & Pal, D. K. (2015). Likert scale: Explored and explained. British journal of applied science & technology, 7(4), 396.

Kayad, A., Paraforos, D. S., Marinello, F., & Fountas, S. (2020). Latest advances in sensor applications in agriculture. In (Vol. 10, pp. 362): MDPI.

Kirsten, J. F., & Van Zyl, J. (1998). Defining small-scale farmers in the South African context. Agrekon, 37(4), 551-562.

Kumar, S., Raut, R. D., Nayal, K., Kraus, S., Yadav, V. S., & Narkhede, B. E. (2021). To identify industry 4.0 and circular economy adoption barriers in the agriculture supply chain by using ISM-ANP. Journal of Cleaner Production, 293, 126023.

Landau, L., & Gindrey, V. (2008). Migration and population trends in Gauteng province 1996–2055. Migration Studies Working Paper Series, 42.

Leamer, E. E. (2009). Gross domestic product. In Macroeconomic patterns and stories (pp. 19-38). Springer, Berlin, Heidelberg.

Lee, G., Armstrong, B. (2019) Digitalisation. An Introduction. Accessed from: [https://wits-e.wits.ac.za/access/content/group/51757895-9d65-4dc2-bdd7-5ceb9d79a0bf/Tech%20fundamentals/Introduction%20to%20Digitalization-1/Intro%20to%20digitalization%202020-01%20PDM.pdf].

Louangrath, P. I. (2017). Minimum sample size method based on survey scales. Int. J. Res. Methodol. Soc. Sci, 3, 45.

McFadden, J., Casalini, F., Griffin, T., & Antón, J. (2022). The digitalisation of agriculture: A literature review and emerging policy issues.

McGrath, S. K., & Whitty, S. J. (2017). Stakeholder defined. International Journal of Managing Projects in Business.

Memon, M. A., Ting, H., Cheah, J. H., Thurasamy, R., Chuah, F., & Cham, T. H. (2020). Sample size for survey research: Review and recommendations. Journal of Applied Structural Equation Modeling, 4(2), 1-20.

Mtshali, T. L., & Jili, N. N. (2022). THE EFFECTIVENESS OF THE 4IR TECHNOLOGIES IN ELEVATING SMALL-SCALE FARMING AT KWADLANGEZWA, KWAZULU NATAL IN SOUTH AFRICA. International Journal of eBusiness and eGovernment Studies, 14(1), 388-408.

Nasirahmadi, A., & Hensel, O. (2022). Toward the Next Generation of Digitalization in Agriculture Based on Digital Twin Paradigm. Sensors, 22(2), 498.

Nkambule, T. B., & Agholor, A. I. (2021). Information Communication Technology as a tool for agricultural transformation and development in South Africa. A review. Turkish Online Journal of Qualitative Inquiry (TOJQI).

Ojakorotu, V., Olajide, B., & Dunmade, B. (2020). The Political Economy of Digitalization and Climate Change Response in Nigeria. International Journal of Criminology and Sociology, 9, 508-517.

Oliver, E., & Oliver, W. H. (2017). The colonisation of South Africa: A unique case. HTS: Theological Studies, 73(3), 1-8.

Peng, W., & Berry, E. M. (2019). The concept of food security. Encyclopedia of food security and sustainability, 2(1), 1-7.

Pestryakov, A., Sbrodova, N., & Titovets, A. (2021). Digitalization of crop production as a factor in strengthening the economic security of the region.

Ratner, B. (2009). The correlation coefficient: Its values range between+ 1/− 1, or do they? Journal of targeting, measurement, and analysis for marketing, 17(2), 139-142.

R Shamshiri, R., Weltzien, C., Hameed, I. A., J Yule, I., E Grift, T., Balasundram, S. K., . . . Chowdhary, G. (2018). Research and development in agricultural robotics: A perspective of digital farming.

Sadiku, M. N. O., Ashaolu, T. J., & Musa, S. M. (2020). Big data in agriculture. Int. J. Adv. Res. Comput. Sci. Softw. Eng, 9, 70-72.

Smidt, H. J., & Jokonya, O. (2022). Factors affecting digital technology adoption by small-scale farmers in agriculture value chains (AVCs) in South Africa (Sept 10.1080/02681102.2021. 1975256, 2021). INFORMATION TECHNOLOGY FOR DEVELOPMENT.

