THE EFFECT OF ICT USE IN ENHANCING MARKET PARTICIPATION AND HOUSEHOLD WELFARE OUTCOMES AMONG SMALLHOLDER FARMERS IN THE EASTERN CAPE PROVINCE OF SOUTH AFRICA

by

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DEDICATION

I dedicate this work to the pillars of my strength, namely, my mother **Zanele Victoria Cebiso**, my brother **Yonela Cebiso**, as well as everyone who contributed to me in reaching this level of my education.

DECLARATION- PLAGIARISM

I, **Cebiso Zodidi**, declare that:

a) the research reported in this thesis, except where otherwise indicated, is my original research;
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c) this thesis does not contain other people's data, pictures, graphs, or other information, unless expressly acknowledged as being sourced from other people.
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Signed:  Date: 30/07/2022

As the candidate's supervisor, I, **Professor Maxwell Mudhara,** agree to the submission of this thesis.

Signed:  Date: 02/08/2022

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ABSTRACT

Enhancing the ability of smallholder farmers to actively engage in markets is one of the most pressing development challenges in sub-Saharan Africa. Despite being deemed significant contributors towards the production of various commodities, smallholder farmers have weak linkages to the markets. They are poorly equipped to make sound marketing decisions, partly due to a lack of access to market information. As the agricultural sector becomes more knowledge-intensive, due to the availability of the new information technology there is a greater need for a good information flow and sharing among all agricultural stakeholders. Therefore, since Information and Communication Technologies (ICTs) are emerging as key source of information on new production technologies, they could contribute immensely to the amelioration of the dearth of information among the poor smallholder farmers along the value chains and could thus link them to profitable markets.

The number of mobile phone subscribers in South Africa is increasing daily and most rural households currently own ICT tools. However, the extent to which rural households utilize these technologies for agricultural activities remains unexplored. Therefore, this study adds to the existing literature on the use of ICT amongst smallholder households by examining the effects of its use in enhancing market participation and the household welfare outcomes among smallholder farmers in the Eastern Cape Province of South Africa. Data were collected by using a questionnaire survey from 246 randomly selected smallholder farmers in the Port St John's Local Municipality. The first objective was to investigate factors influencing the use of ICT by smallholder farmers for accessing market information, by using binary logistic regression. The second objective was to examine the effects of ICT-use on smallholder market participation and the quantity of green mealies sold, by using the double-hurdle model, while the third objective was to assess the effect of market access on the welfare outcomes of smallholder farmers, by using propensity score matching.

The results from the descriptive statistics showed that 78% of the sampled population used ICT for accessing market information, which was mostly accessed by using mobile phones. The results also showed that only 2% of the population was familiar with agricultural farming applications, with the mostly used applications being Leaf Snap, Plantix and Agri-assistant apps. Based on the

empirical results variables such as age, household income, access to electricity, and quality network coverage, are positively and statistically significant in influencing the use of ICT by smallholder farmers for accessing market information, while farm size was negatively and statistically significant in influencing the use of ICT by smallholder farmers for accessing market information. Among the variables tested against market participation and the quantity of green mealies sold the farm-level characteristics that were found to be statistically significant for market participation included gender, being a member of a farmer' organization, access to extension services and the use of ICT. The age, gender, farm size, and ICT use of those participating in markets were found to be statistically significant in relation to the quantity of green mealies sold. Furthermore, those variables tested with regard to market access, marital status, being a member of a farmers' organization or group, and access to market information were negatively and statistically significant in relation to market access, while access to extension services, was positively and statistically significant in relation to market access.

Based on the results, the study concludes that farmers in the study area are using ICT to access market information. However, the use of ICT for accessing market information seems to be ineffective for enhancing the market participation of smallholder farmers and their welfare outcomes. This is shown by the negative effect on the use of ICT on both smallholder market participation and on the quantity of green mealies sold. Therefore, the study recommends that an awareness should be created focusing on the potential advantages of ICT applications and services on agricultural marketing and that this should be accomplished through training. The supply of marketing information alone to farmers is not sufficient for transforming their produce marketing. Therefore, the study also recommends that farmers should be trained in how to interpret marketing information.

Keywords: smallholder farmers, market participation, market information, ICTs, profitable markets.

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LIST OF ACRONYMS AND ABBREVIATION

AMIC - Agricultural Market Information Centre

AMT - Agricultural Market Trend

ARC - Agricultural Research Council

ATT - Average Treatment Effect

BMC - Botswana Meat Commission

DAFF - Department of Agriculture, Forestry and Fisheries

ECSECC - Eastern Cape Socio-Economic Consultative Council

ECX - Ethiopia Commodity Exchange

FAO - Food and Agriculture Organization

GDP - Gross Domestic Product

GPS - Global Positioning System

ICTs - Information and Communication Technologies

IMR - Inverse Mills Ratio

ITU - International Telecommunication Union

KACE - Kenya Agricultural Commodity Exchange

LM - Local Municipality

MACE - Malawi Agricultural Commodity Exchange

MIS - Market Information Systems

MITRA - Mobile Interventions and Technologies for Rural Areas

NGO - Non- Governmental Organization

OMA - Malian Agricultural Markets Observatory

PSJ - Port St John's

PSM - Propensity Score Matching

PSU - Principal Sampling Units

SAFEX - South African Futures Exchange

SDGs - Sustainable Development Goals

SIMA - Agricultural Market Information System of Mozambique

SPSS - Statistical Package for the Social Sciences

SRC - Simple Random Sampling

Stats SA - Statistics South Africa

RATIN - Regional Agricultural Trade Intelligence Network

USAID - United States Agency for International Development

WDR - World Development Report

ZFU - Zimbabwe Farmers' Union

ZIMACE - Zimbabwe Agricultural Commodity Exchange

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

According to Mdlalose (2016), the agricultural sector remains the mainstay for most developing countries on the African continent. The sector plays a vital role in poverty alleviation and human development and contributes significantly to the Gross Domestic Product (GDP) of these countries (Temba *et al*., 2016). It also provides a reliable platform for rural development through many small-scale producers who supply mainly the informal markets (Nkukwana, 2018). However, although the sector usually receives much attention from all stakeholders when it comes to addressing issues related to smallholder market access, small-scale producers are still excluded from the more lucrative markets (Obi *et al*., 2012; Ntshangase, 2014; Langat *et al*., 2016; Ochieng *et al*., 2018). These farmers can hardly make informed marketing decisions partly due to a lack of access to market information (Okello *et al*., 2020). Thus, it becomes a challenge for them to compete successfully, especially with the resource-endowed large-scale farmers (Mudhara, 2010).

Market information is becoming an essential factor in agriculture as it provides farmers with up-to-date information, thus enabling them to respond to opportunities that could improve their income and welfare (Nzonzo and Mogambi, 2016; Sehar, 2018). Access to perfect information constitutes a key component for improving the livelihoods of rural small-scale farmers by increasing their agricultural productivity and creating a better linkage to remunerative markets (Dankwah and Hawa, 2014). The agricultural sector is complex, with numerous operational bodies, and the level of information within the different bodies is never the same. Therefore, as the agricultural sector becomes more knowledge-intensive, due to the development of new technologies, there is a greater need for a good information flow and sharing among all agricultural stakeholders (Mittal and Hariharan, 2018).

Bharath (2017) asserted that the power of information is the source of enlightenment. Despite significant setbacks, due to previous top-down extension approaches, extension officers remain the most important source of information for smallholder farmers (Nyaga, 2012). The extension system often lacks up-to-date and modern mechanisms that are necessary for obtaining and sharing information before it becomes outdated, thus disadvantaging farmers (Akintude and Oladele, 2019). The extension system is not different from disseminating agricultural information by means

of the radio, newspapers, and television, through which information is disseminated regularly and only to selected market segments (Khapayi and Celliers, 2016). In this way, market information is limited to a small number of markets and a few individuals, while the majority remain uninformed.

Given the challenge of information asymmetry in agriculture, the arrival of ICTs seems to be well-timed (Saidu *et al*., 2017). ICTs are emerging as key source of information on new technologies; they could ameliorate the dearth of information among the poor along the value chains and thus link them to profitable markets. Businesses today cannot function properly without ICTs, and agribusiness is no exception. Contrary to the past, a standard mobile device has gone from being merely a two-way pager to being a mobile phone, a GPS navigation device, an embedded web browser, and an instant messaging tool, just to name a few functions of its functions (Cudjoe, 2015).

With the sudden proliferation of modern technology, the number of ICT-based Market Information Systems (MIS) projects aimed at increasing agricultural commercialization by improving farmers access to markets, have increased considerably over the past decade (Baumuller, 2018; Aker and Ksoll, 2016; Musungwini, 2018; Abebe and Mammo Cherinet, 2019; Ifeanyi *et al*., 2019). Several studies conducted in South Asia and Africa have shown the transformative potential of ICTs in agriculture (Oladele, 2015; Deichmann *et al*., 2016). A study conducted in Bulawayo, Zimbabwe, reported that the use of mobile telephony in agriculture had provided the previously excluded village farmers with an opportunity to access market information (Ifeoma and Mthitwa, 2015). Similarly, Chhachhar *et al*. (2014) stated that ICTs had provided new ideas, methods and techniques for disseminating and improving knowledge and information among people from different societies. In South Africa, farmers have been exposed to several agricultural farming applications to help close the gap between themselves and the markets. These information platforms include the FarmBoek, ARC Hub and Khula farming applications, to name a few.

Therefore, this study aims to add to the existing literature on the use of ICT in agriculture by examining the effects of ICT use on enhancing the market participation and household welfare outcomes among smallholder farmers in the Eastern Cape Province, South Africa. The findings and recommendations of this study will be helpful to farmers, extension advisors and policymakers in the Department of Agriculture in their attempts to close the information gaps among poor

farmers and link them to lucrative markets. Moreover, this study will be helpful to researchers working on the same, or related, topics.

1.2 Problem Statement

The goal of every producer is to maximize profits of each harvest; unfortunately, many small farmers get stuck in the marketing process. The problem is their limited access to markets and market information, which is a crucial requirement for rural farmers who seek to improve their household food security and increase their income (Aku *et al*., 2018; Kyaw *et al*., 2018). Unlike commercial farmers who can obtain reliable and up-to-date market information from trusted websites and publications, smallholder farmers rely on other farmers and government extension workers to obtain the same information (DAFF, 2010). The main disadvantage of these sources is that they usually share obsolete information. Therefore, in the absence of reliable and accurate market information, farmers are not motivated to increase the yields of products that they cannot sell (Anjum, 2015).

Although the government has taken several measures to protect and safeguard the interests of farmers, the problem of the lack of market information persists today. With the sudden increase in the use of mobile phones around the world, a growing body of literature has identified these mobile ICTs as a solution to the problem of information asymmetry in rural agriculture (Tumbo *et al*., 2018; Nwafor *et al*., 2020; Okello *et al*., 2020). ICT-enabled market information services are believed to increase the welfare of smallholder farmers by improving their competitiveness, eliminating the interference of intermediaries and thus improving their market performance (Katengeza *et al*., 2011). Although the number of mobile phone subscribers in South Africa is increasing daily, and most rural households currently own these ICT tools, the extent to which they utilize these technologies for agricultural activities remains unexplored. Therefore, to add to the existing literature on the use of ICT in agriculture, this study examines its effect on the market participation and household welfare of smallholder farmers in the Eastern Cape Province of South Africa.

1.3 Research Questions

a) What are the factors that influence smallholder farmers' use of ICTs?
b) What effect does the use of ICT have on the market participation of smallholder farmers and the quantity of green mealies sold?

c) What effect does market access have on the welfare of smallholder farmer households?

1.4 Research Objectives

The broad objective of the study is to investigate the effect of ICT use in enhancing market participation and household welfare outcomes among smallholder farmers in the Eastern Cape Province of South Africa. While the specific objectives are to:

i. Evaluate the factors influencing ICT use of in accessing market information by smallholder farmers;
ii. Examine the effects of ICT use on smallholder farmers' market participation and the quantity of green mealies sold; and
iii. Assess the effects of market access on the welfare of smallholder farmers.

1.5 Limitations of the Study

The study included only 246 smallholder farmers from the Port St John's Local Municipality. As a result, this sample is not a representative of all South African smallholder farmers, and the findings cannot be generalized for all smallholder farmers in other districts, or municipalities, in South Africa.

1.6 Organization of the Thesis

This thesis consists of six chapters. Chapter One is the introductory chapter which discusses the background of the study, the research problem, the objectives, the research questions and the importance of the study. Chapter Two consists of the literature review, which defines the key terms that relate to smallholder market participation. Thereafter, it examines the market participation of smallholder farmers, the role of ICTs in agriculture, and lastly, the effect of market access on the welfare of smallholder households. Chapter Three to Five are the empirical chapters. Chapter Three evaluates the factors influencing ICT use in accessing market information by smallholder farmers, using a binary logistic regression model. Chapter Four examines the effects of ICT use the market participation of smallholder farmers and the quantity of green mealies sold, by using the double-hurdle model. Chapter Five assesses the effects of market access on the welfare of smallholder farmer households, by using the propensity score matching. Lastly, Chapter Six concludes the entire dissertation by presenting the conclusions, policy recommendations and areas for future research.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter discusses, in detail, the literature in relation to the study objectives. It starts by defining the key terms that relate to the market participation of smallholder farmers. It then provides a discussion on the market participation of smallholder farmers in Africa, by looking more in depth at the determinants of their participation, the role of ICTs in agriculture and the effect of ICT use on the market participation of smallholder farmers. Furthermore, it discusses the effect of market access on the welfare of smallholder farmer households, followed by a summary of some existing Market Information Systems in Africa. Lastly, a summary of the chapter is provided.

