Information and Communication Technology adoption and its determinants among smallholder maize farmers in Mqanduli, Eastern Cape Province, South Africa

By

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DECLARATION

I, Azola Mhambi, declare that this dissertation, which I hereby submit for the degree Master of Agriculture in Rural Development at the University of Pretoria, is my work and has not previously been submitted by me for a degree at this or any other tertiary institution.

SIGNATURE ……

DATE: …….

DEDICATION

I dedicate this study to my dear daughter, Timna Mhambi, and my family, who made sacrifices beyond imagination to educate and support me.

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Firstly, I would like to give praise to Almighty God, for the life He has given to me. My greatest thanks go to my supervisor, Professor CL Machethe, for his guidance and critical comments that kept helping me not only accomplish this research but also to develop better research skills.

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ABSTRACT

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The adoption of technology by smallholder farmers has been shown to have a positive impact on their productivity. This applies to Information and Communication Technology (ICT) as well. Despite the important role played by ICT in smallholder agriculture, little is known about the extent to which smallholder farmers in South Africa have adopted ICT and the factors which determine adoption. Most studies on ICT adoption focused on the health, education, banking, tourism, and e-government sectors.

The main objective of this study was to determine the level of ICT adoption and its determinants among smallholder maize farmers in Mqanduli, Eastern Cape Province, South Africa. Sixty smallholder maize farmers were interviewed using a structured questionnaire. Availability or convenient sampling, which is one of the non-probability sampling procedures, was used to select the sample. The responses of the farmers to the questions in the questionnaire were captured and coded in Microsoft Excel.

The main finding of the study was that smallholder maize farmers experienced challenges, including low quantity and poor quality of maize, lack of market information, lack of on-farm infrastructure, climate change, high transaction costs, lack of capital, and land fragmentation. The main factors which affected ICT technology adoption were the level of education, gender, willingness to use compatible phones, as well as the cost of adoption.

The findings further revealed that smallholder farmers were aware of some of the ICT that is related to agriculture, but the level of usage was low. The smallholder farmers were willing to adopt ICT once they received the necessary training on ICT. There is a need for cellular telephone network providers, in partnership with the government, to install telecommunication infrastructure in rural areas and to develop mobile applications that can be used by farmers for agricultural purposes. This would help to ensure that farmers receive timely and accurate information and that they are not dependent entirely on extension workers for information. This would also assist in improving communication channels between the farmers and extension workers.

Keywords: ICT, smallholder maize farmers, adoption, determinants, challenges, South Africa.

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CHAPTER 1: INTRODUCTION

1.1 Background

Information and communication technology (ICT) refers to any communication equipment or application, such as radio, television, mobile phones, and computers. ICT can increase access to and the use of well-documented agricultural information (Maqsood, 2015). Joel (2011) stated that ICT in agriculture is increasingly becoming an enabling mechanism for farmers to respond to opportunities, with the potential to improve agricultural productivity, and access to markets, knowledge, and information. According to Frimpong (2009), ICT remains the best hope for underdeveloped countries to accelerate their growth. For Eamin et al. (2012), improved information and communication processes have been achieved through the development of mobile applications for agriculture, and this has led to agricultural and rural development. Eamin et al. (2012) stated that information that was formerly not accessible by most farmers can now be easily accessed using mobile applications for agriculture, which provides farmers with cheaper ways of accessing financial, marketing, and governance systems.

Agriculture is an important sector in many developing nations because it employs most of the rural population (Stienen et al., 2007). Barrett (2008) noted that the sector faces the challenge of limited market access and a lack of market information. Smallholder farmers have been producing food in their communities but are still struggling to market their produce through (high-value market) intermediaries, and so resort to marketing directly to consumers (Chikazunga & Paradza, 2013).

According to Kathlee and Fridah (2017), ICT is a one-of-a-kind tool for combating poverty, limited market ties for smallholder farmers, high transportation costs, and price instability. Kathlee and Fridah (2017) mentioned that ICT has been associated with better buyer-seller efficiency, productivity, and communication, as well as a reduction in waste and price discrepancy. Furthermore, the use of ICT to promote market access has the potential to help smallholder farmers to overcome their obstacles. Many individuals now have access to information on markets, financing, and governance systems, which were previously unavailable to them, because of the use of ICT in agriculture (Maqsood, 2015). Therefore, this study seeks to understand the extent to which smallholder maize farmers use ICT, as well as the factors that affect the adoption of ICT. In South Africa, ICT dissemination in the

agricultural sector is limited due to a lack of research. Most studies conducted in South Africa are focused on the health, education, banking, tourism, and e-government sectors.

1.2 Smallholder agriculture in the Eastern Cape

This section reviews the available literature on the nature of smallholder agriculture and the importance of maize, and the challenges faced by smallholder farmers in the Eastern Cape Province.

1.2.1 Nature of smallholder agriculture

The agricultural sector makes a major contribution to economic development and household food security in South Africa (DALRRD, 2019). In the Eastern Cape Province, maize is mainly produced by resource-poor farmers in low-input environments (Chimonyo et al., 2019). According to AgriSETA (2010), the agricultural sector plays a critical role in the generation of jobs and the provision of sustainable livelihoods in most provinces. The Eastern Cape Province is noted for its abundance of natural resources, ranging from grazing space to forests, marine life to fertile farming soils, water to wildness, and the ability to grow a wide range of crops due to its climate. Smallholder agriculture is most dominant in the province, which is known to have the smallest commercial agricultural sector (DALRRD, 2019). The province has a diversified agricultural sector, producing cash crops, critics, and livestock. The eastern part of the province has substantial agricultural production potential due to its fertile soils (DALRRD, 2019).

Agricultural development is a crucial feature in the development of a people's socio-economic livelihood, according to AgriSETA (2010), because two-thirds of the population live in rural areas. StatsSA (2018) has reported that 29.3% of households in the Eastern Cape participate in agricultural production activities and that it is the second province leading in agricultural production. The agricultural sector contributes to growth and development by ensuring household food security through the efficient utilisation of agricultural land in the homelands.

The Provincial Department of Agriculture has implemented many ad-hoc initiatives to provide project support for smallholder development. As part of these efforts, the government has provided business development support, which includes projects such as the creation of farmer cooperatives, on-farm infrastructure investment, and niche-commodity schemes (Tregurtha, 2009). Because of their narrow focus, as well as poor implementation and oversight, the majority of these projects failed, contributing to the high failure rate (Tregurtha, 2009). The

Department of Agriculture in the Eastern Cape has introduced many programmes that have focused on strengthening food security through increasing maize production. The province has encouraged conservation farming by strengthening black economic empowerment in the agricultural sector, boosting private-sector development and rural markets, and promoting environmental sustainability.

The Eastern Cape makes use of co-operatives to develop smallholder farmers, such as the Siyakhula/Massive maize project and the Rural Enterprise Development hubs, which are linked to co-operatives. Chimonyo et al. (2019) reported that, on an annual basis, large quantities of maize in the Eastern Cape are imported from other provinces because of the low maize yields that are obtained in the province. Furthermore, these low yields are attributable to maize varieties being grown that are not suitable for the Eastern Cape, the farmers' limited knowledge of new varieties, and the use of traditional maize varieties.

1.2.2 Challenges faced by smallholder farmers

This section aims to identify the challenges faced by smallholder farmers, such as asymmetry or lack of information on markets, lack of on-farm and off-farm infrastructure, and high transaction costs. Smallholder farmers face difficulties in competing in markets because they face massive problems when it comes to physically gaining access to markets.

1.2.2.1 Lack of market access

Smallholder maize producers frequently face many challenges when they are willing to compete in competitive markets, or want to access markets (Sikwela, 2013). According to Marvin (2019), the market access and the competitiveness of farmers are related to the options that farmers can use to purchase their inputs and sell their commodities. Commercial farmers and the more-capitalised farmers have greater access to the markets, as compared with smallholder farmers who usually have low or poor market access and lack the necessary resources. Moreover, these farmers face challenges, such as a lack of infrastructure, trade restrictions, and physical limitations, in reaching the market or achieving minimum product characteristics or requirements (Sikwela, 2013).

Marvin (2019) noted that although some markets were available, smallholder farmers were then not selling their products or commodities because of the constraints they faced. However, many developing countries with the ability to mitigate hazards are underdeveloped, leaving smallholder farmers vulnerable to market risk (Baloyi, 2010). In most cases, the smallholder

farmers are not as competitive as the commercial farmers are because they lack support from the government and private sector in meeting the stipulated product market standards or grades, or in supplying the proper qualities required (Sikhweni & Hassan, 2014). Smallholder farmers are not properly organised and lack knowledge about markets and the required standards. They sell their products or commodities at low prices to intermediaries or at the farm gate (Marvin (2019). Nevertheless, new marketing arrangements have the potential to change market relations in favour of smallholder farmers (Sikwela, 2013). Cooperatives and producer organisations are well-positioned to seize these new opportunities for smallholder farmers to join high-value chains (Sikwela, 2013).

According to Baloyi (2010), the crucial question raised by many researchers concerning farmers and markets is related to how rural decision-makers respond to poor markets. Marvin (2019) indicated that smallholder farmers based in rural areas are affected by imperfect information and a lack of markets, which negatively affects their ability to make informed decisions. The bulk of smallholder farmers lives in distant areas, with little access to proper or formal markets or agro-processing enterprises (Sikhweni & Hassan, 2014). These farmers are thus obliged to sell their products at low prices at farm gates and local markets, or they have to transport their produce to towns at higher costs (Baloyi, 2010).

1.2.2.2 Lack of on-farm infrastructure

Biénabe et al. (2011) have stated that lack of infrastructure, such as cold rooms and storerooms, is a challenge that most rural farmers face, and this affects the quality of their product because they are unable to keep their produce in good condition after harvesting. These farmers lack access to proper storage and processing facilities. However, the ability of farmers to market products or commodities such as maize becomes more flexible when they have access to storage facilities (Baloyi, 2010). The marketing options for rural farmers have been limited by a lack of storage, handling, processing, and other post-harvest equipment and facilities (Biénabe et al, 2011). Specifically, this has resulted in a reduction in the farmers' income due to post-harvest losses. Furthermore, the lack of storage facilities inhibits farmers from producing greater quantities because they are unable to store their maize for longer periods. It prevents them from adding more value to their products through further processing, and consequently from earning more income. Thus, access to storage facilities by smallholder farmers is likely to improve their flexibility in selling and marketing their products, as well as their bargaining power (Biénabe et al, 2004).

According to van Schalkwyk et al. (2010), poor market infrastructure is usually a problem for smallholder farmers. As stated by van Schalkwyk et al. (2010), market infrastructure is frequently lacking in rural areas, and some farmers sell their goods from the back of their vehicles, rather than selling them at a market. In general, these conditions are unfavourable for marketing fresh products, exacerbating perishability and loss. Rural farmers offer their products in depressed markets, which places farmers in danger of losing customers and rendering their products less appealing to consumers. Fresh produce has a short shelf life and so cannot be held for longer periods. This means that fresh produce must be processed or sold when still in good condition (van Schalkwyk et al., 2010).

As an example of poor infrastructure, Barlow & Van Dijk (2013) referred to eight smallholder farmers in KwaZulu-Natal who had highlighted the fact that their fences were very old and damaged, and as a result, animals easily destroyed their fence and their commodities and produce (such as maize), leading to poor quality or damaged produce. The poor infrastructure thus caused subsequent difficulties for the farmers in marketing their damaged commodities. However, these farmers further reported that poor fencing results in criminals being able to easily break in and steal their agricultural commodities and produce (Barlow & Van Dijk, 2013). Because of poor infrastructure, smallholder farmers are struggling to market their commodities (such as maize), mainly because what they produce is poor in quality and is not properly stored.

1.2.2.3 Asymmetry or lack of information on markets

Market-demand information is expensive to acquire, and most smallholder farmers do not have access to it (Baloyi, 2010). However, at times, these farmers gather information from other actors in the product chain, although the correctness of this information is questionable because of the opportunistic behaviour of some actors in the chain.

Smallholder farmers, according to Baloyi (2010), lack information about local product prices, quality requirements, the best venues, the times at which to sell their crops, and possible purchasers. This reduces the benefits that smallholder farmers might receive from the marketable parts of their commodities, as well as their ability to trade their commodities efficiently.

Otunge et al. (2010) have argued that maize production in Tanzania is dominated by smallholder farmers. The efforts of these farmers are constrained by factors such as inadequate

access to proper information about how to market maize commodities and to extension services that could advise or assist those smallholder farmers on how to increase their maize productivity (Ninsiima, 2015). Nevertheless, it has been noted that smallholder farmers are willing to increase maize productivity. According to Otunge et al. (2010), most rural farmers plant maize types that are unsuited for growing in their areas due to a lack of awareness about superior maize technology. This is also caused by limited interaction between farmers and extension officers (Ninsiima. 2015).

1.2.2.4 Transportation problems

Baloyi (2010) noted that most rural farmers lack the transport facilities to move their maize to the market. Smallholder farmers stated that they have to sell their maize at lower prices because of the loss of quality and late delivery caused by transportation challenges. The well-organised movement of agricultural produce from rural areas to the market has been negatively affected by the lack of transportation infrastructure (Ninsiima, 2015). The lack of farm-to-market roads and the higher transport costs per kilometer to distant markets make it problematic for farmers who are at greater distances from markets to gain access to lucrative markets (Baloyi, 2010). Smallholder farmers who are based in remote areas are far away from the markets, which results in high transaction costs for these farmers, as compared with farmers who are based in areas closer to markets, which usually also have good road infrastructure.

Furthermore, van Schalkwyk (2010) claimed that smallholder farmers based in rural areas are faced with a transportation challenge attributable to limited and unreliable public transport, which leads to difficulties in getting their fresh produce to the market on time, resulting in spoilage and losses. The lack of dependable transportation will increase transportation expenses, which will thus increase transaction prices for smallholder farmers.

According to Barlow and Van Dijk (2013), many smallholder farmers do not have access to vehicles that would allow them to deliver their produce such as maize to the point of collection. Accordingly, they often have to carry their maize or produce by buckets or by using wheelbarrows (Barlow & Van Dijk, 2013). This restricts the amount of maize produce that the farmers can transport to the collection point. Furthermore, where the product has been rejected due to poor quality, the farmer has to carry the produce back to the farm (Barlow & Van Dijk, 2013).

1.2.2.5 Low quantity and poor quality

Smallholder farmers mostly have small land areas on which to produce, leading to a low quantity of production, and poor or low capital assets for maintaining their farms (Baloyi, 2010). Furthermore, most commodities produced by smallholder farmers are ignored by output markets due to the poor quality and low quantity of produce. These problems are caused by inferior factors of production, such as land, capital assets, and water. The food value chain is characterised by a universal trend that leads to increasing concentration (Baloyi, 2010). This tends to make it very difficult for smallholder farmers to reach high-value markets because of the low quantities and poor quality of their products, which difficulty is aggravated by increasingly demanding consumers and worries about food safety (Baloyi, 2010). Agricultural commodities such as maize are likely to be rejected and lost after the production process because of poor quality.