Spykman, O., Gabriel, A., Ptacek, M., & Gandorfer, M. (2021). Farmers' perspectives on field crop robots–Evidence from Bavaria, Germany. Computers and Electronics in Agriculture, 186, 106176.

stats.sa. (2017). Agriculture and finance help lift SA out of recession. Accessed from: [https://www.statssa.gov.za/?p=10426].

stats.sa. (2017). Bumper harvest helps keep economy afloat. Accessed from: [https://www.statssa.gov.za/?p=10764].

stats.sa. (2018). Economic growth better than what many expected. Accessed from: [https://www.statssa.gov.za/?p=10985].

stats.sa. (2013). Gross Domestic Product (GDP) figures released. Accessed from: [https://www.statssa.gov.za/?p=903].

stats.sa. (2019). These goods drive South African agriculture. Accessed from: [https://www.statssa.gov.za/?p=14370].

stats.sa. (2017). Media release: Community Survey 2016, Agricultural Households. Accessed from: https://www.statssa.gov.za/?p=9468].

stats.sa. (2017) QUARTERLY EMPLOYMENT STATISTICS. Accessed from: [https://www.statssa.gov.za/?p=10530].

stats.sa. (2014) Unemployment rate decreases slightly. Accessed from: [https://www.statssa.gov.za/?p=3448].

Taherdoost, H. (2016). Sampling methods in research methodology; how to choose a sampling technique for research. How to choose a sampling technique for research (April 10, 2016).

Tranmer, M., & Elliot, M. (2008). Multiple linear regression. The Cathie Marsh Centre for Census and Survey Research (CCSR), 5(5), 1-5.

Udovita, P. (2020). Conceptual review on dimensions of digital transformation in modern era. International Journal of Scientific and Research Publications, 10(2), 520-529.

Valiyev, A., oglu Rustamov, F. V., Huseynova, R. A., Orujova, M. S., & Musayeva, S. N. (2022). The Digitalization Effectiveness as an Innovative Factor Development of the Agriculture in Azerbaijan. Journal of Eastern European and Central Asian Research (JEECAR), 9(2), 194-205.

Viziteu, Ș., Brezuleanu, S., Leonte, E., VÎNtu, C. R., & Micu, M. M. (2017). DIGITALIZATION IN FARM MANAGEMENT. Indicator, 2019(2019).

Yueh, H.-P., Chen, T.-L., & Chen, C.-T. (2013). A spatial exploration of factors affecting digitalization of farmers' associations in Taiwan.

Yueh, H. P., Chen, T. L., & Chen, C. T. (2013, November). A spatial exploration of factors affecting digitalization of farmers' associations in Taiwan. In Aslib proceedings: New information perspectives. Emerald Group Publishing Limited.

Zinke-Wehlmann, C., & Charvát, K. (2021). Introduction of Smart Agriculture. In Big Data in Bioeconomy (pp. 187-190). Springer, Cham.

APPENDIX A

Graduate School of Business Administration
University of the Witwatersrand, Johannesburg

Wits Business School

Wits Business School Ethics Committee
Constituted under the University Human Research Ethics Committee (Non-Medical)

Ethics Clearance Certificate

Ethics protocol number: WBS/DB2261860/558
This certificate is only valid with a legitimate ethics protocol number and signed by the Researcher (below).

Project title	Perceived barriers to digitalization by small-scale farmers Gauteng Province
Investigator / Researcher	Mr Donald Choguya
Nature of Project	MM (Digital Business)
Decision of the Committee	Approved, provided stakeholders and participants are guaranteed anonymity and confidentiality.
Issue Date of Certificate	2022-12-06
Expiry date	Date of submission of the project / research report
Chairperson	Prof Anthony Stacey ☎ +27 11 717 3587 +27 82 880 4531 ✉ anthony.stacey@wits.ac.za

Declaration by Researcher

One copy must be signed by the Researcher and returned to the Chairperson of the Wits Business School Ethics Committee.

I fully understand the conditions under which I am authorized to carry out the abovementioned research and I guarantee to ensure compliance with these conditions. Should any departure to be contemplated from the research procedure as approved I undertake to resubmit the protocol to the Committee.

Signature

14/12/22
Date:

APPENDIX B: Research Instrument.

QUESTIONNAIRE.

Perceived barriers to digitalization by small-scale farmers Gauteng Province

Good day

My name is Donald Choguya. I am a Masters student in the field of Digital Business at the University of Witwatersrand in Johannesburg. As part of my studies, I have to undertake a research project under the guidance of my supervisor Prof. Pius Oba. I am conducting a research study about the perceived barriers to digitalization by small-scale farmers in Gauteng Province. The study title is " Perceived barriers to digitalization by small-scale farmers Gauteng Province".