2.2 Definition of Key Terms used in this Study

2.2.1 Smallholder farmers

In sub-Saharan Africa, smallholder agriculture has been, and will remain, of paramount importance for the foreseeable future among rural households (Gollin, 2014). Agriculture has long served as a dominant activity for most rural households, and it is therefore their only source of income. The definitions of smallholder farmers differ between authors. Some are based on land/size criteria, some on production levels, and others on resource scarcity (Mudhara, 2010). Basing his definition on the size or land criterion, Cousins (2010) defines smallholder farmers as those that farm on a tiny piece of land and rely on additional forms of income, such as social grants, as a means of livelihood. Similarly, Nagayets (2005) views a smallholder farmer as owning a farm that is two hectares, or less in size. However, the size-based definition of smallholder farmers has been criticized by several authors, who argue that it does not reflect the labour arrangements, efficiency and productivity of a farm (Kirsten and van Zyl, 1998).

For some authors, the definition of smallholder farmers depends on their context, country and ecological zone (Mmbando, 2014). According to Ngemntu (2010), the term ‘smallholder’ refers to black rural households that are involved in farming activities on a small scale. Mvelase (2017) argued further that smallholder farmers live in communal land, with no individual land entitlement. Most of them produce food that is mainly for household consumption and rarely for market sales. This study adopts the definition by Khapayi and Celliers (2016) who define smallholder farmers

as those farmers who are active players in formal markets and who are eager to produce and sell more of their produce.

2.2.2 Household welfare

The definitions of household welfare vary across the literature. According to Wang *et al*. (2017), the welfare of a household is achievable when a household when it can manage stress, as well as maintain and enhance household capabilities and capital, without destroying natural resources. On the other hand, Mmbando (2014) and Muricho *et al*. (2015) define household welfare as the maximum utility that households derive from an activity e.g. market participation. Furthermore, Akaakohol and Aye (2014) alluded that the activity can be either a farm or non-farm activity.

Across the literature, household income, consumption and the poverty gap have been the most used measures of household welfare. Over the years, great emphasis has been placed on measuring the strengths and weaknesses of the above measures, with a clear unanimity favouring consumption over income. According to Deaton and Zaidi (2002), unlike consumption, income is more likely to be affected by seasonal patterns, which results in underestimation or overestimation of the real income. Moratti and Natali (2012) pointed out that consumption best captures the welfare outcomes of households because households, because they derive their well-being from the actual consumption of goods and services, rather than from the receipt of an income. Researchers have also had intense debates on the wealth index or asset-based welfare measurement. Some have considered this measure a sparse estimation of well-being, as it does not consider the current poverty level or welfare of other households (Filmer and Pritchett, 2001; Howe *et al*., 2008). In contrast, others see asset-based wealth indices as an alternative welfare measure because wealth reflects long-term welfare better as it is less volatile than income and consumption (Manyaja *et al*., 2018; Mulford, 2013).

2.2.3 Market information

About 75% of the developing world's population consists of smallholder producers who are needy, food insecure, and whose livelihood strategies depend on agriculture, in one way or another (Ferris *et al*., 2014). Traditionally, smallholder producers in developing countries have focused their efforts on producing sufficient food for household consumption and only a small amount for market surplus (Lundy *et al*., 2007). Therefore, most farmers do not transition from subsistence to

commercial operations, because a lack of market information is the stumbling block (DAFF, 2010; Khapayi and Celliers, 2016; Masuka et al., 2016; Obi *et al*.,2012).

According to Sharma *et al*. (2020), it is important to minimize the information gaps among all agricultural stakeholders to ensure that there is a sufficient food supply and adequate information regarding all market operations. Imperfect information regarding the markets can easily lead to the misallocation of resources, which may result in two outcomes, namely; the consumers may end up paying too much or too little, and producers may produce too much or too little (Nkuba, 2016). The insufficient market information also provides intermediaries with an opportunity to manipulate price information and increase the profit margins at the expense of farmers (Lundy *et al*., 2007). Without market information (and other uncertainties), farmers may not produce the most profitable mixture of crops or use the most efficient technologies (Baumuller, 2015). Therefore, timely and reliable market information is necessary for smallholder farmers to make sound production and marketing decisions.

Shepherd (1997) declared that market information is of two types i.e. it is either current or historical information. Therefore, the current price information is as up to date as possible and facilitates bargaining and spatial arbitrage. In contrast, historical information is compiled over several years and is helpful for production planning, for alerting systems regarding food security and making storage decisions. Fonteneau and Khalil (2017) regard market information as a public good because many individuals can use it interchangeably without reducing its quantity. Such information tends to boost the farmers' confidence, as it reduces any intervention from intermediaries, thereby empowering the farmers' bargaining power for a better price in the marketplace (Ifeoma and Mthitwa, 2015). Moreover, it can help to assist in identifying shortage areas and to highlight whether prices are above or below the average seasonal trends.

2.2.4 Information and Communication Technologies (ICTs)

In literature, there is no definite definition of ICTs; therefore, any definition is acceptable. According to Ajayi (2009), ICTs can be defined as a technological means of collecting, collating, and conveying information via technology. Oladele (2015) refers to ICTs as all technologies that allow for the efficient and cost-effective flow of information. According to Ologundudu and Eniola (2021), ICTs can be interpreted broadly as "technologies that facilitate communication and the processing and transmission of information by electronic means." The World Bank (2011) defines

ICT as any device, tool or application that permits the exchange, or collection, of data through interaction or transmission. ICT encompasses both the Internet-enabled sphere as well as the mobile sphere, which is powered by wireless networks (Pawar and Yadav, 2021), and it includes technologies such as radios, televisions, landline telephones, mobile phones, computers, etc.

2.2.5 Market Information Systems (MIS)

Shepherd (1997) defined an MIS as a service that is usually public, which involves collecting information on wholesale and retail prices and, in some cases, the quantities of widely traded agricultural products. According to the FAO (2017), this information is accessible to all agricultural stakeholders through various media platforms, such as websites, digital newspapers, and social media. MIS can fulfill two different requirements i.e. they can improve public policies by providing an increased awareness of market realities, and they can also increase market transparency to bring about a fairer and more efficient allocation of resources (Aku, 2017; Galtier *et al*., 2014). Therefore, these services and the farmers' participation in markets can reduce the information asymmetry and, consequently, the cost of information (Nakasone *et al*., 2014).

Two types of MIS often appear in the literature, and these include the farmer-organization MISs and ICT-based MISs. According to Aku (2017), a farmer-organization MIS is an instrument that is designed to collect, process, and disseminate market information to a group of people who have a common interest in improving the marketing of their products. A farmer organization MIS also enhances the social capital of farmers by establishing contact between the farmers, traders and processors (Aku *et al*., 2018). In contrast, ICT-based MISs refers to market information services that function with the help of ICTs, particularly the mobile phone.

2.3 The Market Participation of Smallholder Farmers in Africa

About two-thirds of the developing world's population consists of rural people who farm on plots of less than two hectares. Many are needy, food insecure and have limited access to markets and services (Rapsomanikis, 2015). Markets are an important aspect of market participation (Otekunrin *et al*., 2019). Market access allows farmers to specialize in products with a comparative advantage, thereby enjoying a diverse consumption bundle and exploiting the gains from trading (Ismail, 2014: Poole 2017; Ouedraogo, 2018). The definitions of market participation differ among various authors. Poole (2017) defines it as the ability of an individual to participate in a market efficiently

and effectively. Some regard market participation as an individual's decision to participate in the markets, along with the volumes of the products to be sold (Adeoti *et al*., 2014).

Despite the major structural adjustments made in the agricultural sector, limited market participation is a well-recognized problem that has kept many smallholder farmers subject to poverty and meagre livelihoods. Market participation is viewed as both the cause and the consequence of economic development, and it therefore provides a pathway to the increased household welfare of rural households, through an improved income and food security. Commercialization leads to the improved welfare of households which changes the focus of production from consumption to production for the markets (Jaleta *et al*., 2016; Muriithi and Matz, 2015).

There is increasing evidence that most small-scale producers fail to produce enough food, hence their participation in the secondary markets is limited (Murray *et al*., 2016; von Loeper *et al*., 2016). In essence, small-scale producers usually produce more food than the statistics reveal (von Loeper *et al*., 2018; World Food Programme, 2020). In actuality, the problem does not lie in how much these farmers can produce but in how much quality they can produce (Louw and Jordaan, 2016; Mdlalose, 2016). Small-scale producers generally lack the knowledge and information needed to meet the stringent quality standards and formal market requirements (Magesa *et al*., 2020). This has resulted in farmers being poorly equipped to make sound marketing decisions, and experience difficulties in reaching the markets, in order to sell their products, which leads to them incurring losses (Tadesse and Bahiigwa, 2015; Musungwini, 2018).

2.4 Determinants of Market Participation by Smallholder Farmers in Developing Countries

2.4.1. Transaction costs

According to Tadesse and Bahiigwa (2015), the search for information can be very costly for smallholder farmers in the sub-Saharan Africa region. Before making any exchange, producers incur information costs as they try to establish who to sell to, and at what price to sell which are referred to as transaction costs (Mabuza *et al*., 2014). According to Eggertson (1990), transaction costs are the observable and non-observable costs associated with the enforcement and exchange of property rights. Transaction costs consist of fixed (direct) costs and variable (indirect) costs; these include the cost of searching for a trading partner, screening for a partner, as well as

bargaining, monitoring, enforcing and transferring the product to its destination (Moyo, 2010). Table 2.1 tabulates the two categories of transaction costs.

Table 2.1 Transaction costs that farmers incur when marketing crops

Direct costs	Indirect costs
Hiring vehicle to transport agricultural inputs	Costs of searching for trading partners.
Transporting products from farms to markets	Costs of screening trading partners
Trading partners' commission	Costs of bargaining
	Costs of monitoring and enforcement
	Costs of searching for information

Source: Adapted from Maltsoglou and Tanyeri-Abur (2005) and Delgado (1999)

The concept of transaction costs can partly explain why some farmers produce for the markets and others for home consumption. Transaction costs are a significant barrier to the participation of smallholder farmers (Mmbando, 2014; Okoye *et al*., 2016). The magnitude of the costs depends on the farmers' access to infrastructure facilities, particularly to roads. Mdoda (2017) argued that the poor quality of roads tends to inhibit the timely access to inputs and to decrease the access to output markets, thereby reducing the transmission of market signals. High transaction costs tend to reduce the net benefit of exchange, which results in reduced market participation and welfare (Mmbando, 2014). These costs dramatically affect the quantity of the output traded, which explains why smallholder farmers avoid participating in larger markets and resort to other marketing channels (Mdlalose, 2016).

2.4.2. Access to market information

According to Jari and Fraser (2014), smallholder farmers in developing economies still find it challenging to take part in formal markets, due to a range of technical and institutional constraints, and a lack of market information being one of them. The amount of information available to the farmers guides their decision-making considerably and paves the way for making informed decisions and improving their economic welfare (Msoffe, 2015). However, imperfect market information seems prevalent in developing countries where communication technologies and infrastructure are often deficient (Nakasone, 2014). These imperfections often lead to market distortions in terms of equilibrium prices.

Whenever farmers are on a mission to market their products, it is vital to choose the best market channel for the profitability of the farm business (Soe *et al*., 2015). However, in an attempt to

supply their products to the formal markets, smallholder farmers face severe competition from experienced and well-informed commercial farmers (Abebe *et al*., 2016). Price setting is mainly based on the farmers' relationship with the buyers or the ability to access information (Minkoua Nzie *et al*., 2018). As a result, the only choice for smallholder farmers is to resort to local markets where there is free accessibility, even though this is likely to lead to reduced profitability and exploitation from those who are well equipped with market information (Mdlalose, 2016).

When farmers lack the appropriate market information, they tend to produce small quantities of products that do not meet the quality standards of the market and that are unattractive to potential traders, and they also end up incurring higher transaction costs (Maponya *et al*., 2015). Information asymmetry has made it difficult for rural farmers to be active players in the formal markets, which leads to market floodings, lower prices and food wastage (Masuka *et al*., 2016). Therefore, farmers need reliable information, in order to carry out their agricultural activities and to be competitive throughout the value chain (Matto, 2018).

2.4.3. Distance to markets

According to Mdlalose (2016), the distance to the markets indicates the transportation cost incurred when moving a product from production to consumption. Most studies on market participation have shown that the distance to markets is a barrier to smallholder market participation, especially in developing countries. The distance to the markets increases the cost of the inputs and the transportation costs, and it reduces the efficient outputs of farmers (Buckmaster, 2012). It seems that market access favours those whose farms are closer to markets, as it easier for them to access them and supply their products than their counterparts. Several studies recognize the negative effect of distant markets on the participation of smallholder households. A study conducted in Rwanda revealed that farmers had difficulties in connecting to the primary market in the area, due to the long distances from the marketplace, which lead to the reduced probability of selling their bean harvest (Ingabire *et al*., 2018). Similar findings were shared in studies conducted in Limpopo, South Africa (Baloyi, 2010), and Central America (Buckmaster, 2012).