Sikwela and Mushunje (2013) argued that in South Africa, smallholder farmers produce commodities of poor quality and that the farmers fail to access the better-paying markets because the quality of their products is often lost after the production process. Furthermore, these farmers are faced with a variety of institutional and technical aspects prompting market access (Sikwela & Mushunje, 2013).

Salami et al. (2010) observed that, for the smallholder agricultural sector to be moved from commercial production to subsistence production, there are key preconditions it needs to meet, such as improved access to input and output markets. Baloyi (2010) argued that for smallholder farmers to be visible to competitive markets, well-organised markets, and local-level value addition need to be put in place. However, markets in many countries, including South Africa, are still struggling to meet the needs of smallholder farmers in the marketing of both agricultural inputs and outputs (Solami et al., 2010).

According to Solami et al. (2010), in East Africa, the major challenge facing smallholder farmers in increasing productivity on the output side is the inability to link these farmers to supermarket chains. The main impediment or hurdle is that they are unable to meet international value-chain requirements for safety and high-quality commodities or produce, as well as delivery timetables, which prevents them from competing in such markets (Baloyi, 2010).

1.2.2.6 Climate change

The FAO (2018) has reported that agriculture is significantly impacted by climate change. In most rural areas of South Africa, climate change has been a major cause of the reduction in agricultural production because of changes in weather patterns that lead to higher average temperatures and increases in damages caused by pests and diseases. Moreover, most crop production is rain-fed and is seriously affected by weather fluctuations that disrupt rainfall. Climate change is expected to exacerbate poverty and food insecurity in most rural communities in South Africa. It has been stressed that climate change will affect all four dimensions of food security: food supply, accessibility, consumption, and food system stability (FAO, 2008). According to empirical research, climate change is expected to have a smaller impact on developed countries than on developing countries. However, little research has been conducted on the effects of climate change on third-world economies (Gbetibouo & Hassan, 2005).

1.2.2.7 Lack of access to credit markets

Okurut et al. (2004) defined credit as a key tool for enhancing the well-being of the poor, directly through consumption smoothing, which lessens their reliance on short-term revenue. The productive ability of the poor is boosted through credit-based investments in human and physical capital (Okurut et al., 2004). Poor farmers are more likely to request credit for productive investments because they are less risk-averse. Access to credit allows them to overcome liquidity constraints, permitting them to make investments that will increase production, employment, and income. (Mdoda, 2014). A study in Uganda has shown that smallholder farmers are linked with high risk, high costs, and low returns, with the result that formal banks are unable to provide services to them (Okurut et al., 2004).

Spio (2002) has noted that South African financial intermediaries find it difficult to associate themselves with small-scale rural farmers because they are classified as being high-risk, costly, and difficult to associate with because of high transaction costs. Formal financial institutions lack credit information about smallholder farmers and the poor, which renders them unable to serve the poor and small-scale farmers. On the other hand, they serve large-scale, commercial farmers. Matlou (2018) noted that in Limpopo Province, most banks are unable to meet their clients' needs due to the business methods and practices used by them.

1.2.2.8 High transaction costs

According to DAFF (2019), high transaction costs, mostly caused by poor infrastructure, constitute one of the major factors that limit the growth of smallholder farmers. Furthermore, smallholder farmers are often located in areas with poor road networks, which reduce their productivity due to the unreliable distribution of goods and services. These poor road networks also prompt suppliers to increase their delivery costs due to having to travel over poor roads, which then increases the transaction costs for farmers. The high transaction costs affect the inputs and the market strategies used by the rural farmers and can be worsened by inefficiencies in relevant information and by institutional issues such as the lack of established markets (DAFF, 2019).

1.2.2.9 Lack of reliable markets

Small-scale farmers sell their products at their farm gates or local marketplaces, according to DAFF (2012), and they obtain poor prices. However, by selling their commodities in exchange for expertise and selling talents, as well as a lack of understanding of product diversification potential or the boundaries between market research and product creation, these smallholder farmers may be able to get substantially higher rates.

1.2.2.10 Lack of human capital

Baloyi (2010) has noted that smallholder farmers find it difficult to access formal institutions that disseminate technological knowledge because most of them have poor technical skills and are often illiterate. Because they lack the appropriate financial and marketing abilities, most smallholder farmers are unable to achieve the requirements set by food processors and fresh-product markets (Baloyi, 2010). These farmers produce low-quality commodities due to a lack of product knowledge, and they use traditional methods of production, which are often inefficient (Baloyi, 2010).

1.2.2.11 Inconsistency in production and lack of bargaining power

Most smallholder farmers are perceived to be unreliable when it comes to growing produce and supplying it to fresh produce markets and agro-processing enterprises. Because of their lack of negotiating power, these farmers face a barrier represented by limited access to market knowledge and financial markets, which prevents them from selling in profitable marketplaces (Kipkorir, 2016).

1.2.3 The importance of maize

DAFF (2011) has indicated that maize is a key feed grain and a staple diet in South Africa for most people. South Africa produces around 60% white maize for human use and 40% yellow maize primarily for animal feed, with some rural regions growing it for human food. Yellow maize is the more popular crop in the province. This is the second largest industry after sugar cane. Since maize is a raw material for manufactured items, maize production has a multiplier effect, making it vital to the economy as a source of employment and a foreign currency earner. Nevertheless, DAFF (2011) stated that, in South Africa, most of the maize produced is consumed within the country. DAFF (2011) indicated that most of the maize produced in South Africa is consumed by humans, with about 40 percent of maize being used for animal feed, and the rest for seed and other industry purposes.

Several studies have mentioned that, although the province has much potential for large-scale maize production, it only contributes a little to the national total. Sihlobo (2015) has mentioned that the Eastern Cape Province then annually produced about 1.2 million tonnes of maize. In a typical year, maize millers in the Eastern Cape buy 15 000 tonnes of maize grain, with 80 to 90% coming from outside the province. Maize meal prices for local consumers could be reduced if maize grain could be grown in the Eastern Cape and delivered to local millers at a cost lower than interprovincial imports. The ultra-poor in South Africa spend more than half of their monthly budget on food, and this could have a significant influence on poverty reduction. Approximately 20% of this sum is spent on maize meals (Traub & Thomas, 2006).

To meet this difficulty, the Eastern Cape Department of Agriculture devised a stratified and graduated approach to food security. The Siyazondla Programme was at one end of the spectrum of the range. This was a crisis intervention that provided help in the form of starter packs (e.g., seedlings and fertiliser), infrastructure (e.g., irrigation systems and land fertility treatments), and training and skills development, to stimulate homestead production to increase food security. The Siyakhula/Massive Maize Production Programme, at the other end of the spectrum of the range, was created for households that could produce surplus output for resale. These families were given a conditional grant to help cover their input and mechanisation costs, and the initiative was marketed as a step-up programme that would allow small-scale farmers to expand productivity and enter commercial cropping.

1.3 Problem Statement

ICT has fast become the most prevalent means of transporting voice and data services around the world. This has made it possible for many people to gain access to knowledge on markets, money, and governance systems that were previously unavailable to them (Christine et al., 2011; Sokoya et al., 2014). An important component of agricultural development is the sustainable sharing of information in agricultural markets, technology, and knowledge. The amount of ICT dissemination in the agricultural sector in South Africa is unknown because of the limited available research. As mentioned, most studies on ICT distribution in South Africa have focused on the health, education, banking, tourism, and e-government sectors (Tembo, 2008). Nkambule and Agholor (2021) stated that the available IT literature in South Africa is not only constrained but also suggests a limited viewpoint rooted in a global perspective and supported by subpar grey literature.

Namisiko and Aballo (2013) stated that the usefulness and competence of extension officers have been declining over time, because of the drastic reduction in financial support from donor organisations and the high costs of physical movement of extension officers between rural areas. However, ICT has the potential to enhance the agricultural sector by facilitating communication channels and traditional service delivery (Namisiko & Aballo, 2013). ICT in agriculture can be used to help extension officers in the exchange of agricultural information between extension officers, consultants, and farmers.

When it comes to the use and adoption of ICT in African countries, Maumbe and Okello (2010) label South Africa as a "desert" because there are few smallholder farmers who are using and adopting ICT. According to the literature, the main issue is that South African farmers are slow to accept new technology. Ayim et al. (2022) stated that ICT uptake in agriculture in sub-Saharan Africa took a slow start, and a significant transformation of the sector has not yet occurred. In contrast, the efficient integration of ICT in the agricultural sector in developed countries has greatly improved the efficiency and productivity of the agriculture value chain. The availability of more user-friendly software, lower actual costs of computer hardware and software, and an increase in producers who recognize the advantages of using computers for farm management are all possible explanations for the South African studies' findings that computer adoption in South African agriculture appears to be rising. South African agriculture, on the other hand, has followed the global trend of integrating e-agriculture to assist farmers with agricultural information, marketing, and production (Jones, 2011; Mpofu, 2011).

Chisenga (2010) stated that ICT in agriculture contributes significantly to the sustainability and productivity of the agricultural sector and that it also promotes multi-stakeholder partnerships. According to Namisiko and Aballo (2013), many South African e-agriculture research projects focused on the use of satellites to improve agriculture (14 papers, 21.8%), followed by using geographic information systems (GIS) to improve agriculture (12 articles) (18.7%). Mobile agriculture garnered the least attention, with only one paper (1.5%), being overtaken by e-government direct services, ICT in agricultural supply chains, and agricultural networking, all of which received two papers (3.1%). The country's relatively recent adoption of ICT in agriculture may be attributed to a lack of focus on e-agriculture in South Africa. Academics in South Africa still need to solve specific difficulties or challenges related to e-agriculture to improve the socio-economic transformation of farmers and the sector.

There are many advantages associated with ICT that can assist farmers and traders to receive timely information, which would help them to understand efficient ways for procuring inputs, market prices, and trends, and how to receive support services.

Kiambi (2018) stated that farmers and traders must use more efficient and appropriate new modes of ICT to take advantage of existing opportunities, given the current need for efficiency in understanding market price trends, accessing inputs, and receiving support services. He further mentioned that access to reliable and timely information would help smallholders to make economically viable decisions when planning their planting seasons, and deciding what inputs to use, as they would be able to access market information and reliable markets.

The factors that influence ICT adoption in South Africa have received little attention in the available research. Tembo (2008) is one of the few available sources, having investigated the elements that influence the usage of ICT by commercial farmers in the wine business. Little is known regarding the extent to which smallholder farmers in South Africa have adopted ICT. The awareness, attitudes, and willingness of rural farmers to embrace mobile services (m-services) related to agriculture were explored in a study conducted by Bezu et al. (2015). It has been noted that, although little research has been done on the distribution of ICT in agriculture in South Africa, almost nothing has been said about smallholder agriculture. Smallholder farmers dominate South Africa`s agricultural sector; therefore, there is a need for research to be done that will focus on smallholder farmers. Regardless of this recognition, there is not much knowledge available about the types of ICT used by smallholder farmers, or the factors that determine ICT adoption by them. There is further a need to bridge this knowledge gap for

smallholder farmers and dealers to receive timely information so they can make more-informed decisions that will lead to higher profit margins.

1.4 Objectives

The main objective of this study is to determine the level of ICT adoption and its determinants among smallholder maize farmers.

The specific objectives are to:

i. identify the different types of ICT used by smallholder maize farmers and the proportion of farmers using the technology;
ii. identify the factors affecting the adoption of ICT among smallholder maize farmers, and
iii. identify the challenges faced by smallholder maize farmers and ascertain how the use of ICT could address these challenges.

1.5 Research questions

a) What are the different types of ICT used by smallholder maize farmers and the proportion of farmers using the technology?
b) What are the factors affecting the adoption of ICT among smallholder maize farmers?
c) What are the challenges faced by smallholder maize farmers that could be addressed through ICT adoption?

1.6 Scope of the study

This research study is limited to Mqanduli (King Sabata Dalindyebo Municipality) in the Eastern Cape province of South Africa, with a focus on smallholder maize producers.

CHAPTER 2: THE ROLE OF TECHNOLOGY IN AGRICULTURAL DEVELOPMENT AND DETERMINANTS OF TECHNOLOGY ADOPTION

This chapter reviews the literature on the role of technology in agricultural development. It also reviews the literature on the types of technology used in agriculture, and the factors affecting technology adoption. A section of the chapter is devoted to the determinants of the adoption of Information and Communication Technology (ICT). The final section of the chapter presents a review of the literature on the determinants of information and communication technology adoption.

2.1 Role of technology in agricultural development

Technology allows people, with the use of computers, to collect, process, store, share, and broadcast data, both locally and globally. The agricultural sector can benefit from a cost-effective increase in the flow of information to its stakeholders, thanks to various forms of ICT. Kiambi (2018) mentioned that the expanded usage of mobile phones, the internet, and personal computers over the last two decades has created a variety of options for collecting, storing, processing, transmitting, and presenting data in different formats, in response to diverse needs and user requirements.

Thiam (2013) indicated that farmers in most African countries produce under dryland conditions, with rainfall as the only source of water, which results in low yields and productivity. These farmers are also faced with challenges of lack of access to financial services, lack of access to marketing facilities, and lack of vital information, all of which affect their production and sales. Furthermore, Kiambi (2018) mentioned that the use of ICT could play a critical role in overcoming all the challenges faced by these farmers. Thiam (2013) stated that economic development and growth could be achieved through the incorporation of ICT in agriculture, as it would bridge the information gaps between agricultural experts and farmers and provide farmers with access to improved varieties and uses of technology. According to Kiambi (2018), mobile phones constitute the ICT most utilised for the delivery of agricultural information, services, and solutions because they are the most dominant type of ICT. Praburaj (2018) mentioned that the main beneficiaries of ICT usage in agriculture are farmers, the community, the agricultural industry, researchers, and the government.

Many countries are adopting ICT to disseminate agricultural knowledge and information, and the significance of ICT for promoting food security and supporting rural livelihoods is

becoming more widely recognised. Moreover, the contribution of information and knowledge could assist in boosting agricultural production (Kodjo et al., 2021). Information and communication stakeholders and agriculture stakeholders, such as farmers and extension agents, could benefit from using technology to bridge the knowledge gap. “Farmers and rural residents are increasingly realizing the importance of knowledge, information, and appropriate learning methods in moving forward”, according to Syiem and Raj (2015). Therefore, the use of ICT can assist to improve the livelihoods of rural people by bridging the information and knowledge gaps and also by reducing the transaction costs of sourcing information. The use of ICT in agricultural and rural development has exploded over the last two decades, and ICT has played a critical role in rural development. ICT has recently produced major outcomes in practically every aspect of rural life (Fawole & Olajide, 2012).

Existing information systems and networks could be enabled, strengthened, or replaced by using ICT. Information is critical for agricultural and rural development, as well as for bringing about social and economic changes. ICT is promoting and distributes new and current farming information and knowledge, which is shared within the agricultural sector (Swanson & Rajalahti, 2010). For example, information and communication technologies can be used in remote learning programmes to help farmers in developing countries to learn new concepts and technologies for agricultural development. Information about weather, price and profitable revenue can all be provided by such systems. Farmers who use information and communication technologies in agriculture have greater product information and knowledge, according to the findings. Those who have used e-services and e-commerce apps have experienced an increase in their incomes, as well (Chapman & Slaymaker, 2002; Sideridis, 2010). The dissemination of agricultural information should be included within a learning system so that smallholder farmers could acquire appropriate information and knowledge and use it to make decisions in an agricultural production system. Smallholder farmers require education or training to bring them into the contemporary world of labour-saving agricultural technologies and more-productive techniques. The advent of Information and Communication Technologies (ICT) in this era has opened new avenues in agricultural knowledge management that could help meet the current challenges regarding innovation and the sharing, exchanging, and dissemination of agricultural information, knowledge, and technologies to smallholder farmers (Lelisa, 2020).