I, Donald Choguya am inviting you to answer a questionnaire. If you decide to take part, your participation in this research study will last about 10-15 minutes.

This data will be stored in Wits Wired Space for seven years and or deleted after seven years. Only Donald Choguya will have access to the data.

During the research study I will need to ask some personal information about you including gender, race, age, and language both written and spoken.

The questionnaire will be confidential and anonymous. When I share the results of the research study, I will not include your name or anything else that could identify you. With your permission other researchers may use the data collected from this research study, but your name and any personal information will not be used or passed on.

If you decide to take part in the research study, it should be because you want to volunteer. You do not have to take part. You can stop being in the study at any time. You do not have to answer any questions if you do not want to. You will not get any direct benefits if you choose to join the research study. You will not lose any services, benefits, or rights you would normally have if you decide

not to join. Taking part in the research study will not cost you anything. You will not be paid for being in this research study.

The risks of this research study are no more than what happens in everyday life.

This research will be written as a research report. The research report will be available on the university's library website. If you would like to receive the summary of this research report, I will be happy to send it to you.

If you have any questions during or afterwards about this research study, feel free to contact me or my supervisor Prof. Pius Oba on the details listed below. If you have any concerns or complaints about the ethical procedures of this research study, you are welcome to contact the University Human Research Ethics Committee (Non-Medical), telephone +27(0) 11 717 1408, email hrecnon-medical@wits.ac.za

Researcher: Donald Choguya, Wits email: 2261860@students.wits.ac.za, Cell Number: 0736143447.

Supervisor: Professor Pius Oba, Wits email: pius.oba@wits.ac.za, Phone: 011 717 3976.

Thank you for considering participating in this research project. By answering the questions on the questionnaire, you are giving full consent to participate in this research report. The questionnaire can be accessed on the next page.

Yes	

Are you a small-scale farmer?

Yes	
No	

Do you reside in Gauteng province?

Yes	
No	

How old are you?

Under 18 years.	18-24 years old.	25-34 years old.	35-44 years old.	45-54 years old.	55-64 years old.	65+ years old.

1. Digitalization of agricultural activities has had an impact on the way I do farming, and I have realized an improved harvest than before?

Strongly Agree	Disagree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

2. I can confidently state that I have had access to the digitalization of operations in my farming activities just like any other farmer around Gauteng e.g., access to the AgriBEE Fund.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

3. Harnessing the digital technology is cheaper for me to conduct my farming activities as a small-scale farmer than to do it without?

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

4. I have never been exposed to the digital technologies since the era of the 4IR and I am not confident enough to utilize them.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

5. The government has given the support that I need to utilize the digital technologies on my farm as a small-scale farmer and I can see the rewards of such an effort? E.g., utilization of smart phones to forecast the weather accurately and have real time market demands.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

6. As a small-scale farmer I can confidently say that my harvest can have an impact on the national harvest.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

7. Digitalization is a cheaper option to improve production for me as a small-scale farmer and I will use it to boost my production.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

8. As a small-scale farmer I feel that the commercial farmers are given more attention by the government than the small-scale farmers.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

9. I supply some of the large retailers with my produce as a small-scale farmer that are also supplied by some of the commercial farmers.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

10. The infrastructure in my area is conducive enough to utilize the digital technologies like the use of e.g., drones to monitor and treat my crops, the use of monitoring devices on my animals e.g., wireless sensors?

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

11. Competition between small-scale farmers and commercial farmers is extremely high when it comes to resources allocations by the public and the private sector.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

12. Digitalization of operations for small-scale farmers is a good thing towards the contribution of production to boost the national harvest.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

13. I have support from some of the digital platforms like eSusFarm, AGRI 5 etc., as a small-scale farmer and it does help me boost my agricultural productivity.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

14. All my harvested products are sold just like any for any other commercial farmer, and I do take part in all the activities that commercial farmers engage in when selling my products.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

15. There is reliable ICT infrastructure in my area and as a small-scale farmer I utilize these services most of the time.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

16. As small-scale farmers we always attend some seminars to teach us about digital technologies that are available for farmers, and we are taught about their benefits to production.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree

17. As a small-scale farmer I have the required skills and knowledge to utilize the digital technology e.g., IoT, agricultural platforms, Robotics, drones for my farming activities.

Strongly Disagree	Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Agree	Strongly Agree