However, while past empirical studies established an inverse relationship between distance and market participation, a study conducted on the Determinants of Market Participation Regimes among Smallholder Maize Producers in Kenya found that the opposite was true (Muricho *et al*., 2015). According to Muricho *et al*. (2015), the distance to the main market positively affects the

market participation of households, which implies that the nearer the household is from the market, the most likely the household will participate in the maize market as a net buyer. Alternatively, the further the household is away from the central market, the more likely it is to participate in the maize market as a net seller.

2.4.4 Household characteristics

In an effort to identify the determinants of market participation among smallholder producers, the household characteristics also determine the market participation level of the farmers. According to Mathenge *et al*. (2010) and Martey *et al*. (2012), the age of the household head has a positive and significant impact on smallholder market participation. An older farmer tends to be more experienced than a younger one, and this experience makes it easier for an older farmer to make better production and marketing decisions at a lower cost than a younger farmer. Contrary to this premise, several studies conclude that younger farmers are more likely to participate in the markets than the old farmers, because they are innovative risk-takers, and are likely to be open to new and more progressive ideas; therefore, they may always be eager to try new things (Etwire *et al*., 2013; Randela *et al*., 2008).

According to Sigei *et al*. (2014) and Khoza *et al*. (2019), male-headed households are more likely to participate in markets than their female counterparts. Grace (2014) pointed out that women face restrictions when working outside the compound, because of their perceived role as housekeepers. In addition, Melusi (2012) observed that men are the major title deed holders of land title deeds, compared to women, who still do not have access to land rights. Therefore, this entitlement allows men to hold the privilege of participating and making decisions concerning agricultural productivity, with women giving their input. On the contrary, Onoja *et al*. (2013) found that female-headed households in Nigeria were more likely to participate in the fish markets than male-headed households. The above findings showed no significant association between gender and market participation. A farmer's decision to participate in the markets depends on the availability of resources, such as land, water, labour, capital and other resources, rather than on gender (Polar *et al*., 2017).

Muricho *et al*. (2015) viewed education as a reflection of human capital and management skills. According to Martey *et al*. (2014), the educational level of a farmer has a positive effect on his/her willingness to participate in the markets, because it enables one to make independent choices and

to act swiftly based on those decisions (Asif *et al*., 2017). Mdoda (2017) revealed that the educational level also indicates the farmers' capability to process information. Therefore, it becomes much easier for those who can interpret the information to be active participants in the markets than those who are illiterate and who often become victims of middlemen (Khapayi and Celliers, 2016; Mdoda, 2017).

The size of a household also affects its willingness to participate in the markets. According to Mdoda (2017), the larger the household size, the more willing it is to participate in the markets. Mdoda (2017) posits that a larger household spends more on food and other household needs; therefore, the higher expenditure makes its members more resource-constrained, hence the need for external support through market participation. Martey *et al*. (2013) also argued that the household size serves as a form of family labour and compliments the effort of the household heads on the farm. Therefore, the availability of family labour allows the household head to share the responsibilities and it saves time for other valuable activities.

Contrary to the above-mentioned views, Seng (2016) noted that the household size has a significantly negative correlation with market participation, and he suggests that farm households with larger farming households are more likely to be discouraged from entering the markets. Muricho *et al*. (2015) shared similar findings. They stated that a more larger family size has a higher dependence ratio, which means that there is pressure on the household to provide food for its members, thus reducing the probability of being a net seller and increasing the probability of it being a net buyer.

2.4.5 Social capital

In recent years, social capital has become a critical issue in agricultural development, as it plays a vital role in collective action. According to Sinyolo and Mudhara (2018), the choice of smallholder farmers to become entrepreneurial in their farming businesses depends on several factors, one of them being social capital. Social capital refers to the social networks, institutions, and associated norms of trust that underlie social relationships and the resources that are accessible to individuals. Social capital ownership can result in more favourable exchange terms, a reduction in the transaction costs, as well as a more extensive range of options for coping with risks through social networks and organizations. These social networks build trust among their members, and they encourage cooperation and regular exchange (Mmbando, 2014).

In developing countries, where there is inequitable access of smallholder farmers to higher-value markets, social relationships may help farmers to overcome such problems and to provide fair access to the markets for all (Ortmann, 2007). The formation of producer, or farmer, organization or groups positively impacts market participation of smallholder farmers, as it tends to close the gap between farmers and the markets (Stockridge *et al*., 2003; Hellin *et al*., 2009; Markelova and Mwangi, 2010). Such groups are seen as a possible solution for overcoming the high transaction costs and other market failures in developing countries, thereby providing a robust platform for capacity building, information exchange, and innovation in rural settings (Aku *et al*., 2018). However, Sigei (2014) pointed out that being a member of such groups could negatively impact one's market participation, due to disagreements that may arise among group members, which may lead to distorted marketing decisions.

Farmers also collaborate in the form of commodity groups. According to Pradip *et al*. (2014), such a group is a self-managed, independent group of farmers who share the same goal and interests. This group can serve several functions, such as taking joint responsibility for credit, arranging for the delivery of inputs, and collecting crops after the harvest (Moyo, 2010). Similarly, such groups can also make it easier for farmers to access markets, to achieve economies of scale when marketing their products and to minimize the transaction costs (Olwande and Mathenge, 2011). According to Ncube (2014), farmers can also collaborate by means of contract farming, which links smallholder farmers to the markets, stimulates agricultural production in the expression of globalization, and serves to fill the void that governments leave, in the wake of market deregulation under its structural adjustment programs. In addition, Mdoda (2017) argued that cooperatives positively impact market participation, they improve the negotiation skills that most farmers lack, and they put farmers in a position of strength when negotiating for the prices of their produce.

2.5 The Role of ICTs in Agriculture

According to the World Bank (2011), the public and private sector actors have long been searching for effective measures to address the short and long-term challenges in agriculture, which includes meeting the needs of the farmers. As the agricultural sector becomes more knowledge-intensive regarding new farming methods, technologies and inputs, there is a greater need for a good flow and exchange of information among all the agricultural stakeholders (Mittal and Hariharan,2018). Nzonzo and Mogambi (2016) noted that the availability of information opens up new windows regard to gaining experience, obtaining the best prices, sources of financial support and new markets. However, even though agriculture remains mainly in the hands of the smallholder farmers, they lack the strategies and tools that are needed to transition from subsistence to commercial farming, in part, due to the lack of access to agricultural information (Saidu *et al*., 2017; Murray *et al*., 2016; von Loeper *et al*., 2016). Such information is instrumental in making decisions about future crops and commodities and about the best time and place to sell and buy goods. The majority of farmers do not have a single channel that serves as a comprehensive source for all their information needs. The most common sources of their information are still by the word of mouth, government extension services, the radio and television. However, the quality and relevance of the information provided by these sources can be highly variable. Most farmers in developing countries therefore lack access to consistent and reliable information for many of their needs, and they often rely on a combination of these varied, but inconsistent sources, plus their own traditional knowledge, experience and estimates, when making decisions (FAO, 2017). Traditionally the information flow has been one-way.

Given the challenge of information asymmetry among the rural poor, the introduction of Information and Communication Technologies (ICTs) seems to be timely (Chavula, 2014; Saidu *et al*., 2017; Tadesse and Bahiigwa, 2015). Although ICT may not be a remedy that will solve all the issues related to value chain development, it can rectify the problem of information asymmetry amongst the weakest in the value chain (Kabbiri *et al*., 2018; Hoque *et al*., 2021; Mapiye *et al*., 2021). The use of ICTs has ensured that, agriculturists and farmers can stay up to date with the latest crop cultivation practices and market information. The following sub-sections discusses the role of ICT in food production and market access:

2.5.1 The role of ICT in food production

Farming involves risks and uncertainties, such as poor soils, drought, erosion, pest infestations, etc. Increasing the efficiency and productivity of small-scale farms is another area in which ICT can make a significant contribution. In many developing countries, the farmers determine the fertilizer usage. However, smallholder farmers often fail to use the correct fertilizer dosage due to a lack of the appropriate knowledge (Radebe, 2014). ICT provides online-tools that provide guidance to farmers regarding the type of fertilizer to be used for a specific crop and the correct fertilizer dosage. The fertilizer recommendation tools available online include the Fertilizer Recommendation Solution, as well as the Mobile Interventions and Technologies for Rural Areas (MITRA) (Uddin and Hossain, 2019).

According to Harvey *et al*. (2018) climate change is adding another level of instability to the lives of farmers; therefore, the increasing weather instability and temperatures require them to adapt their techniques to the changing ecological conditions. In this environment, ICTs provide information on weather-related advisories and alerts, to help farmers prepare for sporadic events, such as floods, droughts, as well as pest and disease outbreaks, thus preventing significant crop losses (Amarnath and Andriessen, 2018; Yohannis *et al*., 2019).

The use of ICTs has also gained momentum in the livestock sector. Maru *et al*. (2018) noted that access to up-to-date information and knowledge can help farmers to improve their farm management and production skills when dealing with natural disasters, diseases, pests, marketing, etc. Several studies in the livestock sector have shown the importance of a formal record-keeping system for smallholder farmers (Mapiye 2017; Molotsi, 2017; Molotsi, *et al*., 2017). In South Africa, there is no proper record-keeping system for livestock farmers and such as system could help them to improve the performance of their livestock, which makes it sustainable (Molotsi, 2017). The application of ICT tools in record-keeping at farm level assists farmers with a knowledge of the diverse characteristics of the various livestock breeds, in terms of their adaptability, weight gain and production (Masuka *et al*., 2016), which then assists them to select the best livestock breeds that can adapt to changes in the different weather patterns. ICTs also provides information relating to animal health, which helps reduce the incidence of disease outbreaks. For example, the iCow platform in Kenya offers digital information on vaccination,

spraying, mastitis control, deworming, hygiene and other dairy management practices (Marwa *et al*., 2020).

2.5.2 The role of ICT in market access

Because smallholder farmers are not acquainted with the updated prices of commodities, the proper place to sell their products, the consumer trends, etc., it means that gaining access to current and up-to date market information can provide invaluable support to those aiming to penetrate commercial markets (Khapayi and Celliers, 2016; Ameru *et al*., 2018; Maseti, 2018). By using ICT, their fixed transaction costs, such as the costs of searching for information, as well as screening and negotiation costs, are reduced. Furthermore, farmers can advertise their products on a mobile platform, on which interested buyers can contact them, and most agreements can be reached through phone calls (Ifeoma and Mthitwa, 2015). This reduces the transaction costs, as farmers no longer have to make frequent trips to the markets to exchange their produce with buyers.

Smallholder farmers are often unaware of the value of their crops on the main markets, and they are therefore often exploited by middlemen, who are better equipped with market information (Mashangwa, 2018). ICTs can play an important role in this process by supplying them with the current commodity prices. Typically, information on commodity prices is collected from the key markets, organized in a central database, and then published on the websites. In this way, farmers will now be in a better position to access the prevailing market prices, which will enhance their bargaining power and put them in a better position to negotiate prices with the retailers. The E-Commerce Project operated by the Ministry of Agriculture in Ghana is a good example of such an approach (Wafula and Moturi, 2022).

2.5.3 Overview of studies that demonstrate the role played by ICTs in the agricultural sector

A study conducted on the sardine market in Kerala, in South India showed that marketing sardines to other markets is now less time-consuming and less costly than before the use of mobile phones (Jensen, 2007). The findings of this study are consistent with those of studies conducted in Ghana, Uganda and Zimbabwe on the use of mobile phones by smallholder farmers (Folitse *et al*., 2018; Hailu *et al*., 2017; Masuka *et al*., 2016). The use of these technologies has also been demonstrated in Tamil Nadu, India, where a mobile phone application called the Fisher Friend Application has helped fisher families after the 2004 tsunami (Anabel *et al*., 2018). This application provided

fishermen with information on the wave height at different distances from the coast, which has resulted in lower risks and higher yields. ICTs, especially mobile phones, are also beneficial for the health and welfare of animals, as farmers can talk to extension workers and veterinarians daily, as well as in emergencies when their livestock becomes sick (Martin and Abbott, 2011). These technologies also help to prevent post-harvest losses as farmers can now contact the weather services to get information on the weather conditions before applying pesticides to their crops (Duncombe, 2016).

In a study conducted in India, Ravikishore (2014) posited that ICT initiatives such as ITC e-choupal, Warana Model and iKissan have provided Indian smallholder farmers with timely and reliable information on crop production and protection. This enabled them to be aware of the correct fertilizer dosage to use, thereby protecting plants from wilting or drying out. Evidence from Kenya showed that participation in ICT-based MIS projects increased the level of participation in output and input markets by smallholder farm households, which in turn resulted in improved welfare of smallholder households (Okello *et al*., 2020). Findings of a study conducted in Malawi have shown that participation in ICT-based projects had a substantial effect on the level of household income. Specifically, the results suggest that reduction in the amount of transaction costs is higher among participants of ICT-based MIS projects than non-participants, something which has been translated into increased income (Katengeza *et al*., 2014). Chikaire *et al*. (2017) showed that access to ICTs have direct relation with farmers' welfare improvement. Their finding signified that access to quality health services, increase in income, improvement in supply chain and access to nutritional food are the welfare contributions of ICTs. Similarly, a study by Yohannes (2017) showed that ICTs, particularly mobile phone, helped livestock producers to get price information, increase bargaining power of farmers, increase price negotiation and minimize market information searching cost.