According to Ilahiane (2007), technology offers greater potential for improving both traditional and innovative services. Mobile phone programmes are increasingly being provided to traditional agricultural extension agents to improve their performance by connecting them to

knowledge banks. The extension agent is thus able to show a video that gives farmers recommendations on how to enhance their agricultural skills and knowledge. This can be done by using mobile-based learning platforms and textual platforms, which can reach more farmers (Nkaelang et al., 2012). According to Masuki et al. (2012), mobile phones are frequently purchased as a status symbol, and their uses are not always economically productive (entertainment and other social applications are common). However, some mobile phone owners may choose to use financial applications on their phones to pay for essential expenses, such as school tuition or meals.

According to Lwesya and Kibambila (2017), although ICT use in agriculture is still in its early stages, the sector is progressing. The successful use of ICT in agriculture is thought to be a key driver of major growth in the sector. Although large portions of the population rely on agriculture for a living and live-in rural region, the adoption of information and communication technologies by them is crucial for agricultural and rural development because ICT facilitates communication and access to information. Oladele (2010) has stated that economic transformation in the agricultural sector could be achieved with the use of ICT. As a result, if ICT is used effectively in agriculture, farmers would be informed about input pricing and market information, thus allowing them to increase product yields. According to Bolarinwa & Oyeyinka (2011), "...timely flow of agricultural information between extension agents and farmers will happen if ICT components are linked with the supply of agricultural information to farmers". For Sutrisno and Lee (2010), these technologies are becoming more cost-effective and useful tools for farmers, extension agents, and other stakeholders to share information and knowledge.

Agriculture in Africa is primarily carried out by smallholder farmers in rural areas, who face certain challenges such as a lack of reliable markets, a lack of reliable sources of market information, falling labour and land productivity due to poor technology use, and reliance on unreliable and irregular weather conditions. Furthermore, Tadesse and Bahiigwa (2015) point out that village marketplaces have asymmetric knowledge, with traders knowing more about prices in central or regional markets than farmers do. In such circumstances, ICT could help smallholder farmers to increase their agricultural productivity by resolving market information asymmetry and making extension services more accessible. According to Agwu et al. (2008), communication, knowledge, and information have an influence on the farmers' decisions regarding production, marketing, and selling prices. As a result, according to the World Bank (2012), the advent of adaptive and more affordable technology and gadgets has increased the

role of ICT in smallholder agriculture, and agricultural output will improve when farmers are connected to market information. ICT has immense potential for providing information, accessing resources, and expanding learning and research sources. It is a popular approach to use for finding agricultural information, products, and services that are continuously expanding.

2.2 Types of technology used in agriculture

The following sections discuss the types of technology used in agriculture.

2.2.1 Farm machines

Farmers are faced with the challenge of high labour costs, and they are not able to satisfy labour. The cost of labour is rising, necessitating the adoption of new techniques for achieving lower labour costs. Planters and combination harvesters are examples of mechanisation that assist farmers to save money and simplify the procedure. Production and time are two important elements in agriculture. Planting early, harvesting on time, and storing the produce at the appropriate time are all critical considerations. The application of contemporary technology in agriculture allows farmers to produce a large amount of food in the shortest amount of time. Self-driving sprayers and tractors that do not require a driver were developed through the use of GPS technology. This technology is useful for promoting efficient farming practices, and this is important for agricultural development. Tractors and sprayers equipped with autopilot tracking systems, for example, eliminate human error and save money on fuel and equipment repairs.

2.2.2 Crop sensors

Determining what fertiliser will work best for different plants when to apply it, and in what quantities poses a challenge for most farmers, as well as ensuring that it is applied effectively. Crop sensors can make it simpler for farmers to apply fertilisers and insecticides, exactly as needed by their crops. Crop sensors help farmers to ascertain how plants are coping and then reduce the chances of leaching. These kinds of sensors help farmers during fertiliser application to determine the amount of the fertiliser resource the crop needs, and at what time it should be applied. Ayoka (n.a) indicated that These sensors are reliable, discrete, and reasonably priced. They are affordable enough that even small farms may use them, and they have a lot of advantages. According to previous studies, commercial farmers mentioned that crop sensors result in more efficient resource utilization and hence cheaper costs, but it also helps the farm

be more environmentally friendly by conserving water, controlling erosion, and lowering fertilizer levels in surrounding rivers and lakes.

2.2.3 GPS use in field documentation

The utilisation of GPS is one of the common techniques adopted in agriculture to document the status of farmland. This type of technology aids in the recording of fertiliser application rates, as well as the determination and documentation of farm yields. The collected and recorded data serves as a point of reference for farmers, which allows them to make informed decisions. A preferred documentation technique to use is the yield map, which may be used to present a summary of an entire year's activity. Such maps are crucial because they can reveal a wealth of information, including the status of a field's drainage system.

2.2.4 Biotechnology

Biotechnology, also known as genetic engineering, refers to the practice of improving crop genes. This technology is mostly used to improve the resistance of certain crops to farm inputs such as herbicide treatments. Areas that are considered dry or desert can also be planted with the use of such technology. Using biotechnology, a farmer saves on the cost of farm resources because fewer farm inputs will be applied. A profitable economy and better output can be achieved in agriculture by making use of this modern agricultural technology. Fertiliser application and management, irrigation, theatre, intense tillage, monoculture, and the use of other resources are all critical considerations for farmers, as well as understanding the concept of modern farming and the use of technology. Crop-protection technologies are used by both commercial and smallholder farmers because they give cost-effective solutions to pest issues that, if left uncontrolled, would drastically reduce output. Obokoh (2019) stated that since 1998, commercial farmers have implemented new agricultural technology that provides enhanced seeds (Bt maize) and high agricultural production. A Study by Thomson (2008) indicated that large-scale farmers plant the majority of Bt yellow and white maize in RSA. Small-scale farmers who grow maize for personal consumption only cultivate white maize.

2.3 Types of mobile phones that are popular in smallholder farming areas

The Human Science Research Council (HSRC) (2014) noted 2014 that rural areas were then becoming more adapted to mobile phone usage and that 90% of the population in the rural areas of South Africa then owned mobile phones. According to Simpson and Calitz (2014), cited by the Human Science Research Council (2014), most commercial farmers use digital

tablets and have high-quality access to the internet. In rural areas, 90% of farmers own working mobile phones and 31% of businesses have access to functional landline telephones, but internet connectivity is limited. Peyper (2013) stated that the types of mobile phones that are common in rural areas are those that are not complex, like tablets, as some of the rural farmers are not that well learned in using mobile phones. They have low levels of awareness of using them, and, with their low incomes, they see mobile phones as being meant for rich people only. Although these farmers have limited access to acquiring information, they might not know that cheaper mobile phones can provide a means for gaining access to information.

For South African subsistence farmers to receive information more easily regarding production and market prices, and to reduce their transport costs, these farmers need to be able to adapt to using other types of mobile phones. By doing so, they might be enabled to close their gulf of efficiency to reach the level of commercial farmers. According to Torfin (2015), various countries are using different kinds of mobile phones that are improving farmers' productivity and reducing transport costs by allowing a farmer to know what is in the market before the farmer departs for the purchase of a particular desired product.

Torfin (2015) mentioned that these specific phones can send and receive vital SMSs that notify crop prices in the agricultural sector through services like SokoniSms64 in countries such as Kenya. Phones are also used to ensure the farmer's production by using phones that can ensure production. In places like Tanzania, phones are used for weather updates, and in other countries like Ghana, phones are used for delivering information to cocoa farmers through free SMSs text messages about farm safety, child labour, health, improvements in farming practices, crop diseases prevention, and crop marketing. These phone messages are sent in English or the language of the relevant locality. This indicates that agricultural farmers, whether in commercial or subsistence farming in South Africa, must be enabled to acquire mobile phones that are adaptable to receiving agricultural updates, as this would improve farming efficiency. Lana (2014) highlighted the point that cell phones comprise one of the mediums of communication that reduce costs, especially for informal businessmen and low-income earners, where most of these phones are smartphones. In 2013, about 10 million smartphones were sold, with 50% of user devices being made by Nokia, Samsung, and Blackberry with an 18% market share with Apple having its share with a 20% increase of smartphones purchased a year.

2.4 ICT as a tool to promote market access for smallholder farmers

The agricultural sector utilises ICT devices for making informed decisions, especially in agricultural marketing (Jairath & Yadav, 2012). In addition, the use of ICT in agriculture allows farmers to receive market price information and to make informed decisions that lead to more efficient production and trade. Jairath and Yadav (2012) mentioned that digital devices are helpful for farmers who sell at local and regional markets because the devices provide producers with important information, such as what to produce, where to sell, and whether to store their crops until prices are high, and they also link them with traders. According to Lashgarara et al. (2012), for farmers to improve their market access, accurate market information is required, which leads to improvements in the quality and quantity of products.

A marketing system of agricultural products is comprised of product distribution, and it can increase the welfare of farmers and consumers, and can also create employment opportunities (Lashgarara et al., 2012). In addition, ICT provides important tools for reducing poverty in rural areas, improving service delivery, and expanding rural industries, which will lead to the development of rural communities. Jairath and Yadav (2012) indicated that improving the productivity of smallholders has a positive correlation with an increase in income and improving the livelihoods of rural people. This enhanced productivity is critical for both household food security and the greater economy's agricultural-based growth and poverty alleviation (McNamara, 2009). Nevertheless, smallholder farmers lack information about suitable crop varieties, production techniques, information on procedures of disease management that are suitable to their local conditions, and market prices, which all limit their output. Accordingly, reliable sources of information for rural farmers would provide them with accurate information, such as early warnings about disease and pest outbreaks, seasonal risks, and other services that could help them (Lashgarara et al., 2012). The use of ICT has the potential to improve this situation and to help with the dissemination of appropriate information to farmers (Lashgarara et al., 2012).

ICT comprises a set of resources and technical instruments for linking, distributing, storing, and managing data that is used to improve market access for farmers. Lashgarara et al. (2012) revealed that ICT facilitates market access, increases selection power, improves communication, identifies markets, saves time and energy, improves marketing, and lowers corporate costs. Smallholder farmers require data to make informed decisions at every stage of the production cycle, from crop selection to planting, harvesting and selling. In addition to

informing production, decisions regarding crop mix and the demand for inputs, timely information about prices and consumer preferences allows farmers to balance their investment of family labour in farm and non-farm activities during the growing season. Smallholders can benefit from information and communication technology by producing high-value commodities and taking advantage of possibilities to engage in these markets. The access of smallholders to knowledge about these high-value commodity markets, and what is required to produce for them, could be aided by information and communication technology. ICT could also substantially assist in networking among smallholders and open up new channels of communication with institutions involved in transactions in these markets.

2.5 Factors affecting technology adoption

Many factors affect the decisions made to adopt technology, including the size of a business, technological infrastructure, social influence, demographic factors, individual characteristics, benefits associated with the use of the technology for farmers, the cost of adopting the technology, and lack of skills.

2.5.1 Size of the business

George et al. (2013) stated that, when considering the adoption of new technologies, the size of the business is an important consideration. It is cheaper for a large business to adopt new technology because it always budgets to invest in new technology. Gloy and Akridge (2000) observed that there is a fragile statistical relationship between farm size and Internet usage. This could signal that the Internet is quickly becoming an indispensable component of manufacturing. Ferrer et al. (2003) observed that to stay in business, both large- and small-scale farmers will need to employ the technology if it becomes required. Farmers who make time to use the Internet may benefit from using time-saving Internet applications. The use of the Internet by farmers could lead to learning about improved production methods, which would result in improved production outputs. Thus, it is expected that farmers with off-farm employment and who use intensive management plans might use a range of Internet applications (Ferrer et al., 2003). However, it could also be argued that these farmers have less time to spend on the Internet due to their busy schedules.

2.5.2 Technological infrastructure

The tools, methods, and access patterns that are utilised to make information management and transfer more efficient are referred to as technological infrastructure. In most underdeveloped

nations, a lack of suitable technological infrastructure continues to be a key impediment to ICT adoption. The infrastructure expenditure required for ICT adoption, according to Guermazi and Satola (2005), far surpasses the resources of most developing countries and is either prohibitively expensive or not financially viable. When countries such as Malawi and Mozambique are considered, this is especially true. Sierra Leone's ICT infrastructure, according to Wambui (2005), is in desperate need of reform due to its poor state. The country lacks communication infrastructure, and the radio remains the most effective mode of communication. Jorge (2002) noted that in most impoverished countries, telecommunications infrastructure is insufficient, and telecommunication costs are quite high. The limited accessible infrastructure is generally concentrated in larger urban areas, neglecting, and denying, the needs of individual farmers and companies in rural locations, who require a regular flow of information and access to wider commercial networks (Galloway & Mochrie, 2005). This is a bad situation because the bulk of the world's poorest people lives in rural and underdeveloped locations that have limited or non-existent ICT infrastructure.

2.5.3 Social influence

A person's attitude toward a particular behaviour, as well as how he believes others would regard him if he engaged in the behaviour, is referred to as social influence. According to Kargin et al. (2009), social impact is more significant than technology user features in fostering technology adoption. Similarly, Jain and Hundal (2007) reveal that when it came to determining the type of cell phone to buy, rural consumers relied on the advice of a trusted source. According to research, people who are seen as being important and who utilise technology might influence the decisions of others, because the latter believe it would boost their images and reputations.

2.5.4 Demographic factors

Several studies have ascertained that demographic characteristics play a significant role in predicting technology adoption. In this category, age, education, gender, household income, occupation, culture, and ethnicity are all important factors (Ninsiima, 2015). In the literature on technology adoption, age is the most-researched variable. Crandall et al. (2012) stated that some authors reported that older people have negative attitudes toward ICT adoption, while other researchers reported that they have a positive attitude. Van Biljon and Kotze (2008), for example, discovered that age had a strong and positive link with social pressure to use a cell phone. According to the study conducted by Ninsiima (2015), younger respondents felt less

pressure from society to use their phones than older respondents did. Van Biljon and Kotze (2008) stated that age and the level of education had an influence on older persons' perceptions and attitudes about the usefulness and ease of use of ICT. Fawole and Olajide (2012) stated that there was no significant difference between younger and older people's perceptions of the usefulness of ICT. The findings in the study by Fawole and Olajide (2012) suggest that the youth have a positive attitude regarding the ease of use of ICT, as compared with older people. Furthermore, Ninsiima (2015) discovered that more than 60% of mobile phone users in rural India were between the ages of 20 and 40. Crandall et al. (2012) noted that higher expenditures for better service are more likely to come from younger phone users aged 20 to 30, an age group that would be more receptive to a larger range of phone services, including card phones, according to Grameen Telecom's Village Phone Program. Van Biljon and Kotze (2008) mentioned that mobile phone adoption and usage are influenced by cultural beliefs. Ninsiima (2015) found that the degree to which a foreign culture's rules, practices, and communications mirror the regular way of doing business in the home culture has a beneficial impact on technology adoption behaviour. Ninsiima (2015) mentioned that income and education influence the decision to use a mobile phone. Moreover, using and learning how to use new technology is easier for educated people. Most farmers in underdeveloped countries have low levels of education, which is a barrier when it comes to using mobile phones. Ninsiima (2015) found that the likelihood of adopting technology is influenced by the farmers' level of education. Crandall et al. (2012) stated that farmers with more education were more likely to use better maize seed and fertilizer, with each additional year of education increasing the chances of adoption by 5%. Ninsiima (2015) stated that men make use of emails as compared to women. Furthermore, he concluded that, while men and women have different perceptions of email, they do not differ in their use of it. According to van Biljon and Kotze (2008), men's technology use is influenced more by their assessments of its utility, whereas women's technology use is influenced by their impressions of its ease of use. Furthermore, except for the mobile Internet, which was dominated by educated male youth, Crandall et al. (2012) observed no gender differences in mobile phone use.