2.6 The Effect of ICT Use on the Market Participation of Smallholder Farmers

Market participation holds significant potential for revealing the suitable opportunity sets that are necessary for providing better incomes and sustainable livelihoods for smallholder farmers (Machete, 2016; Ingabire *et al*., 2018). Studies conducted by Langat *et al*. (2016), Ochieng *et al*. (2018) and Ngenoh *et al*. (2019), have shown that despite the benefits of market access, smallholder participation in profitable markets remains constrained by market imperfections that

lead to widespread market failure. With most smallholder farmers residing in remote areas, access to output markets becomes limited because of the poor infrastructure, which is necessary for direct trade between farmers and consumers (von Loeper, 2016). Therefore, many small farmers have resorted to selling their produce in informal markets and some to middlemen, who tend to take advantage of the farmers, as they pay them too little for their produce (Mashangwa, 2018).

It is an indisputable fact that information plays an important part in ameliorating the living conditions of rural farmers. Farmers are presently seekers of information, advice and opportunities that will not only help boost their production levels, but also improve their market participation for enhanced profitability (Taku -Forchu, 2019). Macdonald (2019) highlighted that the majority of the smallholder farmers in South Africa are currently inactive participants in the formal markets and are often obliged to sell at lower prices (immediately after harvest) and buy at higher prices, with little information on where to sell and at what prices to sell. This has led to them becoming 'price takers', who are often paid too little for their produce by retailers, and who adopt a "take it or leave it" attitude (Maseti, 2018).

Information asymmetry is an old problem in agriculture. Recent attempts to resolve the problem of poor access to profitable markets by smallholder farmers have thus focused on promoting the transfer of information through ICT-based innovations. The advent of digital technologies, such as mobile technologies, could be leveraged to provide market driven solutions to the agricultural challenges of smallholder farmers in sub-Saharan Africa (Yao and Shanoyan, 2019). The World Bank (2011) and van Zyl *et al*. (2014) have noted that these mobile technologies have the great potential to provide marketing information, especially information on market prices and demand, and to promote access to markets for smallholder farmers. This enables smallholder farmers to produce products that meet the market demands and to take advantage of the opportunities to participate in high-value markets (Lashgarara *et al*., 2011).

Across the African continent, a growing body of literature has demonstrated the positive impact that these ICT-based MISs have on smallholder market participation. According to Yohannes (2017) the use of mobile phones in Ethiopia has helped livestock producers to get updated information on commodity prices, it has helped them to increase their bargaining power and it has minimized the costs of searching for information. Using an ICT-enabled MIS called MACE in Malawi has resulted in lower transaction costs and higher market participation (Katengeza *et al*.,

2014). Similar studies conducted in Nigeria and Tanzania reported that ICT-based MIS improved market access for cattle, by enabling owners to trade their live animals effectively (Kubkomawa and Salihu, 2010; Urussa, 2013). In contrast, a study conducted in Malawi found insufficient evidence with respect to the impact of ICT on smallholder market participation (Chikuni and Kilima, 2019). The results of the study showed that the knowledge of current market prices does not necessarily guarantee the farmers' market participation, especially when buyers determine market prices and high transaction costs. Similarly, a study conducted in South Africa on the adoption of ICT-enabled MIS found that there was no significant relationship between the use of ICT-enabled MIS and the market participation of farmers (Atoma *et al*., 2020). Nwafor *et al*. (2020) pointed out that there are other factors that determine a farmer's marketing decisions or market participation level, besides using ICT-based MIS.

2.7 The Effect of Market Access on the Welfare of Smallholder Farmers

According to Yobe *et al*. (2019), rural people seek diverse opportunities to increase and stabilize their welfare, and one way of achieving this is through farming. The income growth generated from agriculture is four times more effective in reducing poverty than the growth from other sectors (World Bank, 2018). This income generation explains why scholars regard agriculture as the best tool for addressing the poverty and income challenges confronting many smallholder producers (Agoben, 2018; Pawlack and Kolodzieiezak, 2020). Improved market access results in the commercialization of agriculture, which has short, medium, and long-term benefits for farmers. In the short term, market access can result in the production of marketable surplus and hence gains in the income from agriculture (Atoma *et al*., 2018).

A farmer’s decision to participate in agricultural markets is one of the most important determinants of a household’s welfare (Barret, 2008). Households seek to maximize their utility through the consumption of various agricultural commodities. The household may produce some crops to consume or trade, in order to obtain those that it cannot produce. The smallholder farmers' unlimited access to lucrative markets holds considerable potential for unlocking suitable opportunities to provide a better income and a sustainable livelihood (Omitti *et al*., 2010). Market participation ensures that smallholder producers are efficiently integrated into the local and national markets, thereby increasing their income (Chikaire *et al*., 2017; Zhou *et al*., 2013). When farmers have unlimited access to lucrative markets, they produce more, due to market assurance.

However, the literature reveals that smallholder farmers face severe constraints that hinder their optimal participation in lucrative markets, hence the need for improved market access (Obi *et al*., 2012).

Enhancing the returns from agricultural production through improved access to the market can be a vital element of poverty alleviation strategies and livelihood improvement (Sigei, 2014). Several studies have shown the effectiveness of improved market access on the welfare of households. In a study conducted in Kenya on the effects of vegetable commercialization on the welfare of households, the improved commercialization of vegetables led to a market-oriented output that resulted in the improved welfare of households from an increase in income, which in turn resulted in more consumption (Muriithi and Matz, 2015). Another study conducted in Tanzania on the effects of market access provided by farmer organizations on smallholder vegetable farmers improved market access, leading to an increase in farm income (Aku *et al*., 2018). According to Aku *et al*. (2018), farmers belonging to a farmers' organization tend to receive higher market prices for their produce than those who do not belong to one. Moreover, a study conducted in Tanzania on the welfare impacts of smallholder farmers' participation in maize and pigeon pea markets revealed that their increased participation in these markets led to a 19.2-20.4% increase in smallholder consumption expenditure, which then resulted in increased food security (Mmbando *et al*., 2015). There is therefore, a greater need for advancement in market orientation and market participation, to better link the farmers to the markets to have a suitable market for their agricultural produce and to receive a boost for their income generation (Otekunrin *et al*., 2019).

2.8 Existing Market Information Systems in Africa

From an economic perspective, the market performance of smallholder farmers depends heavily on the quality the of information available to them. In developing countries, agricultural markets are a chain of intermediaries between the farmer and the consumer, including the traders, wholesalers and retailers (Aker and Fafchamps, 2015). The smallholder farmers of developing economies rarely sell directly to consumers, partly due to a lack of market information (Khapayi and Celliers, 2016; Minkoua Nzie *et al*., 2017), which remains a serious barrier to smallholder market participation. Therefore, for this and other reasons, organizations involved in agricultural marketing development have advocated for establishing MISs, in order to increase the market efficiency and to promote the improvement of market information. According to Shepherd and

Seid (2018), an MIS aims to improve the marketing efficiency by disseminating timely and reliable market information to producers and other value chain actors. However, its effectiveness usually remains limited, as it is less responsive to the critical constraints of the market participants, especially smallholder farmers (David-Benz *et al*., 2016).

MISs emerged in sub-Saharan Africa when the government stopped intervening directly in the markets through marketing boards, which was a consequence of structural adjustments in the agricultural sector in the wake of globalization and liberalization (Gatlier *et al*., 2014). They aimed to correct the information asymmetries created by economic liberalization, in order to give farmers more bargaining power, and thus, to create a more transparent trading environment (Sopov, 2018). The first generation of MISs in developing countries was established in the 1980s. It was run by the government, with information on agriculture being collected, compiled, and then disseminated through newspapers, television and the radio (Zolner and Steffen, 2013). However, information dissemination through this generation did not help to improve the farmers' access to market information, as it was associated with higher costs. The information was often limited to some farmers, and it was inaccurate. It did not reach the farmers on time and resulted in it having low economic impact (Khapayi and Celliers, 2016; World Bank, 2011). Moreover, this type of MIS covered only one category of product at a time and focused exclusively on price information (David-Benz *et al*., 2016).

According to Galtier *et a*l. (2014), the rapid spread of mobile phones and the Internet in the late 1990s led to a new generation of MIS, the so-called second generation. In the past, the transmission of price data from the collection point to the central unit took several days; today, 'real-time' information can be delivered within a few hours (David-Benz *et al*., 2016). According to Kizito (2011), there are four main types in this generation of MIS, namely:

i. public MISs - government or government-owned MIS designed to ensure food security. Examples include the following: the Agricultural Market Information System in Mozambique (SIMA), the Agricultural Market Information Center in Zambia (AMIC) and the Ethiopian Commodity Exchange (ECX).
ii. farmer organization-based MISs - these are led by farmer organizations and aim to provide information on markets, in order to help the farmers to market their products more effectively. Examples include the Zambian National Farmers' Union (ZNFU), the

Zimbabwe Farmers' Union (ZFU) and the Malian Agricultural Markets Observatory (OMA).

iii. private MISs - these are supported by private entities that are not involved in the marketing of agricultural products and that aim to provide marketable information to private market participants, in order to improve their production and trading decisions (Gatlier *et al*., 2014). Examples include ESOKO, Infotrade, KACE, MACE, and AGRITEL.

iv. trade and NGO-based MISs - these are managed by trader organizations, such as the Regional Agricultural Trade Intelligence Network (RATIN). They aim to inform market participants about existing production and trade opportunities.

This generation of MIS is considered to be better than the first, as it improves the farmers' market participation by providing timely and relevant information on the markets, weather forecasts, input prices and agricultural extension (Lwesya and Kibambila, 2017; Magesa, 2015). In addition, the information collected, captured, and disseminated through this generation of MIS is cost-effective and less time-consuming (Ojo and Oluwatusin.,2017). These MISs have been launched in most parts of sub-Saharan Africa and have shown a transformative potential for improving the market participation of smallholder farmers. Table 2.2 summarizes some of the existing MISs in Africa, with their country of origin and benefits.

Table 2.2 Existing MIS in sub-Saharan Africa

ICT applications	Country	Applications benefit	Author(s)
KACE	Kenya	• Provision of market information to all market players.	Mukhebi and Kundu (2014)
M-Farm		• Access to ready markets that provide crop-price information helps make online transactions.	Situma (2013) Baumuller (2015)
FARMIS Info trade FOODNET	Uganda	• Link farmers to the markets	Magesa (2015); Tollens (2006)
Lima Links	Zambia	• Live horticultural market price data to farmers.	
ZNFU		• Traders can sell out produce volume requests to distant farmers to fulfill certain sale quota requests	Steffen and Woodard (2012)
		• Trains farmers on grades they should provide to millers to avoid disagreements over quality s as to bargain for higher prices	Kizito (2011)
Nokia Life Tools	Nigeria	• It provides farmers with information regarding inputs, market prices, and weather.	Zoltner and Steffen (2012); Kizito (2011)
MACE	Malawi	• Provision of market-price information	Tollens (2006)
ZIMACE	Zimbabwe	• Provision of market-price information • Provision of exchange commodity information	Odunze and Hove (2015)
AGRITEL	South Africa	• It provides information on fruit and vegetable prices.	FAO (2012)
AMT SAFEX		• It analyzes and forecasts the national and regional agricultural industry and market information. • It provides current/ prevailing market prices.	DAFF (2012)
ESOKO	Zimbabwe, Ghana, Nigeria, Zambia, Tanzania, Uganda, Mozambique, Malawi	• Information on markets and trade • Provides and collects content such as prices, bids, offers, and weather forecasts.	David-West (2010) Payne (2011); Odunze and Hove (2015)
Links database	Ethiopia	• Provision of price information and sales volumes for livestock such as cattle, goats, and sheep, based on breeds, age, gender, and grade.	Mapunda *et al*. (2011)
Vet Africa		• It provides veterinary service and market-related information.	Beyene *et al*. (2018)
OMA	Mali	• Provision of market news, more especially wholesale prices.	Galtier *et al*. (2014) Kizito (2011)
ECX	Ethiopia	• Provision of rice information to market players via websites and electronic billboards.	Galtier *et al*. (2014)
FOODNET	Ghana	• It provides customized information on wholesale and retail prices and new market entrants.	Kizito (2011)

Source: Own Compilation

2.9 Chapter summary

This chapter has provided a literature review that is related to the effect of ICT use in enhancing the market participation and the welfare outcomes of smallholder farmer households. It started by unpacking the market participation of smallholder farmers in Africa, and it then took a general look at the determinants of smallholder market participation, which included the following: transaction costs, access to market information, distance to markets, household characteristics and social capital. The chapter also looked at the role of ICTs in agriculture. The literature revealed that using these ICTs plays a crucial role in producing and marketing agricultural products, by providing timely and reliable market information to active market participants. By using ICT, the constraints that normally hinder the market participation of smallholder farmers can also be corrected, thereby providing them with unlimited access to profitable markets and an improved household welfare through an increased income, which is likely to lead to increased consumption. Lastly, the chapter looked at some of the existing MISs in Africa, including a mixture of public MISs, farmers' organizations-based MIS, Private MISs and trade and NGO-based MISs.

CHAPTER THREE: FACTORS INFLUENCING ICT USE IN ACCESSING MARKET INFORMATION BY SMALLHOLDER FARMERS

Abstract

Information asymmetry has long been a problem faced by smallholder farmers of the developing economies and, to date, the dissemination of agriculture- related information is still largely conveyed by word of mouth, with the help of extension officers or by using media, such as radio and television, to broadcast it. Such information is generally only disseminated periodically and for selected markets; in this way, market information becomes limited to a small number of markets and to fewer individuals while leaving the majority unattended. Several studies conducted on the African continent have shown that the use of ICTs in the agricultural sector is an essential tool that encourages farmers to be active participants in lucrative markets by increasing their access to timely and relevant market information. However, despite the rapid increase of ICTs in the agricultural sector of developing economies, the use of such technologies remains unpopular among the rural communities. In order to obtain a clear view of the cause of this, this study therefore seeks to investigate the factors influencing the ICT use of smallholder farmers in the Port St John's Local Municipality of the Eastern Cape Province, of South Africa. A sample of 246 households was randomly selected, using structured questionnaires. The study used descriptive statistics to describe the farm-level characteristics and the binary logistic regression model was used to evaluate the factors influencing the ICT use of smallholder farmers.

The results from descriptive statistics showed that 78% of the sampled households used ICTs to access market information, with the most used ICTs being mobile phones (76%), followed by radios (2%). Only 2% of the households used agricultural farming applications in their businesses. The empirical results of the study revealed that age, household income, farm size, access to electricity and having quality network coverage statistically influenced the ICT use of smallholder farmers. However, it should be noted that although 78% of the sampled households used ICTs to access market information, this was mainly by means of interactive voice responses, and not the other uses of ICTs. Therefore, the study concludes that farm-level characteristics do not influence the ICT use of smallholder farmers entirely. A lack of awareness regarding ICT-based MISs is also a factor that influence the ICT use of smallholder farmers. The study recommends that the government, with the help from extension officials, should embark on more enlightenment

programmes to support the use of ICTs among smallholder farmers, for the purpose of agricultural marketing.

Keywords: ICT-use, small-scale producers, market information,

3.1 Introduction

According to Eskia (2019), the agricultural sector remains significant for poverty reduction in most developing countries. This sector consists of numerous small-scale farmers who produce about 80 % of the developing world's food and it also create jobs for most rural households by employing them as permanent or casual labourers. Therefore, any attempts to reduce rural poverty should focus on the smallholder farm sector (Ebata and Hernandez, 2017). In an attempt to reduce poverty and increase the food security for the world's impoverished population by 2030, the Sustainable Development Goals (SDGs) aim to increase the agricultural production of resource poor-farmers, expecting that this will stimulate their incomes and the food security status at a household level. However, the SDGs will be futile if the production problems of the smallholders are not addressed (Gwademba *et al*., 2019).

It is necessary to increase agricultural productivity for the promotion of sustainable development but increasing productivity will have limited success if the smallholders' connectivity to the markets is not strengthened. There is increasing evidence that most small-scale producers fail to produce enough food, hence their secondary market participation is limited (Murray *et al*., 2016; von Loeper *et al*., 2016). In essence, small-scale producers usually produce more food than what the statistics reveal (von Loeper *et al*., 2018; World Food Programme, 2020). The problem is with the quality of their produce (Louw and Jordaan, 2016; Mdlalose, 2016). Small-scale producers generally lack the knowledge and information that are needed to meet the stringent quality standards and formal market requirements. Therefore, to promote food security and sustainable agriculture, the focus should be more on improving their access to agricultural information.

Reitz (2004) refers to information as 'data that are presented in a readily-available and comprehensive form, and to which the meaning has been attributed, within a given context for its use'. The power of information is a source of enlightenment (Bharath, 2017). The agricultural sector is complex; it has numerous operational bodies, and the level of information within the different bodies varies. Access to perfect information constitutes a key component in the improvement of the rural livelihoods of small-scale farmers, so that they can increase their agricultural productivity and connect more effectively to remunerative markets. In addition, for information to contribute meaningfully to agricultural development, its quality should have the following attributes: accuracy, timeliness and relevance (Folitse *et al*., 2018). However, a growing

body of literature reveals that the quality of information accessible to smallholder farmers is often compromised (Annop *et al*., 2015; Girma and Abebe, 2019; Magesa *et al*., 2020).

Bell (2015) highlighted the fact that weak information results from inadequate extension services caused by limited staff and operating funds. The extension officers often fail to deliver timely and reliable information to farmers before it becomes obsolete. Information needs start when a farmer decides to plant, i.e. (at the production level), right through to the consumption level. If a farmer does not get all the relevant information from the outset, it is difficult to be competitive within the value chain. Most small-scale farmers embark on the farming journey with little, or no, information, so when they reach the consumption level, many risks arise that are linked to the adherence to quality and quantity standards, including the prescribed packaging, grading, labeling and traceability (Louw and Jordaan, 2016). Because of their failure to comply with the market requirements, the products of smallholder farmers are therefore regarded as unsuitable for the markets.

Most problems in the agricultural sector result from information asymmetry among smallholder farmers. Madibela (2014) explains the information asymmetry among smallholder farmers by using the Botswana Meat Commission (BMC) scenario. The author states that the BMC seeks high-quality beef from its local farmers, in order to supply overseas markets. The question that arises is how will the farmers know the mechanisms of producing this high-quality beef in the absence of information? Therefore, the author suggests that, in order to produce this high-quality beef, farmers need information on the beef quality and the carcass characteristics, the beef production methods and the beef breed choice, under certain climatic conditions. As in any other economic sector, information is required for developing agricultural practices, such as crops, livestock and other farming enterprises (Akinola, 2017). Therefore, Information and Communication Technologies (ICTs) are believed to have substantial power for filling the knowledge gap between the farmers and the markets (Nwafor *et al*., 2020; Okello *et al*., 2020). The following is a summary, or overview of the past studies on role and use of ICTs in agriculture in smallholder farming communities.

3.2 ICT Use in Agriculture

According to Mittal and Hariharan (2018), as agriculture becomes more knowledge-intensive due to the new farming methods, technologies and inputs, there is a greater need for good information flow and sharing among all the agricultural stakeholders. The availability of information opens up windows that supply details on the experience, best prices, the sources of financial aids and the new markets (Nzonzo and Mogambi, 2016). However, Saidu *et al*. (2017) noted that even though farming remains mainly in the hands of smallholder farmers, these farmers still possess little or no information regarding the markets. Given this challenge of information asymmetry, the arrival of ICTs seems to be well-timed (Chavula, 2014; Saidu *et al*., 2017; Tadesse and Bahiigwa, 2015).

Mobile technology is widespread in South Africa, with a better penetration rate than any other ICTs (Nwafor *et al*., 2020). Today about 20-22 million people in South Africa use smartphones, which accounts for about one-third of its population (O'Dea, 2020). The overall number of mobile connections is much higher, with more than 90 million, as feature phones are still popular and widely used in the country and on the continent overall. This widespread use has led to the deployment of ICT in the agricultural sector. Figure 3.2 below shows the trends in mobile telephone acquisition:

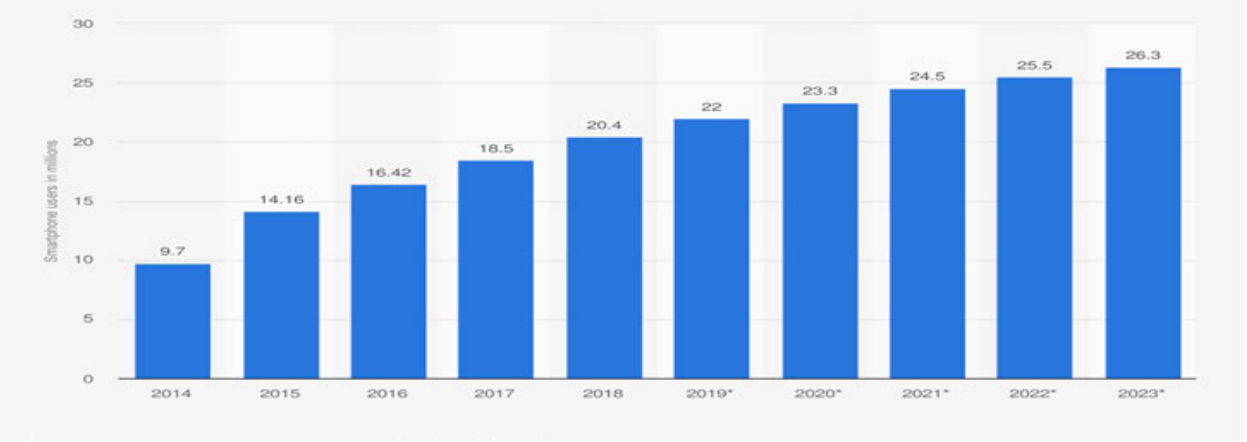

Figure 3.1: Trend showing the number of smartphone users in South Africa from 2014 – 2023 (in millions)

Source: Statista Digital Market Outlook, 2021

According to Franklyn and Tukur (2012), the increased information flow from ICTs has positively affected the agricultural sector. These technologies have provided significant opportunities for improving the performance of the agricultural sector, from the point of production to the point of consumption (Verdier-Chouchane and Karaguezian, 2016), with different types of ICT tools tending to serve various functions in this sector. Table 3.1 shows some of the ICTs used in the agricultural sector, with their primary uses or functions.

Table 3.1: Types of ICT tools used in agriculture and their uses

ICT TOOL	FUNCTION/USE
1. Telephone	Interactive voice responses
2. Computer and websites	Agriculture information and marketing
3. Broadcasting (on television and radio)	Expertise, sharing, advisory and community.
4. Satellite	Weather, universal accessibility and remote sensing
5. Mobile	Advisory, sales, banking, market platforms and trading.
6. Internet and broadband	Knowledge-sharing, social media, e-community, banking, market platforms and trading.
7. Sensor networks	Real-time information, better data, quantity, and quality, decision-making
8. Data storage analytics	Precision agriculture, actionable knowledge

Source: FAO and ITU, 2017

The importance of agricultural digitalization became evident in South Africa during the Covid-19 pandemic, which was a sudden event. The pandemic continued to sweep across the continent, and the lockdown disrupted the markets. South African farmers started to break down the traditional notion of the agricultural markets, as they opted to use a more direct-to-consumer sales approach by means of social media (Ngcakani, 2020). Social media platforms appear to have become the new farmer's market. Farmers have joined forces and created Facebook and WhatsApp groups to ease their cash flow concerns and it allows for direct transactions to occur between farmers and consumers. These information platforms include the Koop Direk van die Boer group, which was created on 1st May 2020 and Vhulimisi which was created in November 2019, to name a few. However, despite such a remarkable penetration of smartphones and the Internet, as well as their deployment in the agricultural sector, there are still disparities with regard to the usage of ICTs among rural farming communities. The low usage of ICTs for agricultural activities is a problem that is faced not only by South Africa, but by every developing country on the African continent

(Kabbiri *et al*.,2018). Therefore, it is necessary to have a clearer understanding of the slow uptake of ICTs amongst the rural farming communities. This section will consist of an overview of the past studies on the factors influencing/ affecting the use of ICTs by smallholder farmers.

3.2.1 Empirical studies on the factors affecting the use of ICTs by smallholder farmers

Sikundla *et al*. (2018) and Bryan and El Didi (2019) highlighted that, the socio-economic characteristics of smallholder farmers that have affected their ICT use include variables such as their age, gender, and household income. On the other hand, Kante *et al*. (2016) noted that the relative advantage, simplicity, compatibility, and observability of ICT, also affects its use among smallholders. Titilope (2020) noted that the slow uptake of ICTs by smallholder farmers might be due to their low income (or no income at all), the lack of ICT infrastructure, their health status, the cultural differences, and other reasons. Shemfe (2018), highlighted that the high cost of ICT tools, high data costs, lack of technical know-how and language barrier are among the factors influencing smallholder farmers' ICT use. In their study, Abebe and Mammo-Cherinet (2019) noted that inadequate electricity supply, literacy, knowledge and skills for operating ICT applications are the main factors affecting smallholder use of ICTs. According to Eskia (2019) and Nwafor (2020), lack of ICT awareness has also been as a contributing factor to the low adoption of ICTs among smallholder farmers. Mdoda and Mdiya (2022) found that the socio-economic and institutional factors influence the use of ICTs by livestock smallholder farmers in the Eastern Cape Province. Additionally, Urassa (2013) highlighted that, poor network coverage, distance to the marketplace and access to mobile banking affects beef cattle farmers use of ICTs.

Existing literature shows that ICTs exist in rural areas, (Freeman and Mubichi (2017); Kamarudin *et al*. (2019)), but their utilization and the ways in which they help smallholder farmers are limited. Therefore, this study intends to add to the existing literature on ICT use in agriculture by investigating the factors influencing ICT use among smallholder farmers in the Port St John's Local Municipality. While other studies have focused only on the socio-economic factors or ICT adoption drivers (Sikundla *et al*., 2018; Bryan and El Didi, 2019), Mdoda and Mdiya (2022) focused on both the socio-economic and institutional factors. This study combines the demographic, socio-economic and institutional factors.

3.3 Material and Methods

This section provides an overview of the methods employed for data collection and analysis. The section starts by giving a clear description of the study area, with a map showing the Port St John's Local Municipality and other municipalities of the O.R Tambo District. It moves to the data collection part (including the type of data, the research method and data collection technique used). Furthermore, the section shows the sampling procedure that was employed, the sampling unit and size, as well as the data analysis methods.