It has been noted that younger and better-educated commercial farmers who are intensively managed are mostly connected to the Internet. Younger farmers adopt the use of technology early in their farm business, and it is expected that the use of technology would decline with the increasing age of computer operators. Therefore, there is a direct correlation between age and the rate of adoption of technology. Older farmers are assumed to have more farming

expertise and, as a result, would place less value on information obtained from the Internet than younger farmers with less experience would (Ferrer et al., 2003). Furthermore, because older people have less time available to them until they retire, they have less time in which to reap the benefits of their investment (Ferrer et al., 2003).

2.5.5 Individual characteristics

Individual traits that influence the adoption of technology are distinguished from demographic factors in the research. Individual traits include innovativeness, a positive attitude toward new technologies, and technological knowledge. Nkonya et al. (1997) revealed that individual traits, such as farmer innovativeness, had a significant impact on maize seed and chemical fertiliser uptake in Tanzania. Individual traits, on the other hand, are more essential than technological characteristics in the technology adoption process, according to Sultan and Chan (2000). Thong and Yap (1995) investigated the impact of Chief Executive Officer (CEO) traits on small business technology adoption. They claim that small businesses, regardless of size, are more likely to adopt technology if the CEO is more imaginative, has a more positive attitude toward information technology adoption, and has more expertise in information technology. Adopters and non-adopters are distinguished, according to Gatignon and Robertson (1989), by the information-processing qualities of the decision-maker (the person who decides to adopt a technology). Exposure to personal information, for example, reduces the likelihood of rejecting a technology. Psychological factors (i.e. perceived popularity of a mobile phone, the perceived need for a mobile phone, and perceived qualities of a mobile phone) have a less significant effect on mobile phone adoption in a rural context, according to Wei and Zhang (2008).

However, younger farmers are more exposed to technology and are more informed and confident in the benefits of using technology. Better-educated people are expected to absorb technology more readily, since they have had greater exposure to it, and information is likely to be more helpful to them. As a result, more-educated people may require different types of information than less-educated people do, and extensive management and planning may necessitate acquiring a larger amount of external information, which may be found on the Internet.

2.5.6 Benefits associated with the use of technology and the ease of use by farmers

According to a previous study, these two characteristics are two of the most important drivers of system utilisation (Davis, 1989). People will employ a system if they believe it will benefit

them in their work. However, even if a technology is valuable, consumers may choose not to utilise it if it is too difficult to use. Kwon and Chidambaram (2000), in their study of mobile phone adoption, suggest that perceived ease of use has a significant effect on users' extrinsic and intrinsic motivations. They also discovered that apprehension, or the fear of using new technology, harmed intrinsic motivations. According to Agarwal and Karahanna (2000), the perceived ease of use and perceived usefulness accounted for 88% of the variance in behavioural intention. The importance of perceived simplicity of use and perceived usefulness in deciding on the adoption of technology has been repeatedly supported by a body of study (Anakwe et al., 1999; Majchrzak et al., 2000; Mbarika et al., 2002).

2.5.7 The cost of adopting technology

According to Pillay (2016), the high cost of technology is a common barrier to technology adoption because farmers do not have a budget for it, and they perceive that ICT applications are costly. Furthermore, ICT is frequently connected with high expenditures and budget overruns. Depending on which technology platforms are chosen, technology could be pricey or inexpensive. Understanding the role of ICT will make it easier for a company to reach its aim, once again (Modimogale & Kroeze, 2011). The cost of technology, according to Dixon et al. (2012), is a key influencing element in the adoption and usage of technology. The authors argue that, when the initial set-up cost of technology is high, smaller enterprises are less likely to accept and use it. For Pillay (2016), many smallholder farmers experience challenges when seeking financial assistance from outside sources. As a result, due to a lack of financial support, many farmers have seen the adoption and usage of new technologies as costly and excessive.

2.5.8 Lack of skills

The adoption of ICT by a farming business is highly dependent on the farmers' ICT skills, personalities, and attitudes toward technology, since most, if not all, of the decisions, are made by the owner (Pillay, 2016). The shortage of specialists in ICT in Africa is a bigger problem. Hence, the South African government has introduced Skills Education Training Authority organisations to foster the development of increasingly scarce skills, such as those in ICT. The perception of the farmer also has a vital impact on how the farmer views the role of ICT, and small-scale farmers, who are unfamiliar with operating a computer, often believe that ICT is only for large-scale farms, and are unlikely to become involved in ICT-related activities (Pillay, 2016). When farmers had a good attitude toward ICT, the largest hurdle to adoption would be a scarcity of competent workers. Farms that wish to use ICT must have owners or personnel

who have a basic understanding of how to use technology. As a result, if farmers are well-trained in information and communication technology, they are more likely to adopt and use ICT as a competitive tool. Furthermore, according to Manueli et al. (2007), key decision-makers are responsible for creating acceptable ICT goals, recognising crucial ICT business needs, and allocating financial resources to encourage ICT adoption. According to Gray (2006), SME owners with appropriate qualifications and ICT abilities are more likely to be growth-oriented, whereas those without these traits are more likely to be growth averse.

2.6 Determinants of ICT adoption

Many factors determine the adoption of ICT, such as degree of awareness, a farmer's perceptions, educational attainment, income level, age, training, and costs of ICT devices, which are significant determinants. On the other hand, gender differences do not significantly determine ICT adoption.

2.6.1 Smallholder farmers' perceptions of ICT related to agriculture

According to Simpson and Calitz (2014), many farmers in South Africa do not fully relate to advanced mobile phones and Internet access. They also noted that 50% of commercial farmers then had access to tablets and that 70% of them had access to the Internet. Commercial farmers use those devices for communication and for searching the Internet to learn more about product prices and implemented agricultural policies that are supported by agricultural programmes. Makhijani et al. (2015) reported that some farmers are unwilling to receive information on mobile phones because they consider face-to-face human involvement to be most important in some farm activities. As a result, farmers believe that they cannot rely solely on mobile information systems because they are skeptical about the technology. According to the World Bank (2012), farmers have trust in the services offered by middlemen because they receive their payments immediately, while they do not know how to get payments through mobile phones, so they do not trust mobile phone services for buying and selling.

Mobile phones close a gap of missing information, such as about government intervention for improving the rural livelihoods of farmers, which is vital for farmers (Makhijani et al. 2015). Maumbe (2010) mentioned that most farmers have become used to mobile phones with built-in radios. On a positive note, some farmers perceive those mobile phones have the potential to introduce them to innovations that could help them to produce crops of good quality as a result of technological support (Okoboi et al., 2013). Shah and Shaukat (2013) stated that in Pakistan,

farmers who use technology see it as more useful than farmers who do not have it, but are aware of it, do. According to Shah and Shaukat (2013), the latest technologies make life easier, save time, and provide an easy and quick link to other people/organisations and departments. Tembo (2008) mentioned that mobile phones provide an appropriate tool for alleviating poverty. Maumbe (2010) also mentioned that there is a high risk that some South African farmers would fail to adapt to mobile services, and this could widen the gap, as some other countries have experienced this consequence. For South African small-scale farmers to receive information regarding production and market prices, and to reduce their transport costs, they must be able to adapt to other types of phones, such as smartphones. Subsistence farmers might be able to close the gulf of efficiency between them and commercial farmers through the use of ICT.

The perceptions of farmers about new technology and its applications will influence their decisions to adopt it. George et al. (2013) stated that the use of the internet and mobile applications help farmers to reduce risks because this provides farmers with information about production inputs that are available and with knowledge about products that dominate the market risk (Sonka & Coaldrake, 1996). It may appear that delaying the adoption of new technology is advantageous in the early stages, since learning from the mistakes of early adopters may be beneficial (Ferrer et al., 2003). The adoption of technology is based on the perception of enhanced efficiency (Ferrer et al., 2003). Costs are visible, while benefits are more difficult to quantify because of their indirect nature. Another factor contributing to slow adoption is the inability to realise returns on conversion costs (Hooker et al., 2000). As a result, farm businesses that have had access to the internet for longer periods are expected to use more internet applications (Ferrer et al., 2003).

2.6.2 Awareness of ICT relating to agriculture

Fawole and Olajide (2012) observed that awareness of new modes of ICT, such as mobile phones, the internet, and computers, among rural farmers was less prevalent, as compared with older modes of ICT such as radio and television. According to Fawole and Olajide (2012), awareness of new implementations of ICT was relatively low among farmers, except for mobile phones (80.9%), the internet (26.6%), digital video discs (30.4%), and cable television (25.9%), while awareness of old modes ICT such as radio (98.8%) and television (94.7%), was relatively high. Arokoyo (2003) argued that in Niger, radios and television were the types of ICT most used in agricultural extension to deliver information to farmers. However, most farmers who

were aware of the new modes of ICT (particularly cell phones) considered that these were for commercial or wealthy farmers. New implementations of ICT are steadily gaining traction among farmers; however, awareness of the older forms of ICT still outnumbers new ICT awareness.

Peyper (2013) stated that the types of mobile phones that were then common in rural areas were those that were not sophisticated, as tablets are, as some of the rural farmers were not that well learned in using mobile phones. Because of their low incomes, they had a low level of awareness of using them, and they see mobile phones as being meant for rich people only. Although these farmers have limited access to acquiring information, they might not know that cheaper mobile phones can provide a means for gaining access to information.

A study conducted in Kenya by Kirui et al. (2010) indicated that 96.3% of rural farmers were aware of the presence of mobile banking services. Furthermore, Kirui et al. (2010) noted that most farmers in Kenya used the following mobile banking services: M-PESA, Post-pay, ZAP, and YU-cash. M-PESA was then the most widely used mobile money transfer application in Kenya (Kirui et al., 2010). Intermedia (2013) also noted that most rural farmers in Tanzania were aware of M-PESA. Most rural farmers learned about these mobile phone-based money transfer services from radios, friends, and family (Ninsiima, 2015). However, due to the low literacy levels of most rural farmers, many were unable to learn about these mobile banking services from newspapers, billboards/posters, and television. Based on literature in African countries, Vodacom M-PESA is the leading money transfer service used by most households (Vodafone, 2012). Moreover, Intermedia (2013) stated that most users lack awareness about the services provided by mobile money transfer services because they view m-money as basically a service for sending or receiving money. Nevertheless, the awareness of farmers has been slightly improved by the government's intervention by introducing technologies to smallholder farmers.

This is a process whereby farmers are informed about the new product. This is also known as the awareness stage because farmers are informed about the product’s attributes. A study by Kalish (1985) indicated that one of the first stages toward adoption is raising awareness and that a lack of awareness is one of the key reasons why farmers do not accept the technology.

2.6.3 Educational attainment

Smallholder farmers with a particular level of formal literacy are most likely to adequately exploit agricultural information. Farmers with basic education are more likely to adopt new technology and boost their yields. Education enhances one's ability to collect, analyse, and evaluate pertinent agricultural data (Jemal, 2010). According to Gundu (2006), the adoption and use of innovation assume a higher level of literacy. Many smallholder farmers in rural areas in emerging countries are illiterate. He also noted a high degree of illiteracy as being a major barrier to smallholder farmers in using Information and Communication Technology (ICT) to obtain and use agricultural information.

2.6.4 Other exogenous factors that affect the adoption of ICT

Other factors that were not examined in the study, such as social norms, attitudes, and tribe, have been found to have a significant effect on ICT adoption (Erumban & De Jong, 2006). However, it is quite difficult to measure these factors and evaluate them quantitatively. Hofstede (2001) developed a framework to measure the influence of societal culture empirically by using five dimensions, namely the power possessed by certain members, uncertainty avoidance, individualism, masculinity, and long-term orientation. Information and Communication Technology adoption is also connected to political liberties. The propensity to adopt technologies depends on existing liberties. Government must foster liberties, democratisation, human rights, and social empowerment that in turn increase ICT adoption. Corrales and Westhoff (2006) analysed ICT adoption in different countries and concluded that ICT adoption was low in countries that restricted the use of information technologies. Corrales and Westhoff (2006) added that technology adoption depends on the characteristics of both the technology and the farmers. Smallholder farmers can be rigid and might prefer to stick with the old technology. The ability to adopt ICT is therefore determined by the exposure of farmers to the latest technologies, their capacity to adapt, and state policies put in place by the government.

Exposure to ICT technologies refers to the external factors, such as connectedness, provided by the society that provides the necessary knowledge about the technology. Corrales and Westhoff (2006) added that smallholder farmers exposed to advanced technologies would have a higher interest in adopting the latest technology, as compared with farmers without such exposure. The capacity to adopt ICT involves the economic capacity of the farmer, which comprises income and resources, such as land, draft power, and skills. Smallholder farmers

located in developed communities with access to markets, the Internet, and other amenities are likely to adopt ICT technology. The Eastern Cape is one the least developed provinces in South Africa, and smallholder farmers in the Eastern Cape are cut off from valuable infrastructure necessary for ICT adoption. Corrales and Westhoff (2006) also added that technology adoption depended on the government policies put in place. Smallholder farmers in developed countries with access to Internet services by virtue of government policies have shown increasing ICT adoption. The government policies necessary for ICT adoption include Internet tax and tariff subsidies, rules and regulations, restrictions, incentives, and support for a particular technology.

2.7 Chapter summary

Technology aids agricultural development by allowing for the collection, processing, storage, exchange, and dissemination of information between people and computers. Potentially, ICT can play a significant role in addressing some of these challenges. The mainstreaming of ICT in agricultural stakeholder systems could spur economic development. The literature reveals that the role of ICT in improving food security and supporting rural livelihoods is being increasingly recognised. Many countries are using ICT for the dissemination of information and agricultural knowledge. The use of technology is very important for agricultural development because it reduces costs for farmers while increasing production and productivity. There is also a growing recognition of farmers and members of rural communities realising the importance of knowledge, information, and appropriate learning methods.

CHAPTER 3: METHODS AND PROCEDURES

The main aim of this chapter is to describe the methods used for both data collection and data analysis. The chapter also gives a clear description of the study area, with a map provided showing the study area. The sampling procedure, data collection techniques, and data analysis methods used in the research are also described in this chapter.

3.1 Description of the study area

This study was carried out in Mqanduli, a town in OR Tambo District (under King Sabata Dalindyebo Municipality) in the Eastern Cape province of South Africa. It is in the former Transkei and is near the city of Mthatha. The municipality is made up of Mthatha and Mqanduli, covering an area of 3027 square kilometers, and currently has 35 wards (Census, 2011). Furthermore, in terms of climate conditions, Mqanduli normally receives about 611 mm of rain per year, with most rainfall occurring mainly during mid-summer. It receives the lowest rainfall (7 mm) in June and the highest (90 mm) in March. The region is the coldest during July, when the mercury drops to 6.2 °C, on average, during the night.

Various agricultural activities are conducted in Mqanduli, including a government agro-processing programme aimed at boosting maize production (for smallholder maize farmers) in rural areas. Six primary smallholder maize co-operatives are set up in several farming villages (under the programme) around the rural town, supplying a nearby government mill (Phandle, 2015).

Figure 3.1: Map depicting the King Sabata Dalindyebo Local Municipality

Source: Google Maps (2019)

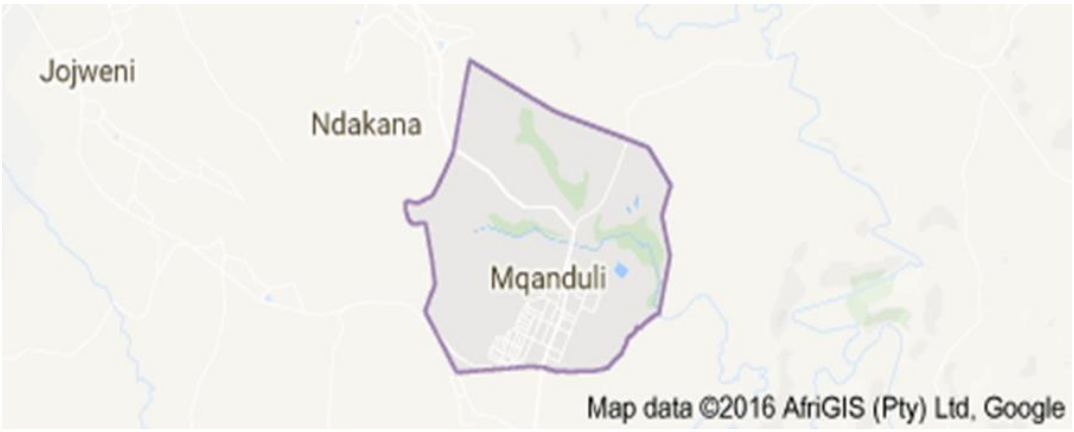

Figure 3.1: Map depicting Mqanduli

Source: AfriGIs (2016)

3.2 Research design

The study used a cross-sectional survey research design due to limited time and financial constraints. When all data is collected at the same time, the research design is typically cross-sectional (Bless et al., 2013). A researcher using this design attempts to understand a topic by collecting cross-sectional information relevant to the topic of study (Bless et al., 2013). The research design of the study outlined the basic approach that those researchers used to answer their research questions. Accordingly, the researcher must choose the most appropriate method to meet the aims of the research.

3.3 Sample frame

According to Bless et al. (2013), a sampling frame sets out a list of all units from which the sample is to be drawn. This is the second important factor that a researcher must consider when planning an appropriate research design. This becomes important when the researcher begins to draw a sample with which to work (Bless et al., 2013). The sample frame in this study comprises individual smallholder farmers in Mqanduli in OR Tambo District (under King Sabata Dalindyebo Municipality), in the Eastern Cape Province of South Africa.

3.4 Sampling methods

The selected sample consists of smallholder farmers in Mqanduli who are involved in maize production. Bless et al. (2013) noted that non-probability sampling is typically used for a case where the probability of including each element of the population in a sample is unknown. Availability or convenient sampling, which is one of the non-probability sampling procedures,

was used for this study. The advantage of using a non-probability sampling procedure consists of taking all cases on hand until the sample reaches the desired size. One of the advantages of nonprobability sampling is its lower cost compared to probability sampling. Monette et al. (1998) argued that the advantages of using a non-probability sampling procedure are that questionnaires can be completed quickly, many participants can be interviewed, and the sampling method is economical. This non-probability sampling was used because not every smallholder farmer at Mqanduli produces maize for sale.

3.5 Sampling procedure

When sampling, it is important to deal with an adequate or sufficient sample size to collect accurate information about a particular group (Bless et al., 2013). A large sample is more representative but costly to deal with, while a small sample is less accurate than a large sample, but more convenient to deal with. Sixty respondents were selected, based on convenient sampling, for face-to-face interviews. While it would be desirable to have used random sampling, the challenge was that maize farmers in this area do not need to register with the municipality, thus there was no existing sampling frame at the municipality on which one could perform simple random sampling. Therefore, the study made use of a convenient sampling method. The survey included 60 maize smallholder farmers as respondents. The researcher then employed convenience sampling or availability of the farmers, which is a non-probability sampling strategy. The farmers were interviewed using a questionnaire until the target sample size of 60 was obtained. It is critical to have an acceptable sample size when sampling to acquire accurate data (Bless, Higson-Smith, and Sithole, 2013). Sixty smallholder farmers were included in the sample because they were the only ones available while other farmers were unavailable due to the Covid-19 pandemic.

3.6 Sampling unit

According to Bless et al. (2013), a sampling unit represents the members or elements of the population, which could be people, groups, organisations, events, human products, or output in the case of human behavioural sciences. The sampling unit in this research comprised smallholder maize farmers of the town of Mqanduli in OR Tambo District.

3.7 Data collection

Smallholder maize producers who were among those engaged in small-scale maize marketing provided the primary data. The research was done in one phase. Interviewing respondents was

viewed as the ideal data collection strategy because smallholder maize farmers' ability to reply to a mail questionnaire was limited due to their relatively high levels of illiteracy and the lack of records at the farm level. It took roughly 50 minutes to administer the questionnaire. Interviewing the heads of households was the plan. When the farmer was not available, an informed adult household member was interviewed. Since appointments were made before the day of the interviews, such situations were uncommon.

In the data collection phase, the respondents were asked a set of questions that were presented in the form of a questionnaire. The questions were read to them in their home language. The questionnaire contained structured questions to elicit specific data, beginning with general questions before proceeding to more specific questions. The questionnaire had six sections. Part A was used to gather data on the demographic information of farmers. Part B focused on the perceptions of farmers about ICT as a tool for promoting market access, where the respondent was asked to select the appropriate answer. Part C dealt with information about the awareness of using ICT to access markets. Part D was about data on different kinds of ICT that were being used by the respondent smallholder farmers. Part E was used to gather information on the factors that influence these farmers to use ICT in agriculture. Part F collected data on the percentage of farmers who had identified new markets through ICT. The questionnaires were administered by an interviewer to ensure that all questions were considered and that respondents did not ignore difficult questions. The interviewer also ensured that information was obtained from respondents who could neither read nor write. Enumerators to assist in data collection were thoroughly trained before the commencement of the exercise. The enumerators used were competent in the language spoken in the sampled villages.

3.8 Data analysis

The responses were captured and coded in Microsoft Excel. The analysis involved using tables, charts, and graphs to show the results of the study. Microsoft Excel was used for descriptive statistics analysis to determine the means and standard deviations. The results were presented in tables, figures, and cross-tabulated forms.

3.9 Chapter summary

The study was carried out in Mqanduli, a town in the Eastern Cape province of South Africa. Many agricultural activities are conducted in Mqanduli such as a government agro-processing programme aimed at boosting maize production in rural areas. A cross-sectional survey

research design was used due to limited time and financial constraints. The sample frame in this study comprises individual smallholder farmers in Mqanduli in OR Tambo District (under King Sabata Dalindyebo Municipality), in the Eastern Cape Province of South Africa. This non-probability sampling was used because not every smallholder farmer at Mqanduli produces maize for sale. Sixty respondents were selected, based on convenient sampling, for face-to-face interviews. The interview was based on interviewing these farmers through questionnaires. The responses were captured and coded in Microsoft Excel. The analysis involved using tables, charts, and graphs to show the results of the study.

CHAPTER 4: RESULTS

This chapter presents the results of the study, under the following categories: demographics, marketing situation, challenges faced by farmers, the use of mobile service in agriculture, farmers' perception of ICT, and the level of ICT adoption.

4.1 Demographic characteristics

Table 4.1 shows the gender distribution of smallholder maize farmers in Mqanduli. The table reflects the gender distribution of all sampled farmers and indicates that 75% of the smallholder maize farmers in the study were females. This shows that most of the smallholder farmers engaged in the production of maize are females. Farming in rural areas is dominated by female farmers because males tend to migrate to urban areas to search for jobs. Previous studies (FAO, 2014) have found that, in most developing countries, agricultural production is mostly dominated by women, but they are marginalised in terms of access to ICT for economic and social empowerment.

The age distribution of smallholder farmers reflects those nine farmers (15%) between the ages of 15 and 30 years, ten (17%) were between the ages of 31 and 40 years and 11 farmers (18%) were between the ages of 41 and 50 years. About 53% of all the farmers were more than 50 years old, suggesting that maize production in Mqanduli is dominated by the senior citizens' sector with a relatively low rate of youth.

Table 4.1 shows the marital status of the respondents in the study area. There were only 13 (22%), single smallholder farmers, while 32 (53%) were married, 14 (23%) were widowed and two (3%) farmers were divorced. Therefore, most of the smallholder farmers who participated in maize production in this study were married.

Table 4.1 presents information on the level of education of the sampled population: 19 respondents (32%) had received primary education, six participants (10%) had attended secondary school, 11 respondents (18%) had attended high school, 15 respondents (25%) had a diploma certificate and eight respondents (13%) had university qualification. This study shows that most smallholder maize farmers in Mqanduli had at least acquired some primary education. Most farmers in underdeveloped countries have low levels of education, which is a barrier when it comes to using mobile phones (Wyche & Steinfield, 2015). Ninsiima (2015) found that the likelihood of adopting technology is influenced by the farmer's level of education.

Table 4.1: Demographic characteristics of the respondents

Variable	Description	Frequency	Percentage
Gender	Male	15	25.00
	Female	45	75.00
	Total	60	100.0
Marital	Single	13	21.67
	Married	32	53.33
	Widowed	13	21.67
	Divorced	2	3.33
	Total	60	100.00
Level of Education	Primary	19	31.67
	Secondary	6	10.00
	High School	11	18.33
	Diploma	15	25.00
	University	9	15.00
	Total	60	100.00
		Mean age	Standard deviation
Age	60	51.55	16.82

Source: Author`s computation using survey data, 2021

4.2 Type of ICT used by smallholder maize farmers

Figure 4.1 provides a summary of ICT tools used by smallholder maize farmers in Mqanduli. The results indicate that all the farmers had at least a cell phone, 15% of the farmers used email, 20% of the farmers used the Internet, 28% of the farmers used all the above-mentioned ICT tools, and 58% of farmers indicated that they made use of other tools such as television and radio.

The results show that cell phones are most popular in rural areas because all farmers use them, as they are cheap and easy to use. Some farmers indicated that they were using their mobile phones for the Internet and emails. Farmers mentioned that televisions and radios assisted them with information dissemination, especially during times of disease outbreaks, and they provide them with information on how to deal with the outbreak. Farmers with low education levels indicated that televisions and radios are helpful to them for knowledge and information dissemination because they are unable to use smartphones, emails, the Internet, and computers.

A study conducted in Kenya by Halima et al. (2017) concluded that radios constitute an important mechanism for disseminating knowledge and information, in different languages and formats. Furthermore, radio has achieved results in the delivery of useful information to poor people.

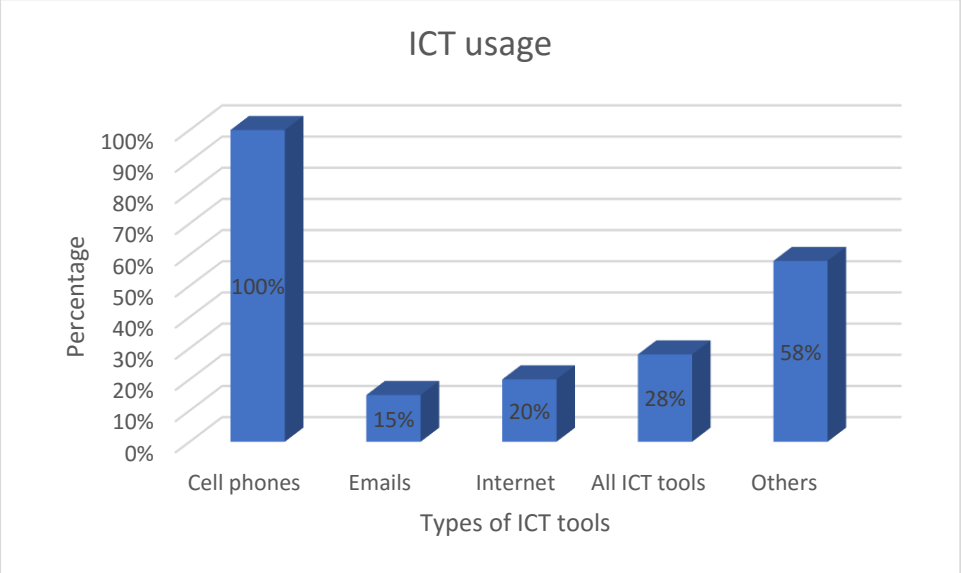

Figure 4.1: Types of ICT tools used by farmers

Source: Survey data, 2021

4.2.1 Mobile devices

Figure 4.2 presents a summary of the mobile devices that are popular in the study area. The results indicate that the following mobile phone devices are popular in rural areas: basic phones (52%), smartphones (42%), and iPads (6%). The results reveal that most smallholder maize farmers use basic phones because they are user-friendly, easy to use and operate, and relatively cheaper. Similar results were reported by Simpson & Calitz (2014), who found that many farmers in South Africa did not fully relate to advanced mobile phones or Internet access.