3.3.1 Selection of the study area

The study was conducted in the Port St John's Local Municipality, a Category B municipality that is situated within the O.R Tambo District along the Indian Ocean coastline in the largely rural province of the Eastern Cape. The Ngquza Hill bounds the PSJ Local Municipality in the North, KSD in the South and the Nyandeni Local Municipality in the West. The municipality is the smallest of the five municipalities in the O.R Tambo District, making up 11% of the geographical area (ECSECC, 2017). It is comprised of 20 wards supported by the small urban center of Port St Johns. The seat of the municipality is in the main town of Port St Johns (31° -37' S, 29° -32' E), a region that is evergreen and lavish, even in the driest months of the year, due to warm and temperate climatic conditions that prevail in the region, which receives a significant amount of rainfall. The main economic activities practised in the Local Municipality are tourism and subsistence farming (ECSECC, 2017), the land is suitable for banana farming enabling access to the Eastern Cape metropolitan markets for this good (O.R Tambo District Municipality, 2015).

The total land size of the municipality is about 1 291 km², and it has a total population of 166 779 people, with 99% of the population being made up by Black people, and the remaining 1% of Coloured people (Stats SA, 2016). Most Local Municipality households are poverty-stricken, have a low educational level and face a high unemployment rate (O.R Tambo IDP, 2016/2017; Fodo, 2018). Between 2006 and 2016, the unemployment rate in the Local Municipality from 30.8% to 40.7% (ECSECC, 2017). According to Betek and Jumbam (2015), the PSJ Local Municipality is a rural area that has no significant industries to provide jobs for the people; thus, subsistence farming is their primary livelihood source. There is tremendous potential for increased agricultural growth through government initiatives that are carried out in the municipality, and these have resulted in increased agricultural productivity. The initiatives have also embarked on persuading

local businesses, including the local Spar, to collaborate with local farmers (Kweza, 2018). This study area has become an area of interest due to the successful initiatives to uplift the livelihoods of the rural people. Figure 3.2 demonstrates the position of the Eastern Cape Province within South Africa and then the PSJ Local Municipality within the Eastern Cape Province.

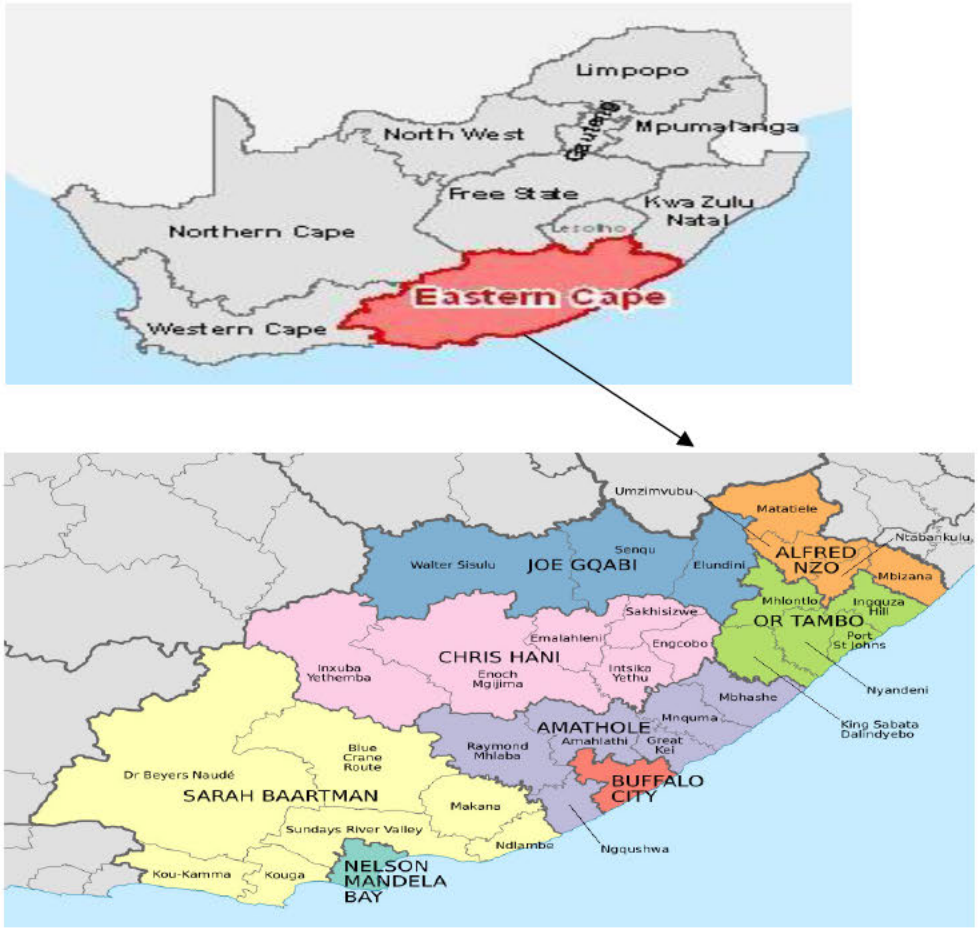

Figure 3. 2: The map depiction of Port St Johns Local Municipality and other municipalities of O.R Tambo District

Source: Google Maps

3.3.2 Data collection

This study used cross-sectional data, which involved taking a snapshot of the population of interest and studying its characteristics at a single point in time. A mixed research method was used, which included qualitative and quantitative methods. Such a research method allowed for both exploration and analysis in the same study, thus providing results with a broader perspective.

Furthermore, the study used primary data from rural households by using structured questionnaires that contain open-ended and closed- ended questions. The study used three experienced enumerators to distribute the questionnaires, who spoke the local Xhosa language. Before the commencement of the fieldwork, they attended a training session, which focused on the content of the questionnaire. The questionnaire was then pre-tested and later adjusted, using insights from the pre-testing, before embarking on the actual data collection. The questionnaires included the following five modules: a) household demographics and socio-economic characteristics (e.g. age, gender and household income); b) institutional factors (e.g. the availability of ICTs); c) access to an ICT-based MIS; d) smallholder market participation; and e) institutional support services (e.g. group membership, access to extension services and access to credit).

3.3.3 Sampling procedure

This study adopted a multi-stage (three-stage) sampling method to draw a sample of the rural households that practise crop and livestock farming in the PSJ Local Municipality. Contrary to several probability sampling methods consisting of a 'single-stage sampling' in a multi-stage setting, the sample is selected in stages, often considering the hierarchical structure of the population (Lavrakas, 2008). According to Battaglia (2008), such a sampling technique uses smaller and smaller units at each stage, or a target population of elements called Principal Sampling Units (PSUs). This sampling technique was adopted mainly for its effectiveness in primary data collection from a geographically dispersed population when face-to-face contact is required. Therefore, the selection of the sampling frame was done under the following stages: (a) The first stage was a Simple Random Sampling (SRS) of all the wards in PSJ, from which ten wards were selected randomly out of the twenty wards; (b) In the second stage, 16 villages within the ten selected wards were chosen as representatives of each ward (based on the availability of farming households); (c) Respondents were selected at the third stage, where rural households practicing farming in the selected villages constituted a sampling frame, from which, fifteen households were randomly selected from each village using a simple random sampling technique making a total of two hundred and forty six (246) respondents.

3.3.4 Sampling unit and size

The sampling unit consisted of those rural households involved in crop and livestock farming, where the household head was interviewed as a critical respondent. In cases where the household

head was absent, a member of the household responsible for the livelihood activities, such as farming, was interviewed on behalf of the household head. When sampling in research, it is advisable to deal with an adequate sample size, in order to obtain accurate results. Therefore, the recommended sample size should not be too small or too big as both can compromise the conclusions that are drawn from the study (Faber and Fonseca, 2014). Using a Rao Soft sample size calculator, with a 94% confidence interval and a 6% margin of error, the sampling size consisted of 246 respondents.

3.3.5 Data analysis

Data from the field were edited, coded and cleaned, to ensure their reliability, uniformity and accuracy. SPSS was used to process and analyze the data, and the study used descriptive statistics and the binary logistic regression model. Descriptive statistics was used to describe the farm-level characteristics of the sampled households, while the binary logistic regression was used to estimate the factors influencing ICT use of smallholder farmers in the PSJ Local Municipality.

3.3.6 Model specification

3.3.6.1 The binary logistic regression model

This study used a binary regression model, which is an extension of a linear regression, where the dependent variable is dichotomous or binary (Harrell, 2015). The model is best suited for this study because it consists of only two predicted outcomes e.g. either Yes or No. Therefore, the predicted outcomes of this study are either positive or negative, which states the predicted relationship between the dependent variable (ICT use) and the independent variables (age, gender, educational level.).

According to Greene (2003), the logistic model takes the form of:

$$\log (Pi / (1 - Pi) = logPi = \beta 0 + \beta_1 X_1 \ldots \ldots \ldots \ldots \ldots \ldots (1)$$

Where Pi is the respondent's probability of using ICTs to access market information, and 1- Pi is the probability of the respondent not using ICTs to access market information. $X1$ is a predictor/ independent variable. Therefore, the parameter $\beta 0$ gives the odds ratio of the dependent variable.

The probability of the occurrence of an event relative to non-occurrence is called the odds ratio, which is given by the following equation: $Pi / (1 - Pi) = \exp (0 + \beta_1 X_1) \ldots \ldots \ldots \ldots \ldots \ldots (2)$

Or in terms of probability outcomes: $Pi = \exp(\beta 0 + \beta_1 X_1)/ (1 + exp(\beta 0 + \beta_1 X_1))$ … … … … (3)

The model is set as follows:

$PI = \beta 0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots. \beta_n + \mu i$ …… (4)

Where: β0=intercept term β1, β2, β3…. βn= slope of the model's parameters or regression coefficients, which measures a unit change in explanatory variables. X1, X2…. Xn = Explanatory or independent variables or factors that influence the use of ICTs by smallholder farmers.

Ui = Error or disturbance term.

For Objective 1: To evaluate factors influencing the ICT use of smallholder farmers for accessing market information.

$P = \beta 0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \ldots\ldots. \beta_n X_n + u$

Where: P (0, 1) = 1 using ICTs, 0 not using ICTs

β = Coefficients

0 = Constant

X_1 = Age

X_2 = Gender

X_3 = Educational level

X_4 = Household size

X_5 = Household income

X_6 = Farm size

X_7 = Farming experience

X_8 = Digital skills

X_9= Access to electricity

X_{10}= Access to quality network coverage

X_{11} = Cost of ICTs

Table 3.2 presents the variables used in the binary logistic model and their expected signs

Table 3. 2: The factors influencing smallholder farmers' ICT use

Dependent variable	**Value**	**Expected signs**
ICT use	dummy 1= ICT use 0= otherwise	
Independent variables		
Age	Continuous	+/-
Gender	Dummy	+/-
Educational level	Categorical	+
Household size	Continuous	+/-
Household income	Continuous	+
Farm size	Continuous	+/-
Farming experience	Continuous	+/-
Digital skills	Categorical	+
Access to electricity	Categorical	+
Quality network coverage	Categorical	+
Cost of ICTs	Categorical	-

Explanation of the explanatory variables presented in Table 3.2

Age: Age was measured as a continuous variable that presented the age of the household head in years. Ekepu and Tirivanhu (2016) noted that there is a positive relationship between the farmers' age and technology adoption i.e. the older the farmer, the more experience has been gained, which makes it even easier than it is for younger farmers to evaluate technical information. In contrast, some studies have highlighted a negative correlation between age and technology adoption i.e. the older a person gets, the more backward they are, when it comes to adopting new and improved technologies (Dhraief *et al*., 2018; Mittal and Mehar, 2016). Similarly, Asif *et al*. (2017) noted that mobile phones are highly technical devices; therefore, older people tend to find it difficult to operate them adequately, as compared to the younger generation. They stated further that the older generation is more likely to stick to outdated technologies and to distance themselves from

different up-to-date technologies. Therefore, in this study, age was expected to have an indeterminate influence on ICT use.

Gender: Gender was measured as a dummy variable with a value of 1 representing Male and 0 Female. According to the USAID, over 1.7 billion women in low and middle-income countries do not own mobile phones, and they are less likely to use them to search for agricultural-related information (FAO, 2018). Bryan and El Didi (2019) reported that, although women farm alongside men and share the same incentive for improving their livelihoods, they tend to benefit less and often face many challenges when using these technologies, compared to men. Conversely, Polar *et al*. (2017) found no association between gender and technology adoption. In the present authors' context, farmers make decisions on technology adoption based on the availability of resources, such as land, water, labour, capital and other resources, rather than on gender. Therefore, in this study gender was expected to have an indeterminate influence on ICT use.

Educational level: The educational level was measured as a categorical variable with four categories based on the relative literacy levels. A value of 0 represented no formal education, 1 represented primary education, 2 represented secondary education, and 3 represented tertiary education. According to Mwangi and Kariuki (2015) there is a positive relationship between education and technology adoption. Therefore, farmers with a high level of education have better access to information and knowledge that is beneficial for farming operations than those with a low level of education (Munasinghe and Kanchanamala, 2018). Therefore, the study expected that farmers who had acquired more than a primary school education would be more productive and more likely to use technology in their farming businesses.

Household size: Household size was measured as a continuous variable and represented the number of people residing in one household. Nwafor *et al*. (2020) found a positive relationship between household size and ICT use. In contrast, Sekabira (2017) reported a negative relationship between household size and technology adoption. The author alluded to the fact that larger households are usually poorer than small households, which hinders the family members from using it. This study expected the household size to have an indeterminate influence on ICT use.