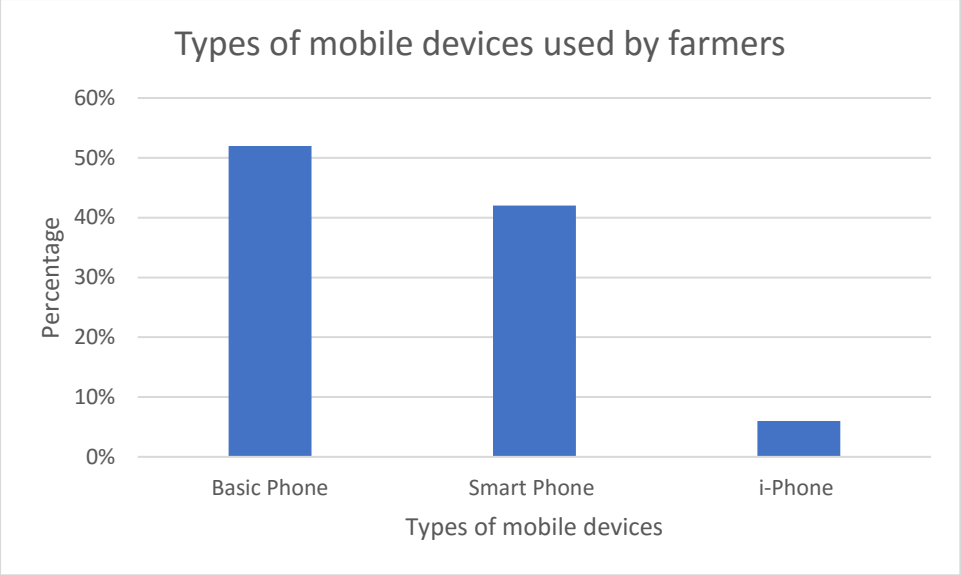

Figure 4.1: Types of mobile devices used by farmers

Source: Survey data, 2021

4.2.2 Automatic ICT systems

Figure 4.3 shows the extent to which farmers have office, procurement, and accounting automation systems, such as Sage Pastel, Dan Soft, and Dynamics Navision, on their farms. The results show that none of the interviewed farmers in Mqanduli used any of these systems on their farms because they lacked knowledge about these systems, and mostly use unpaid family labour and make use of seasonal workers. They do not have offices and instead use their houses as a base for running their farms. Nkambule and Agholor (2021) regardless of the technological challenges, the use of ICT and digital technologies in the agriculture sector in South Africa has begun to gain traction. Satellites, drones, autonomous sensing, wireless connection, and data management are all being used more often (Hanson & Heeks, 2020). These cutting-edge technologies are being used in agriculture to cut input costs, improve sustainability, and boost farm output (Nkambule & Agholor,2021). The costs associated with the usage of advanced digital technology make it difficult for small-scale farmers to adopt these technologies. There is widespread awareness and assumption that technology can help small-scale farmers gain better access to information and markets (Aker 2011). This is because technology may be utilized to alleviate some of the major issues that smallholder farmers confront, as well as to expose them to new opportunities through direct engagement with suppliers, consumers, and financial service providers.

Farmers were also asked about the extent to which they have computerised planting systems (e.g. teff planting machines) on their farms. The results show that all the respondents strongly agreed that computerised planting systems are very helpful. Most of the smallholder maize farmers in Mqanduli make use of computerised planting systems. These farmers stated that Mqanduli Red Hub assists them with computerised planting systems, and their officials operate them for the farmers. When asked about the extent to which they use computerised irrigation and fertigation systems on their farms, the results show that most of the respondents (85%) strongly agreed while 15% agreed that they used fertigation systems. This suggests that most of the smallholder maize farmers in Mqanduli use computerised planting systems. However, most of the farmers do not own these computerised planting systems, they lease them from Mqanduli Red Hub. Few of the farmers own the equipment, but the majority of the farmers are assisted by Mqanduli Red Hub for the provision of fertigation systems.

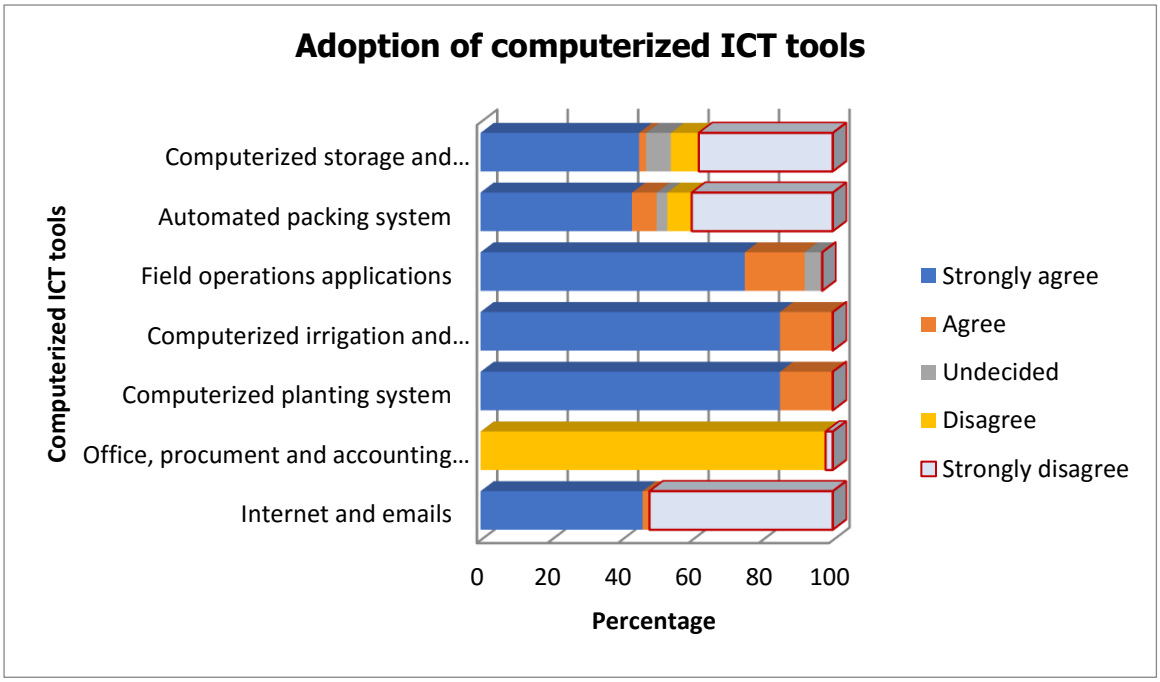

Figure 4.2: Adoption of computerised systems

Source: Survey data, 2021

Figure 4.3 shows the extent to which the farmers use field operations applications (e.g. Scarab) for pest and disease monitoring on their farms. The results show that most of the respondents strongly agree that using field operations applications helps them to kill pests and diseases easily and quickly. The farmers stated that Mqanduli Red Hub assists them with the application of pest and disease treatments in the field. They can access these services through their contract with Mqanduli Red Hub. This saves much time and cost for the farmers while improving

production. Figure 4.3 also shows the extent to which farmers use an automated packing system in their farms. Most of the respondent farmers do not have an automated packing system, while some use traditional methods and others are assisted by Mqanduli Red Hub. Regarding the extent to which farmers use computerised storage and refrigeration systems in their farms, the results show that most of the respondents (45%) use computerised storage and refrigeration systems in their farms. This shows that some farmers used computerised storage and refrigeration methods, while others did not.

4.3 The proportion of farmers using technology

Figure 4.4 presents a summary of how frequently smallholder maize farmers in Mqanduli use computer-related activities on their farms. The results indicate that most of the farmers use computer-related activities on their farms for production. It has been noted that few farmers use computer-related activities for other activities besides production, and most of these farmers are younger and more educated. It has been noted that younger and better-educated commercial farmers who are intensively managed are mostly connected to the Internet. van Biljon and Kotze (2008) mentioned that mobile phone adoption and usage are influenced by cultural beliefs.

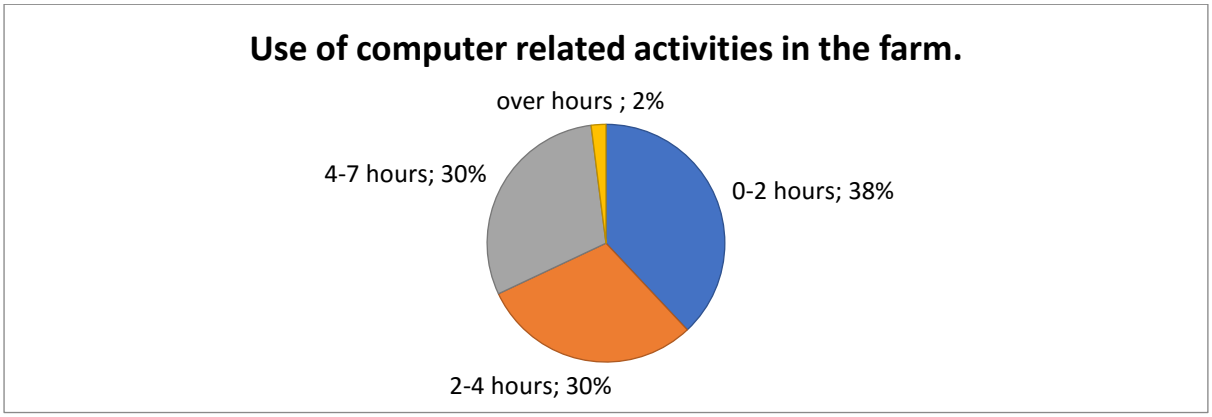

Figure 4.3: Use of computer-related activities on the farm

Source: Survey data, 2021

The majority of the respondent farmers use neither the Internet nor emails. They use basic phones, and they lack knowledge about the Internet and emails, and most of these farmers are above the age of 50 years, with primary education.

4.4 Factors affecting ICT adoption among maize farmers

4.4.1 Demographic factors

The characteristics of a farmer, such as level of education, gender, and age affect his or her adoption of ICT.

4.4.1.1 Gender

The regression results of this study show that females were more likely to adopt ICT than males. However, the effect of gender on the adoption of ICT has shown different results in other studies (Bonabana-Wabbi, 2002). Morris & Doss (1999) argued that gender had no significant effect on technological adoption, and that adoption decisions depended on accessibility to resources such as land, education, and other significant variables. If the adoption of a particular technology depends on the accessibility to such resources, then the adoption of agricultural technology would be in favour of the gender that has access to important resources. In most developing countries, men have greater access to vital resources, such as land, labour, and other important assets, which could have more of an influence on their decision to adopt ICT, as compared with women. Farming in the Eastern Cape is a female-dominant activity, and the number of men involved in farming is low. The Gender variable was significant because the decision to adopt ICT is made by the household head and, in this case, most of the households interviewed were female-headed households. Other studies support our findings that the primary decision-maker will influence the decision to adopt ICT (Mignouna et al., 2011; Omonona, et al., 2006).

Studies done in developing countries have shown that male smallholder farmers were more likely to adopt agricultural technology than female smallholder farmers (Lavison, 2013). Mutune et al. (2011) explained that most agricultural technologies in their initial stages are labour intensive; hence, the a low adoption rate by women in developing countries. However, ICT adoption does not require labour-intensive activities. Agricultural technologies that require the use of land and animals, such as cattle, usually have a low adoption rate by women because most of the resources are owned by men. This explains why the gender variable was significant in favour of women and not men. The interpretation of the gender variable in the complex adoption of ICT technology should be carefully evaluated and interpreted with caution.

4.4.1.2 Education

Farmers with high school qualifications and above tend to adopt ICT the most. In this study, it was noted that men have greater and easier access to ICT and more readily adopt technology than women do. There is a general lack of community awareness about the potential benefits and capabilities of ICT (William et al., 2017). Without a high level of ICT awareness, no community can fully participate in this networked world (William et al. 2017).

The higher education levels of smallholder farmers have been assumed to have a positive effect on ICT adoption decisions because education increases the smallholder farmers' ability to access, process, and implement the relevant information required for the adoption of new technology (Namara, et al., 2014). Ajewole (2010) conducted a study and concluded that education levels had a significant effect on technology adoption. Educated smallholder farmers tend to make more open and rational decisions and can analyse the benefits of adopting new technology (Waller et al., 1998). A study by Uematsu and Mishra (2010) also reported a positive relationship between education and ICT adoption. However, other studies found education to have an insignificant or negative effect on the adoption of technology (Banerjee et al., 2008; Samiee et al., 2009). The study by Uematsu and Mishra (2010) found formal education to have a negative influence on the adoption of genetically modified crops. Despite the studies that show mixed results for the effect of education on the adoption of technology, most of the studies done support our research results.

4.4.2 Lack of ICT knowledge

The majority of the farmers indicated that they lacked knowledge about ICT and how they could use it in agriculture. They were using their cell phones to communicate with other farmers, but they did not know that they were thereby making use of ICT. Furthermore, farmers stated that they need to be taught about the different types of ICT and about how they could use them to develop their farms. Smallholder farmers do not have access to information, knowledge, and communication due to the lack of adequate telecommunication infrastructure. A study conducted by Tembo (2008) in the Western Cape Province found that rural areas have the lowest access to ICT due to a lack of resources and that the inaccessibility of ICT makes it difficult to share information across traditional barriers and to give a voice to traditionally unheard people.

4.4.3 Lack of access to ICT

The less-privileged farmers lack access to computers, email, and the Internet because they believe that these mechanisms are costly, do not know how to use and operate them, and are unable to afford them. Some farmers stated that they do not have a computer, they make use of internet cafes and their smartphones, and it is expensive to purchase data and connect to the Internet. The use of ICT to connect rural farmers is limited due to a lack of Internet connectivity in most developing countries (Tembo, 2008). Many of the interviewed farmers depend mainly on radio, television, exhibitions, field demonstrations, and cell phones for information and communication.

Access to information about the latest and improved modes of ICT, and the use of ICT, are some of the most important determinants of ICT adoption (Mwangi & Kariuki, 2015). ICT information can be accessed via compatible mobile phones, which enables smallholder farmers to learn about the existence and the effective use of technology, and this facilitates ICT adoption. Smallholder farmers can only adopt ICT if they have the right information, including about how it works. Information accessed through using compatible mobile phones reduces doubt about and enhances an individual's assessment of, a particular technology (Caswell, et al., 2001). However, having a compatible phone does not necessarily mean that smallholder farmers are going to use the device to access ICT information. Moreover, accessing ICT information does not necessarily mean that farmers will adopt ICT (Uaiene & Arndt, 2009). The accessibility of information and communication technology information might also lead to the abandoning of the adoption of ICT. For example, when the general population receives a negative experience with a particular technology and that negative information is shared, this type of information might induce the abandoning of a previous adoption of ICT (Bonabana-Wabbi, 2002). The information being shared must be reliable, consistent, and accurate. Farmers need to know about the benefits, usage, and risks associated with a specific technology before they make an adoption decision.

4.4.4 Cost of adopting ICT

Figure 4.5 shows the responses of respondents regarding the high cost of ICT. When compared to cheaper technological tools, 17% of farmers indicated that expensive technology is less likely to be adopted. The cost of ICT adoption is one of the major constraints hindering smallholder farmers from adopting ICT. Wekesa et al. (2003) analysed the determinants of technological adoption in Kenya and discovered that the low rate of technological adoption

was attributable to the high cost of inputs and the lack of access to improved varieties. Muzari et al. (2013) found that the removal of input subsidies contributed to the slow adoption of improved agricultural inputs. Makokha et al. (2001) noted that the high costs of labour and agricultural inputs were the main constraints in agricultural technology adoption. Mwangi & Kariuki (2015) also reported that the high cost of ICT was a hindrance to technological adoption.

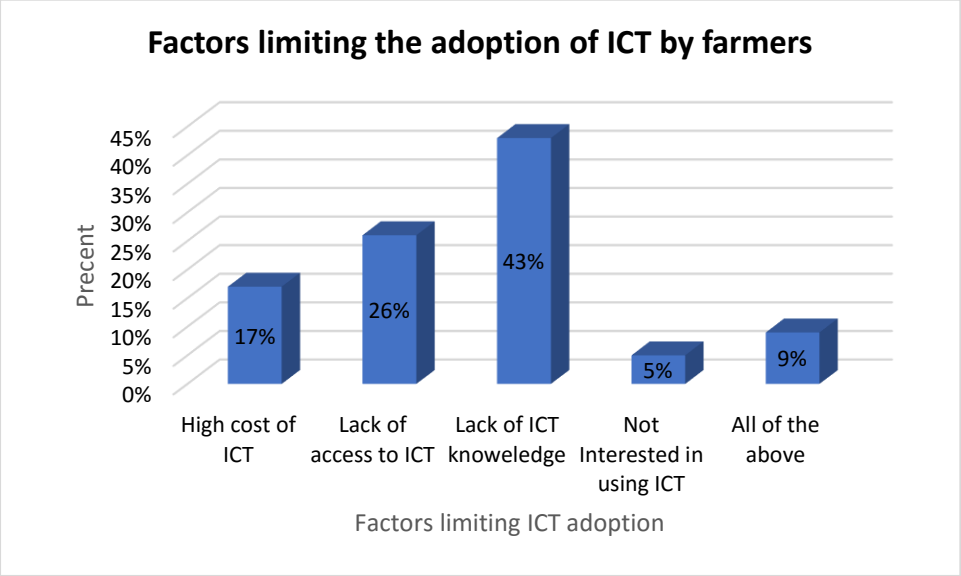

Figure 4.4: Factors limiting the adoption of ICT by farmers

Source: Survey data, 2021

4.4.5 Benefits associated with ICT adoption

This section presents results on the benefits associated with ICT adoption. Figure 5.6 presents a summary of the benefits associated with ICT adoption by smallholder farmers in Mqanduli. Figure 4.6 indicates that 88% of the respondents believe ICT has helped them to increase their production and 12% ICT did not help them to increase their production. These farmers stated that ICT enabled them to research the best inputs and their prices. They were also able to check weather conditions, and this helped them during the planning stages. Results indicate that 80% of the sample ICT helped them to access markets for their maize, with only 20% suggesting they never access markets using ICT. These findings suggest that smallholder farmers who have a high level of ICT access should be targeted for rural development. ICT has helped them to have agreements with Red Hub where they are selling their maize and they do not have to visit the Hub physically.

Figure 4.6 also shows that the use of mobile phones allows easy communication among farmers. The results suggest that 90% of the farmers indicated that ICT has allowed easy communication channels amongst farmers and 10% not using mobile phones to communicate with other farmers. The farmers that are not using mobile phones to communicate with other farmers indicated that it was because mobile phones are not user-friendly due to the language they speak. They also do not have time to be looking at mobile phones and they do not know how to operate them. Farmers use their mobile phones to contact extension officers 88% of the farmers, while only 12% do not use their phones to communicate with farmers. Most of the farmers indicated that ICT has helped them to easily communicate with extension officers since they do not have to wait for extension officers to come physically to assist the farmers. They also stated that with the use of ICT, their problems can easily be resolved, and it saves time and helps them to reduce product losses. Simpson and Calitz (2014) specified that mobile phones are important in the farm business, provided their usage is beneficial to their work. This will also help in market access and in determining the current prices of agricultural products. Moreover, mobile phone services had created a platform for farmers to ensure that they can negotiate deals with traders and improve the time to get crops to the market, using SMS text messaging to transfer accurate information about wholesale and retail prices of crops. According to Taylor (2012), the use of mobile phones allows easy communication among farms. They can easily access and share information and can consult each other whenever facing a problem. MercyCrop (2013) noted that most farmers depend on word of mouth to get the information provided by extension officers thus, there is a need to delaminate more information about market prices, product processing, and weather information because there are few extension officers. Jenny (2011) noted that mobile phones lead to an improvement in market efficiency for certain commodities, and it also acquaints farmers with product prices. Asenso-Okyere and Mekonnen (2012) argued that mobile phones (ICT) can allow extension farmers to help rural area farmers where they might be informed by the latest technologies, rainfall forecasts, and commodity prices and combine meetings through mobile phones for more updates from the agricultural department. Travel and transaction costs for farmers have been reduced through the use of mobile phones to make payments. This has allowed both microfinance institutions and farmers to enjoy higher profits (World Economic Forum, 2012).

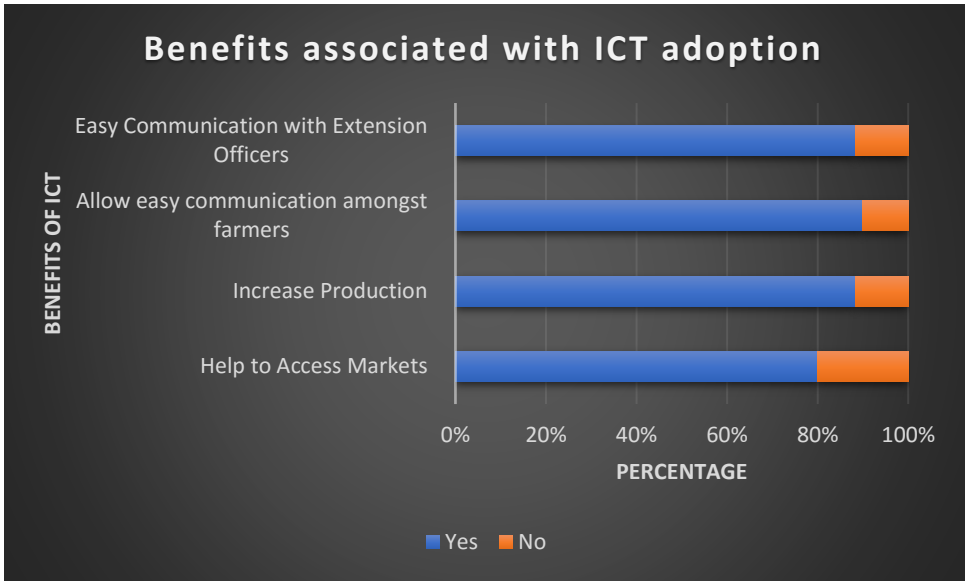

Figure 4.6: Benefits associated with ICT adoption

Source: Own survey (2021)

4.5 Determinants of ICT adoption

4.5.1 Smallholder farmers' perceptions of ICT related to agriculture

Figure 4.7 shows the responses of farmers regarding whether they think that ICT tools are easily accessible. Most farmers think that ICT tools are easily accessible because they are using them daily to communicate with each other, such as cell phones. Some of the farmers could not decide whether ICT tools are easily accessible or not because they lack ICT knowledge. Farmers stated that ICT is easily accessible by farmers as it encompasses many devices that they use daily, such as radios, televisions, cell phones, computers, the Internet, and email.

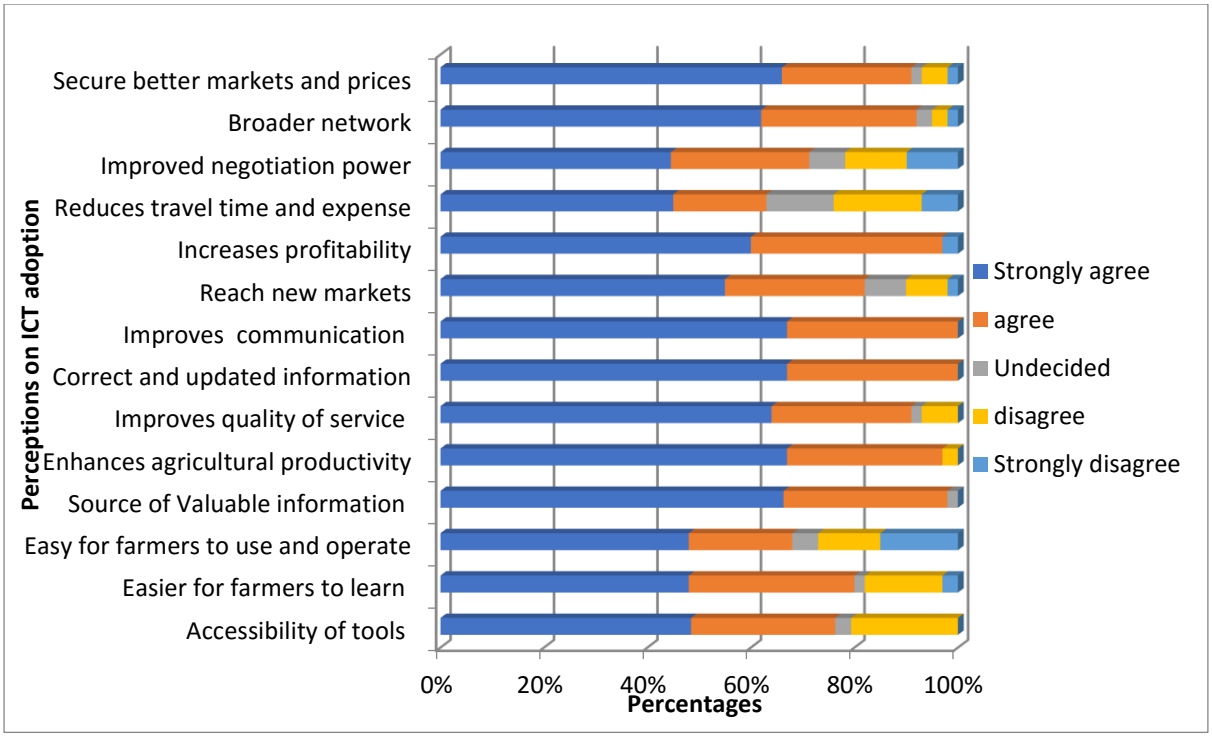

Figure 4.7: Farmers' perceptions of ICT adoption

Source: Survey data, 2021

Among the smallholder maize farmers interviewed in Mqanduli, 48% strongly agreed that learning how to use ICT tools is easy and 32% agreed, indicating that the majority agreed that ICT is easy to learn about and use. Only 2% of the farmers were undecided, while 15% disagreed and 3% strongly disagreed, which is attributable to their low literacy levels about ICT, and this was influenced by their education levels. It has been noted that the youth and farmers with high literacy levels can quickly learn how to use ICT. The majority of smallholder maize farmers in Mqanduli stated that ICT tools are easy for farmers to learn to use. Okoboi et al. (2013) stated that some farmers perceive that mobile phones have the potential to introduce them to innovations that could help them to produce crops of good quality as a result of technological support. Farmers were also asked if the ICT tools were easy to use and operate by farmers. About 80% of the farmers stated that the ICT tools were easy for farmers to use and operate, and these helped them to save time. According to Shah and Shaukat (2013), the latest technologies make life easier, save time, and provide a quick link to other people/organisations and departments. It has been noted that older farmers and farmers with low literacy levels encounter problems regarding how to use and operate ICT tools.

ICT helped respondent farmers to reduce the transaction costs that are associated with sourcing information. Respondents indicated that ICT helped them to receive valuable information.

They further indicated that you do not have to meet with other farmers face-to-face to get valuable information; you can communicate with them telephonically and get all the information you need. Figure 4.6 shows that 65% of the farmers strongly agreed, 31% agreed and 2% were undecided. Halima et al. (2017) found that ICT has the potential to provide easy access to information, facilitate accountability and transparency, improve the distribution of information, and can help to decentralise information systems, reduce dependency and empower rural people with timely and accurate information, and knowledge. Most of the farmers believed that ICT could improve the quality of service offered because they can easily communicate their needs. Farmers mentioned that ICT had improved the quality of services offered to them because they could check if the service provider was offering them the best service by using the Internet to check the best services. Research conducted by Lokeswari (2016) noted that ICT provides a fantastic chance to improve the flow of information and technological services, particularly to farmers.

Based on the results obtained, most of the respondent smallholder maize farmers believed that the use of ICT helped them to boost their productivity, as they were able to receive all the necessary production information, on time. The results indicate that 67% strongly agreed, 30% agreed, and 3% disagreed that ICT can boost agricultural productivity. The farmers noted that ICT can facilitate information transformation about new seed varieties and make markets operate more efficiently, thereby increasing overall production. Figure 4.7 also illustrates that most (67%) of the respondent farmers strongly agreed while 33% agreed that ICT enables farmers to acquire correct and updated agricultural and market information. The farmers indicated that, with the use of cell phones, they could receive the right information at the right time, which would lead to an improvement in their yields.

The use of ICT has also enabled the farmers to be updated easily about current issues in the agricultural sector, such as disease outbreaks, and how they can treat them. It has also helped to keep farmers up to date with information on marketing and risk transfer, which improves their capacity and mitigates risks. ICT provides an opportunity to increase processing power while decreasing costs associated with sourcing information (Halima et al., 2017). In addition, the respondents thought that ICT improves farmers' communication with agricultural workers and suppliers because they can communicate with extension officers without having to go to their offices or wait for them to visit their farms. Farmers also revealed that they could order inputs from suppliers by using their cell phones, which leads to a reduction in transaction costs. According to Lokeswari (2016), ICT needs to be promoted for communication between

extension officers and farmers for the transmission of information and technologies, as it can bring new information services to rural farmers.

ICT also enabled the respondent farmers to reach new markets. The results indicate that 55% strongly agreed and 27% agreed that ICT enabled farmers to reach new markets. Most of the respondents believed that ICT could help them to reach new markets because they can then sell their maize online without having to go to the market. It could also assist farmers to reach many markets besides the local markets. The farmers also stated that they could obtain information that they could then use to improve their agricultural income and their lifestyles. Farmers also believed that ICT reduces travel time and expenses. Most of the respondent farmers indicated that ICT has the potential to reduce travel and expenses because they would not have to travel to the city to access information and service, and they could do all of that by using their mobile devices, which saves much time and costs. A study conducted by Halima et al. (2017) noted that transaction and travel costs can be reduced significantly by receiving accurate and timely information.

Figure 4.7 also presents the results for farmers who think that ICT leads to improved negotiation power. The Figure also presents the results for farmers who think that ICT leads to a broader network. The farmers mentioned that ICT can reach a broader network because they do not have to physically meet stakeholders, and it can assist them to make quick and timely decisions, which leads to the growth of income for the farmer. Respondent farmers stated that there is a problem with connectivity, which limits them from reaching a broader network of stakeholders. Problems with connectivity and poor network coverage have been major setbacks that most developing communities have faced in South Africa since the early 1990s (Tembo, 2008).

Figure 4.7 further presents the results for farmers who think that ICT helps them to secure better markets and prices. Most farmers perceive that ICT can help them to secure better markets and prices. A few farmers stated that they were using cell phones to check Safex prices to determine the right time to sell their maize. Generally, the results suggest that the respondent rural farmers share positive perceptions concerning ICT. There is also a fair share of fears related to costs and devices not being user-friendly, especially for the uneducated. Farmers' positive attitudes toward ICT as an effective and efficient information support tool would lead to greater conviction and more efficient extension program planning in a changing agro-rural environment.

4.5.2 Awareness of ICT related to agriculture

To determine the awareness level of ICT among smallholder farmers, respondent farmers were asked different questions about their ICT awareness. The results show that 95% of the respondents were aware that cell phones can be used to receive information that is related to agriculture, with only 5% being not aware. These results revealed that there is a high level of cell phone growth and use in rural areas. These findings indicate that rural development could be addressed through the high level of mobile service dissemination in rural areas. Figure 4.8 presents the results for farmers regarding agricultural applications on their phones. The results indicate that none of the respondents had agricultural applications installed on their mobile phones. There are many reasons to explain this situation, including language barriers, lack of awareness about these mobile applications, ignorance, unwillingness to use them, and the type of mobile phone (basic) owned by most respondents. Most of the respondents were not aware that there was an available agricultural application that they can download onto their phones.