Household Income: Household income was measured as a continuous variable with two categories: on-farm and off-farm income. According to Nwafor *et al*. (2020), higher incomes are associated with the increased use of ICTs. Kinuthia and Mabaya (2017) noted that smallholder

farmers have always been late adopters of technology, due to several constraints with the low level of their off-farm income. Läpple *et al*. (2015) added that when farmers have a stable off-farm income, they are better positioned to try new and improved technologies because they have sufficient resources to do so. The study expected the household income to have a positive influence on ICT use.

Farm size: Farm size was measured as a continuous variable that presented the total size of landholding in hectares. Mwangi and Kariuki (2015) posited that the farm size has mixed influence on technology adoption. As much as owning a large-sized farm is perceived to be an advantage for technology adoption, it can also be a disadvantage. According to Dhraief *et al.* (2018), farmers with large-sized farms, which are mainly composed of herds are more likely to adopt technologies. Kinuthia and Mabaya (2017) attested to the above view. Conversely, Ojo and Oluwatusin (2017) noted that small farms are more likely to adopt new technologies, hoping that they will improve the current state of their agribusiness and double their returns. Farm size was expected to have an indeterminate effect on ICT use.

Farming experience: Farm experience was measured as a continuous variable and represented the number of farming years of the household head. A positive relationship exists between farming experience and technology adoption. Experienced farmers are risk-takers and are always looking for new and improved technologies that will increase production and marketing (Aker and Mbiti, 2010). However, contrary to the above statement, Asif *et al*. (2017) noted that as the farmer's years of farming experience increase, the tendency to use a mobile phone to access agricultural-related information decreases significantly. Experienced farmers become reluctant to change their usual farming practices, thus making them less interested in utilizing other sources of information gathering. The study expected farming experience to have a positive influence on ICT use.

Digital skill: Digital skill was measured as a categorical variable. The household had to indicate the likelihood of being affected by a lack of digital skills when using ICTs. According to Mutisya (2016), the level of digital knowledge positively affects the optimal use of mobile phones by farmers, which means that an increase in the level of digital knowledge of a farmer increases the probability of the farmer's mobile phone use. Digital skills were expected to have a positive influence on ICT use.

Access to electricity: Electricity supply was measured as a categorical variable. The household had to indicate the likelihood of being affected by a lack of electricity when using ICTs. Access to electricity is fundamental for opportunities in this age, as it is the lifeline for families to meet their most basic needs. Moreover, it is the connection that is required to plug Africa into the grid of the global economy (Sarkodie and Adams, 2020). Muhammad *et al*. (2019) argued that ICT tools are electricity dependent, and households should have access to electricity in order for the use of these tools to be effective. Therefore, in this study access to electricity was expected to have a positively influence on ICT use.

Quality of network coverage: Quality network coverage was measured as a categorical variable. The household had to indicate the likelihood of being affected by network coverage when using ICTs. According to Mammo and Girma (2017), having a poor network coverage is a problem that rural farmers face, and therefore, having full network coverage is compulsory to enable farmers to gain access to information. In addition, Owusu *et al*. (2018) also noted that poor network coverage could impede the delivery of agricultural information delivery to farmers. The quality of network coverage was expected to have a positive influence on ICT use.

Cost of ICTs: The cost of ICTs was measured as a categorical variable. The household had to indicate the likelihood of being affected by high costs, when using ICTs. According to Tegegn and Dafisa (2017), rural farmers are not financially stable, and most of them rely on handouts for their livelihoods, which means that they cannot use the latest technology, like mobile phones to get the latest information in order to improve. Similarly, Mammo and Girma (2017) noted that most smallholders could not afford to purchase mobile phones, due to economic constraints, even if different mobile phones were available in the local market at a lower cost. The cost of ICTs was expected to have a negative influence on ICT use.

3.4 Socio-economic characteristics of the sampled respondents

The table below represents the demographic information of selected smallholder farmers in the PSJ Local Municipality (n= 246)

Table 3.3: Socio-economic characteristics of farmers

Characteristics	Description	Frequency	Percentage (%)
Gender of household head	Male	138	56.1
	Female	108	43.9
Marital Status	Single	53	21.5
	Married	150	61.0
	Other	43	17.5
Educational level of household head	No formal education	14	5.7
	Primary education	75	30.5
	Secondary education	128	50.0
	Tertiary education	34	13.8
Occupation of household head	Full-time farmer	237	96.3
	Part-time farmer	9	3.79
Extension services	Yes	97	39.4
	No	149	60.6
Access to credit	Yes	31	12.6
	No	215	87.4
Member of farmer organization	Yes	85	34.6
	No	161	65.4
		Mean-value	
Age of household head (Years)		56.74	
No of years in school of household head		9.70	
Total household size		6.32	
Farm size (Ha)		6.39	
Farming experience (Years)		11.89	
On-farm income (R/ month)		55811.08	
Off-farm income (R/ month)		669.60	

3.4.1 Gender of household head

Table 3.3 shows that there is a dominance of males (56.1%) participating in agriculture, followed by females (who constitute 43.9%). In the agricultural sector, the issue of gender inequality dates

way back. Historically, women have taken a back seat in almost every aspect one can think of, by being constantly interrupted or taken for granted (Geotina-Garcia, 2021). However, women have been changing the narrative, which has also been evident in the agricultural sector. A previous study conducted in the Maphumulo Local Municipality of KwaZulu Natal, attested to this in a "One home, one Garden" program, women were dominant (89.39%), compared to their male counterparts, who constituted only 10.6% (Ngema, Sibanda, and Musemwa, 2018). Women are now becoming leaders, they are now the CEOs of big companies and the VCs of higher learning institutions, and the list is endless. Nonetheless, a gap still exists in the agricultural sector, as most farming households are still headed by males. Therefore, it is paramount to balance gender equality in the agricultural industry, in order to reach the Sustainable Development Goals (SDGs), which has been highlighted as a top global priority by G7 and G20 countries (Loubser, 2020).

3.4.2 Marital status of household head

The study revealed that majority (61%) of the farming households in Port St John's Local Municipality were married. Correspondingly, 21.5% of the respondents were single and 17.5% were either widowed or divorced. This indicates that most of these respondents engage in farming activities to fulfill their obligation of ensure availability of food and increase their income for other necessary needs in their families.

3.4.3 Educational Level

Mwangi and Kariuki (2015) noted a positive correlation between the educational level and agricultural productivity. Being educated decreases the marginal cost of acquiring information and increases the marginal benefits of information. The survey revealed that, 50% of the sample size had a secondary educational level, followed by 30.5% with a primary education, 13.8% with a tertiary education, and 5.7% with no formal education. This shows that, more educated people are practicing agriculture nowadays than they did in the past, when agriculture was mostly practiced by the illiterate. This shift could be caused by the high unemployment rate in the country, which currently estimated to be 32.6%, and keeps increasing at an alarming rate (Omarjee, 2021).

3.4.4 Occupation of household head

The results in Table3.3, revealed that most households (96.3%) practise farming full-time, and that only a small portion of the population (3.7%) are part-time farmers. This shows that farming remains the only escape for those in the rural communities who are, unemployed and poor.

Subsistence farming can provide farmers with food to feed their families and they can then sell the surplus to generate an income (World Bank, 2018; Sibhatu and Quim, 2017).

3.4.5 Extension services

Literature perceives extension programmes as being pertinent for effecting change and for driving rural development through smallholder agriculture (Mapiye *et al*., 2021). Extension programmes are the main conduit for information dissemination, for the provision of input subsidies and for the provision of technical and managerial skills for smallholder farmers. The survey results show that only 39.4% of the sampled population had access to extension services, while 60.6% were without extension assistance, which shows that the extension services are still inefficient amongst the rural farming communities. The findings are compatible with those of Bjornlud and Pittock (2017), who found that despite the operation of extension programs amongst the rural farming communities in South Africa, a gap still exists between productivity and profitability.

3.4.6 Access to credit

The survey results showed that 12.6% of the sampled population have access to credit (8.1% from informal institutions and 6.5% from formal institutions), and 87.4% of the population have no access to credit. This limited access to credit remains a serious issue for smallholder producers, despite its potentially significant impact on boosting the productivity of agriculture (Chandio *et al*., 2020). Those who are able to access credit, do so mainly through informal institutions, because small producers do not meet the requirements of formal institutions, which require major collateral.

3.4.7 Member of an organization

The income capability and agricultural productivity of small producers have always been essential for Africa's development strategy (Fan, and Rue, 2020; Mujuru and Obi, 2020; Gwademba *et al*., 2019; World Food Programme, 2019). Therefore, the aim of the deployment/ establishment of farmer-based organization/ groups is to assist smallholders to increase their productivity and to become a market outlet. The survey results showed that 34.6% of the population are members of a farmers' organization, while 65.4% are not. When asked why they did not join an organization, their responses were as follows: 11.4% said they were not interested, 39.5% said that they lacked awareness, 0.8% said the organizations were useless, and 0.4% said that they were still finding their feet in the farming business. The organization did not serve many purposes for the rural farmers; from the 34.6% of those who were members of the organization, only 9.3 % said that

being a member had assisted them in their farming business, while 24.45% said that there had been no change.

3.4.8 Age of household head

Age can affect a farmer's perception of production in different ways. It can affect production positively or negatively, since old farmers may be reluctant to adopt new practices; on the other hand, the older farmers may adopt the innovations since they have experience in farming (Abdul-Jalil, 2015). The study found that the average age of the farmers was 56.74 (approximately 57 years), which shows that farming is practised mainly by older people in this study area.

3.4.9 Number of years in school of household head

The survey results presented in Table 3.3 show that the average number of years at school for the household head is 9.7 (approximately 10 years). This means that most households practicing farming have a secondary educational level, which is good. Contrary to the past, the agricultural industry has become a knowledge-intensive industry. It now requires people who are educated and equipped with crucial skills, in order to develop a new breed of high-tech entrepreneurs who have a mastery of the high-technology products and services, as this will improve their productivity and the agricultural value chain (Ahmed and Teng, 2019).

3.4.10 Total household size

The results of the survey showed that the household size was 6.32, which means that the households are comprised of six or more household members. According to Mdoda (2017), the larger the household size, the more willing a household is to participate in farming activities, because it is always looking to increase the availability of food. The household size also serves as a source of faming labour and compliments the efforts of the household head on the farm (Martey *et al*., 2013). Therefore, the availability of family labour allows the household head to share his/her responsibilities and to save time for other valuable activities. In contrast, Muricho *et al*. (2015) found that there was a negative relationship between household size and farming.

3.4.11 Farm size

The results of the survey showed that on average the households own about 6.4 ha of land. This is an indication that farming households in the study area farm on a relatively large land size; therefore they could potentially produce for the markets and realize gains from trade.

3.4.12 Farming experience

According to Mdoda (2017), farmers who possess more years of farming, are much quicker in adopting agricultural techniques that will boost their production and make them participate in markets. The survey shows that, on average, the households have 12 years or more of farming experience. This is an indication that farmers in the study area are equipped to make sound production and marketing decisions.

3.5 Access to Market Information Services

For a very long time, smallholder farmers have been exploited by middlemen who are better equipped with market information (Farm Guide, 2018). With the introduction of the second generation of MIS, these farmers stand a perfect chance of accessing timely and reliable market information by browsing through their ICT devices, this will place them in a better position to seize the more lucrative markets and realize more gains from trading. To have an insight into the level of accessibility and the usage of ICT-based MIS by smallholder farmers in the Port St John's Local Municipality. Table 3.4 shows the level of accessibility, the use of ICT-based MIS, and the sources of information that are mostly used by smallholder farmers in PSJ Local Municipality.

Table 3.4: Access, use of ICT-based MIS and sources of information used by smallholder farmers in the Port St John's Local Municipality

Characteristics	Description	Frequency	Percentage (%)
Do you have access to agricultural market information?	Yes	198	80.5
	No	48	19.5
If yes, which sources of information do you use?	Word of mouth	131	53.3
	Extension officers	66	26.8
	Traders	70	28.5
	Social media	10	4.1
	Newspapers	3	1.2
Do you use any ICT tools to access market information	Yes	192	78.0
	No	54	22.0
If yes, which ICT tools do you use?	Radio	5	2.0
	Mobile phones	187	76.0
Use of agricultural farming applications	Yes	5	2.0
	No	241	98.0

Table 3.4 shows that 80.5% of the sampled population had access to agricultural information, which was mainly by word of mouth (53.3%). Although 78% of the sampled population used ICTs to access market information, it was mainly done by using interactive voice responses, and not the other ICT uses. This also became evident in the responses to the question that addressed the use of agricultural farming applications, with only 2% of the sample utilizing such applications in their businesses. These agricultural farming applications included Leaf Snap, Agri Assistant App and Plantix. From these findings, it can therefore be concluded that despite the deployment of ICTs in agriculture, the use of such technologies by smallholder farmers for accessing agricultural activities remains relatively low.

3.6 Binary Logistic Model Results

Table 3.5 shows the results of the binary logistic regression analysis. It shows the estimated coefficients (β values), standard errors, and significance values of the predictor or independent variables in the model.