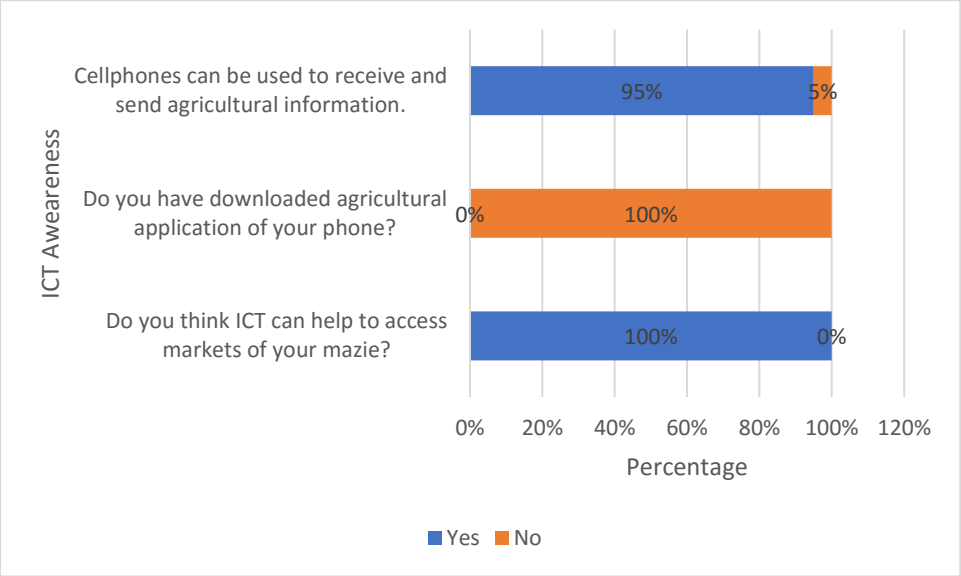

Figure 4.8: ICT awareness of farmers

Source: Survey data, 2021

All the farmers were aware that cell phones can assist them to gain access to markets for farmers. These findings suggest a high level of cell phone dispersion in rural areas, which is worth targeting to address rural development. Mobile phones close a gap of missing information, such as about government intervention for improving the rural livelihoods of farmers, which is vital for farmers (Makhijani et al. 2015). Tembo (2008) mentioned that

mobile phones provide an appropriate tool for alleviating poverty. Figure 4.8 above shows that respondents believe that cell phones can help them to access markets. The farmers also understand that using cell phones for this purpose would help them to reduce transaction costs, as they would then be sure that they would be selling their product when there is a demand for the product. The respondent farmers also indicated that other farmers are helping them to receive marketing information.

Generally, the results indicate that most of the smallholder maize farmers interviewed were not aware of ICT related to agriculture. This is a result of the lack of information dissemination and training by extension officers. Those who confirmed being aware of such ICT tools noted that cell phones were widely used by smallholder maize farmers as an ICT tool in the dissemination of information, and were the easiest form of ICT that all farmers would know how to use. These findings agree with the findings of a study by Halima et al. (2017) which was carried out in Kenya, who reported that farmers had no information about the use of ICT to obtain information. Nevertheless, in most African countries, the radio plays a vital role in the dissemination of information due to low literacy rates.

4.6 Major challenges affecting smallholder farmers

As indicated in Figure 4.9, only six respondents were experiencing low quantities in their production because inputs were being provided by the Department of Agrarian Reform and Rural Development. Furthermore, only 17 farmers complained of poor quality of produce as being a major challenge in their production. Most smallholders produce a low quantity of production, being poor with little capital assets for maintaining their farms, while also experiencing poor water quality. Baloyi (2010) reported that a lack of product knowledge leads to lower quality in production. He noted that supplying fresh produce markets and agro-processing industries was then still a challenge for most rural farmers because they lacked consistency in production.

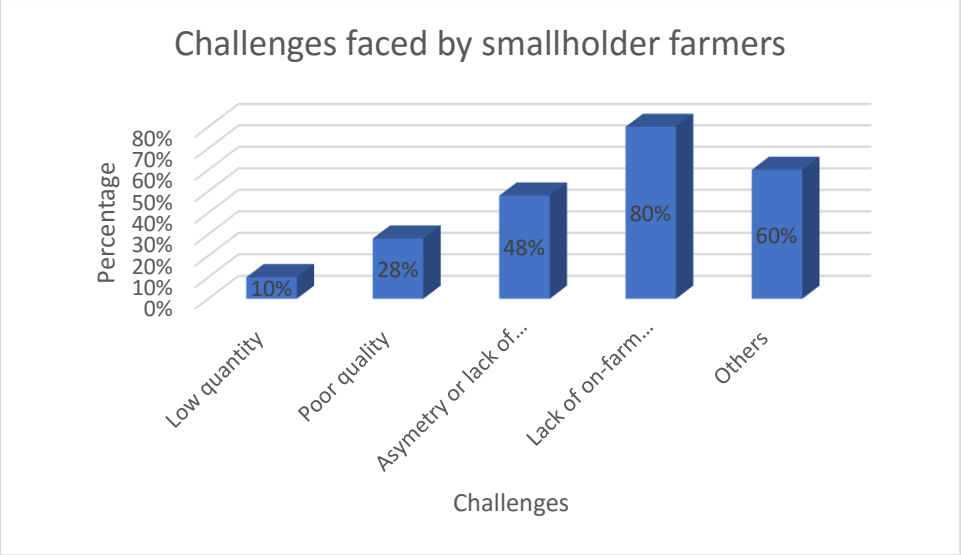

Figure 4.9: Major challenges affecting smallholder farmers

Source: Survey data, 2021

Some of the respondent farmers stated that a lack of human capital is one of their challenges because they lack financial and marketing skills, which renders them unable to meet the quality standards set by the Mqanduli Red Hub. Some of the interviewed farmers indicated that they have a problem with low quality because their maize would be classified as grade 3, which affects their income and the sustainability of their farms. Some of the smallholder maize farmers in Mqanduli mentioned that they have a challenge with irregularity in the quality and quantity of their produce. This resulted in them losing the contracts they had with supermarkets and Mqanduli Red Hub because they were not able to meet the demand and the standards required in the formal markets. A study carried out in Vryheid (Abaqulusi) Municipality, KwaZulu-Natal by Ntshangase (2014) found similar results, to the effect that most smallholder farmers have a challenge regarding low quality and poor quality due to poor resources and are unable to produce a stable amount of output each year.

Most (55%) of the respondent farmers wish to gain access to marketing information so they could sell their maize in other markets, and they wish that extension officers would assist them by providing market information. The farmers indicated that they were only aware of one local market, Mqanduli Red Hub, where they sell their maize. They indicated that the use of Safex prices by Mqanduli Red Hub had affected their return. The information about marketplaces, when to sell products, and potential buyers is limited for most rural farmers. Von Loeper et al.

(2016) have argued that field extension agents are ill-informed about local markets and often do not provide the necessary training and assistance that would enable smallholder farmers to gain access to information about markets. However, all the surveyed farmers had cell phones and a few of them were using their cell phones to check the Safex prices to determine the right time to sell their maize. These farmers indicated that cell phones have helped them to network with other farmers and different stakeholders and to gather market-related information. This shows the willingness of smallholders to use technology for agricultural purposes. A study conducted by Baloyi (2010) in the Limpopo Province also found similar results, to the effect that the use of cell phones has the potential to help farmers reach a broader network of farmers and different stakeholders and to gather market-related information, such as market prices.

About 80% (Figure 4.9) of the respondent smallholder farmers stated that the lack of on-farm infrastructure was the major challenge that they faced. A few of the farmers indicated that they owned tractors that were sponsored by the Department of Trade and Industry (DTI), while most of the farmers indicated that they did not have access to such assets and had to hire the equipment from the more prosperous farmers. According to Baloyi (2010), access to transport by smallholder farmers plays a significant role in their ability to access markets. Most of these farmers do not have harvest machinery, storage facilities, or transport for ferrying their maize to the market. However, most of the respondent smallholder farmers indicated that their contractual agreement with Mqanduli Red Hub had assisted them to overcome all the infrastructure challenges as they received assistance to get their products to the market. The farmers also stated that this was time-consuming at times because many farmers were dependent at the same time on Mqanduli Red Hub for infrastructure, so at times, it took a long time for each of them to receive assistance.

Lastly, 36 respondents stated that they were affected by other challenges when marketing their produce, such as climate change, high transaction costs, and lack of capital because they are not sure when to plant their maize. Moreover, most of the respondents stated that asymmetric information is a major challenge, followed by the low quantity or poor quality of their produce. Most of the farmers indicated that they are facing challenges of drought, which affects their production, and they are not certain when to plant their maize, and this uncertainty is caused by climate change. Some of the farmers indicated that climate change has led to a reduction in their agricultural productivity.

4.7 Chapter summary

The major findings drawn from this study indicated that challenges faced by smallholder maize farmers include the low quantity and quality of maize, the lack of information on markets, the lack of on-farm infrastructure, climate change, high transaction costs, and the lack of capital and production constraints. The findings show that most farmers are facing challenges regarding a lack of infrastructure and climate change. The findings further revealed that smallholder farmers are aware of some of the ICT that is related to agriculture, but the level of usage is very low. Smallholder farmers in Mqanduli face many challenges that hinder them from adopting ICT. The results also reflected that the level of education, gender, and willingness to use compatible phones, as well as the cost of adoption, influenced ICT adoption. Accessibility to information has the potential to improve the adoption of ICT among smallholder farmers. Smallholder farmers with higher education levels were more open and rational towards ICT adoption and were better able to analyse and appreciate the benefits of the new technology. The study also noted that the farmers are willing to adopt ICT because they think it can help them to solve all the challenges they are facing, and it provides a cheap and effective way of disseminating information.

CHAPTER 5: SUMMARY, CONCLUSION, AND RECOMMENDATIONS

5.1 Introduction

This chapter provides a summary of the study, the conclusions, and recommendations. It outlines the objectives of the study, as well as the findings, and formulates the conclusions and recommendations. The chapter shows whether the objectives of this study were achieved, thereby fulfilling the main objective of determining the level of ICT adoption, and its determinants, among smallholder maize farmers in Mqanduli, Eastern Cape.

5.2 Summary

The study was carried out in Mqanduli, Eastern Cape. The main objective of the study was to determine the level of ICT adoption and its determinants among smallholder farmers in the study area.

The specific objectives were to:

1. identify the different types of ICT used by smallholder maize farmers and the proportion of farmers using the technology;
2. identify the factors affecting the adoption of ICT among smallholder maize farmers, and
3. identify the challenges faced by smallholder maize farmers and ascertain how the use of ICT could address these challenges.

It was observed that the respondent smallholder farmers were facing numerous challenges that affected their ability to adopt ICT. The findings drawn from the analytical results showed that basic phones were most common among smallholder farmers, followed by smartphones, and lastly, iPads. The findings of the study showed that there were six types of ICT tools used by smallholder maize farmers in Mqanduli. The computerised systems that farmers in Mqanduli used were provided by the Mqanduli Red Hub. The farmers were provided with mechanisation tools and computerised systems, which made it easier for the farmers to produce maize. However, most farmers still lacked knowledge about ICT and how to use ICT in agriculture. They were using their cell phones to communicate with other farmers, but they did not know that they were thereby making use of ICT. Many factors hinder farmers from adopting ICT, such as lack of knowledge, lack of accessibility to ICT, the cost of ICT, and lack of infrastructure. The major findings drawn from this study were that the challenges that the

smallholder maize farmers face include the low quantity and poor quality of their produce, a lack of information on markets, a lack of on-farm infrastructure, climate change, high transaction costs, lack of capital, and production constraints. The findings show that most of the farmers are facing challenges with a lack of infrastructure and climate change. The farmers understand that ICT can contribute to reducing their production costs and transportation costs. It can assist them in gaining access to financial support and receiving sponsorships.

The results showed the level of education, gender, benefits associated with ICT, and awareness. Perceptions of ICT and the cost of adoption influenced ICT adoption. Improved accessibility to information has the potential to improve the adoption of ICT among smallholder farmers. Compatible phones, such as basic phones and smartphones, enable smallholder farmers to learn about the use of technology and thus facilitate ICT adoption. However, despite some farmers having compatible phones, they did not know how to use the device to adopt ICT. The results indicated that education level had a significant influence on ICT adoption. Smallholder farmers with higher education levels were more open and rational when it came to ICT adoption and can analyse the benefits of the new technology. Gender had a significant influence on ICT adoption, although the impact of gender on ICT adoption depended solely on the accessibility of resources, rather than on gender.

5.3 Conclusions

Smallholder farmers are aware of some of the forms of ICT related to agriculture, but the level of usage is very low. This is attributable to low literacy levels, a lack of infrastructure, a lack of awareness about different ICT tools, and the cost of ICT. Most of the respondent farmers made use of six different types of ICT, namely, computerised storage, automated packing systems, computerised irrigation, computerised planting systems, and marketing through using basic cell phones. It is worth noting that most farmers have basic cell phones and mostly use them to send and receive information related to agriculture. Despite the low usage of ICT, the smallholder maize farmers in Mqanduli have positive perceptions of ICT as a tool for assisting farmers to gain better access to markets. The smallholder farmers were willing to adopt ICT once they get the necessary training on ICT.

Smallholder farmers in Mqanduli face many challenges that hinder them from adopting ICT. Some of the challenges include a lack of on-farm infrastructure, low quantity and poor quality of products, lack of capital, climate change, production constraints, and lack of information on markets. Furthermore, most of the farmers mentioned that asymmetric information, lack of

capital, and climate change are the major challenges they face, followed by the low quantity and poor quality of their produce. Lastly, the study noted that the farmers are willing to adopt ICT because they believe it could help them to solve all these challenges and provide a cheap and effective way of receiving dissemination of information.

5.4 Policy recommendations

Based on the study results, the following recommendations are suggested and can be used as a guide in improving the adoption and usage of ICT amongst smallholder farmers in the study area and South Africa as a whole:

- The government should provide workshops where farmers would be introduced to and trained in ICT and would also be trained on how to use ICT to improve their market access.
- There is a need for network providers, in partnership with the government, to install and improve telecommunications infrastructure in rural areas so that smallholder farmers would be able to adopt ICT.
- The Department of Agriculture and Rural Development should assist smallholder farmers with funding for acquiring ICT infrastructure for their farm businesses.
- The Department of Public Works should assist by improving road infrastructure and building dams in rural areas.
- The government in collaboration with the private sector should provide mobile applications that can be downloaded and used by farmers for agricultural purposes. It would help to ensure that the farmers can receive timely and accurate information and reduce their dependency on extension workers for information. This would also assist to improve communication channels between the farmers and extension workers.
- The study reported here indicates that there is a low level of ICT usage by smallholder farmers. Therefore, smallholder farmers should be trained on the difficult types of ICT and the benefits of ICT for their farm businesses.

5.5 Suggestions for future research

Future studies involving the use of quantitative methods and econometrics approaches are recommended as they are likely to provide better and more interesting results. The nature and quality of the data gathered from the farmers in this study made it difficult to use quantitative

methods. Therefore, future research should collect data from larger samples of farmers and include more variables.

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