Table 3.5: Factors influencing the use of ICTs by smallholder farmers for accessing market information

Variables	Coefficient	Standard Error	Significance
1. Age	0.099	0.022	0.000***
2. Gender	-0.366	0.414	0.376 ns
3.Educational level	-0.131	0.329	0.691 ns
4. Household size	-0.113	0.085	0.184 ns
5. Household income	0.000	0.000	0.017**
6. Farm size	-0.377	0.112	0.001***
7. Farming experience	-0.015	0.024	0.539 ns
8. Digital skills	-0.246	0.319	0.441 ns
9. Access to electricity	0.521	0.233	0.025**
10. Network coverage	0.741	0.227	0.001***
11. Cost of ICTs	0.249	0.310	0.421 ns
Constant	-4.580	1.818	0.012
Prob>chi²	0.000		
Pseudo R^2	0.483		
Adjusted R^2	0.314		

***: significant at 1% level, **: significant at 5% level; * significant at 10% level; ns: not significant

The suitability of the logistic regression model was measured by using the data from the Omnibus Tests of Model coefficient, where X^2 (df, N=246) was equal to 92.77, $p<0.001$. The results indicated that the logistic regression model fits the data well and is suited for predicting the influence of the independent variables on the use of ICTs. The Adjusted R^2 for the regression was 0.31, and the Pseudo R^2 was equal to 0.48, which means that the model explains between 31% and 43% of the variance in the dependent variable. Using the Hosmer and Lemeshow test, the model is insignificant, $p= 0.012$, $p>0.001$. The sign (positive or negative) of each logistic regression coefficient represents the effect of a particular independent variable on the dependent variable. Therefore, a positive sign of the coefficient corresponding to each independent variable increases

the probability of smallholder farmers using ICTs. In comparison, a negative sign of the coefficient decreases the probability of use of ICTs by smallholder farmers.

The age of the household head had a positive influence on ICT use and was statistically significant at 1%, which denotes that a positive relationship exists between the age of the household head and the use of ICT for accessing market information. The survey showed that the average age of the household head was 57 years, which means that the respondents were 57years and above; it can therefore be concluded that the older the farmer, the more likely he/she is to use ICTs for accessing market information. Ekepu and Tirivanhu (2016) also found that the older the farmer, the more experience had been gained, which makes it even easier for them to evaluate technology information than the young farmers.

Household income had a positive influence on the use of ICT and was statistically significant at 5%, which implies that an increase in household income increases the probability of the farmers' ICT use. Nwafor *et al*. (2020) also noted that an increased income enhances the ability of respondents to pay for the possible costs involved in utilizing ICT sources for market information; such costs include the purchase of airtime, the availability, and purchase of electricity and the cost of batteries for the radio.

Farm size had a negative influence on ICT use and was statistically significant at 1%, which implies that an increase in the farm size decreases the probability of using ICTs to access market information. According to Ojo and Oluwatosin (2017), small farms are more likely to adopt new technologies, hoping that they will improve the current state of their agribusiness and double their returns.

In their study, Nwafor *et al*. (2020) revealed that an inadequate electricity supply decreases the farmers' marginal use of ICTs. In this study, access to electricity had a positive influence on ICT use and was statistically significant at 5%, which implies that having access to electricity increased the probability of using ICTs, because it makes it easier for farmers to recharge their ICT devices, and hence the positive influence.

Network coverage had a positive influence on ICT use and was statistically significant at 1%. This suggests that increased network coverage results in the increased use of ICTs by farmers. The

above findings align with those of Yohannes (2017), which stated that full network coverage facilitates the delivery of timely and reliable information to farmers.

3.7 Conclusion and Recommendations

This paper investigated the factors influencing the use of ICT by smallholder farmers for accessing market information. Data were collected from a randomly selected sample in the Port St John's Local Municipality of the Eastern Cape Province. The results of the study revealed that smallholder farmers in the study area use ICTs for accessing market information, with the mostly used ICT tool being the mobile phone. However, the market information is accessed mainly through interactive voice responses and not the other uses of ICT. The results also showed that among the variables tested against ICT use, the age, household income, farm size, access to electricity, and access to quality network coverage were statistically significant. Based on the results, this study concludes that the farm-level characteristics are not the only influence on the use of ICT by smallholder farmers, but that the lack of awareness regarding ICT-based MIS is also a contributing factor. Therefore, the study recommends that the government with the help from extension officials should embark on more enlightenment programmes to support use of ICTs among smallholder farmers for the purposes of agricultural marketing.

CHAPTER FOUR: THE EFFECT OF ICT USE ON SMALLHOLDER FARMERS' MARKET PARTICIPATION AND QUANTITY OF GREEN MEALIES SOLD

Abstract

Despite being deemed as significant contributors towards the production of various commodities, smallholder producers regularly have weak linkages with the markets, partly due to a lack of market information. ICTs are emerging to be a key source of information on new technologies, and they could ameliorate the dearth of information along the value chains among the poor (smallholder farmers) and thus link them to profitable markets. The latter markets offer opportunities for them to increase their farm income and to reduce poverty. While it is agreed that ICTs have spread rapidly, even in the rural areas where most rural farmers own an ICT tool, the extent to which they assist in their market participation remains questionable. Therefore, this study examined the effect of ICT use on smallholder market participation and on the quantity of green mealies sold in Port St John's Local Municipality, by using a double-hurdle model. Data were collected from a sample of 246 respondents, using structured questionnaires.

Based on the results, the farm-level characteristics found to be statistically significant for market participation included gender, being a member of a farmers' organization, access to extension services and ICT use. The age, gender, farm size, and ICT use of those participating in markets were found to be statistically significant with regard to the quantity of green mealies sales. Based on these findings, it can be concluded that the variables affecting market participation and the extent of participation are similar. Therefore, the study recommends that the government and other agricultural stakeholders should find a way to train farmers and to inform them about the ICTS, which that could help them to access market information and that will help them to market their products.

Keywords: smallholder farmers, market participation, market information, ICTs, double-hurdle.

4.1 Introduction

About two-thirds of the developing world population consists of rural people who farm on plots smaller than two hectares; many of them are needy, food insecure and have limited access to markets and services (Rapsomanikis, 2015). Enhancing the ability of smallholder farmers to actively engage in the markets is one of the most pressing development challenges (Andaregie *et al*., 2021). Market access allows farmers to specialize in products that have a comparative advantage, to enjoy a diverse consumption bundle and exploit the gains from trading (Ismail, 2014: Ouedraogo, 2018). Therefore, the proper integration of smallholder farmers into agricultural markets is a viable strategy towards achieving sustainable development goals (Adeoti *et al*., 2014; Aku *et al*., 2018). Empirical evidence has shown that smallholder producers participate in markets and make a sizeable contribution to various commodities, but that they regularly have weak linkages with the markets (DAFF, 2012; Mkhabela, 2014; Poole, 2017). Thus, it becomes a challenge for these farmers to compete successfully in the markets, especially when they are competing with the resource-endowed large-scale farmers (Mudhara, 2010).

Efforts have been made to enhance the prospects of market participation among smallholder farmers by means of globalization and liberalization. However, as much as agricultural liberalization opened opportunities for smallholder farmers, it has also posed some threats. The number of farmers taking advantage of such opportunities is small relative to the total number of smallholder farmers. Therefore, to date, these small producers find themselves locked out of the more lucrative markets that serve the regional, capital or export value chains (Langat *et al*., 2016; Ochieng *et al*., 2018). Whether or not rural farmers can access and participate in more lucrative markets depends on various factors, which range from their physical connectivity with the markets, their access to market information and the type of products they sell to name a few (UNCTAD, 2015). According to Okello *et al*. (2020), small-scale farmers are poorly equipped to make sound marketing decisions, partly due to a lack of access to market information.

As the agricultural sector becomes more knowledge-intensive due to the availability of new technology, there is a greater need for a good information flow and sharing among all the agricultural stakeholders (Mittal and Hariharan, 2018). In this modern age farmers need to receive the correct information at the right time, in order to plan their cultivation well, from the clearing of land to the actual harvest and sale of their farm products. The availability of information opens

windows of giving out experience, best prices, sources of financial aid, and new markets (Nzonzo and Mogambi, 2016). Nonetheless, even though farming remains mainly in the hands of smallholder farmers, they still possess little or no information regarding the market activities (Saidu *et al*., 2017; Mammo and Girma, 2017; Okello *et al*., 2020). Therefore, with ICTs emerging as a key source of information on new technologies, the dearth of information could be ameliorated among the poor along the value chain (smallholder farmers), thus linking them to profitable markets. The latter markets offer opportunities for increasing their farm income and reducing poverty. Today, most rural farmers have access to ICT tools, but the extent to which they have assisted smallholder farmers to participate in the market remains unexplored. Therefore, this study adds to the existing literature by examining the effects of ICT use on the market participation of smallholder farmers and on the quantity of green mealies sold in the Port St John's Local Municipality of the Eastern Cape Province in South Africa.

4.2 Material and Methods

4.2.1 Data collection

As described early in section 3.2.1.

4.2.2 Data analysis

Data from the field were edited, coded and cleaned to ensure reliability, uniformity, and accuracy. The study made use of STATA to process and analyze the data. The study also used descriptive statistics to examine the farm-level characteristics of the sampled households. The double-hurdle model was used to examine the effects of ICT use on smallholder farmers' market participation and on the quantity of green mealies sold in Port St John’s Local Municipality.

4.2.3 Double hurdle model

4.2.3.1 Conceptual framework

The random utility framework considers a smallholder farmer's decision whether to participate in the market (McFadden 1974) and the theory of farm household decision-making under imperfect markets (De Janvry *et al*., 1991). The random utility framework suggests that when the expected utility or net benefit from participation is greater than in the case without participation, the smallholder farmer will decide to participate in the market. The theory of farm household decision-making under imperfect markets indicates that a household's market participation is mainly a function of market transaction costs. When market gains are greater than the transaction costs, the

household will participate in the market. When transaction costs are higher than market gain, the household will not participate in the market.

Majority of the smallholder farmers are in remote areas with poor transport and market infrastructures, contributing to the high transaction costs faced. In addition, they lack reliable market information as well as information on potential exchange partners. In some instances, these transaction costs tend to be so high that markets can be said to be "missing" (Key *et al*., 2000; Alene *et al*., 2008). Transaction costs increases the actual price of products purchased while lowering the actual price that farmers get from the sales of that commodity (Mmbando *et al*., 2015). The situation demonstrates why some households participate in the formal market and others are unable to. As explained in De Janvry *et al*. (1991) and other recent studies (Boughton *et al*. 2007; Alene *et al*. 2008), the household's market participation is influenced by its economic position and institutional environment. The model estimated in this study included proxies for transaction costs, wealth endowment and human capital.

4.2.2.2 Empirical framework

This study used the double-hurdle model to evaluate the effects of ICT use on smallholder farmers' market participation and on the quantity of green mealies sales in Port St John's Local Municipality. Following the assumptions in the double-hurdle model, market participation is generally analyzed by using a two-step approach. In the first stage, (which is considered to be the first hurdle) the Probit model was used to determine whether a farmer participates in the market or not. In the second stage, (which is considered to be the second hurdle) a truncated regression model was used to determine the extent of market participation for those who decide to participate in the market, which is measured as quantity of mealies sold. Furthermore, to account for selectivity bias, an Inverse Mills Ratio (IMR) predicted from the Probit regression model was included as a regressor in the second hurdle.

The regression equation thus defines the latent variable $MKTPAT_i$*:

$MKTPAT_i = Z_i\beta + e_i \quad e_i N \approx (0,1)$ (First hurdle) …….... (1)

$MKTPAT_i = 1$ if $MKTPAT_i^* > 0$, and $MKTPAT_i = 0$ if $MKTPAT_i^* \leq 0$

Where $MKTPAT_i$ is a dummy variable that takes the value of 1 if a smallholder farmer participates in the market, and 0 if otherwise.

A Probit model of $MKTPAT_i$ which follows random utility is expressed as:

$Pr(MKTPAT_i = 1|Z_i, \alpha) = \Phi(h(Z_i, \alpha)) + e_i$ ..... (2)

Where, $MKTPAT_i$ equals 1 for households that participate and 0 otherwise. Z_i represents the vector of ICT use for marketing; α, is a vector of the parameters to be estimated; Φ is a standard normal cumulative distribution function; and e_i is a random error term hypothesized to be distributed normally with unit variance σ^2 and zero mean.

In the second step (hurdle), the generated sample selection term IMR from the Probit model (first hurdle) which accounts for potential selectivity bias is then utilized as an exogenous variable in the truncated model regarding MKTPAT intensity, as described by (Greene, 2003).

The second stage (MKTPAT intensity) equation is expressed as:

$E(Qi / MKTPAT = 1) = f(Z_i, \beta) + \omega\lambda$ (Second hurdle) ..... (3)

Where, Q is the quantity of green mealies sold in the market and is the observed response on intensity; E is the expectation operator; Z is a vector of ICT use for marketing; β is a vector of parameters to be estimated; λ is the IMR which accounts for sample selection bias in the probit model; and ω is the associated parameter to be estimated.

The IMR can hence be calculated as $\lambda = \frac{\varphi(h(Z_i, \beta))}{\Phi(Z_i, \beta)}$ ..... (4)

Where, $\varphi(.)$ is the normal distribution and Φ is the cumulative density function. Therefore, Q can be expressed as follows:

$Q_i^* = \beta' Z_i + \omega\lambda_i + \mu_i \approx N(0, \ell^2)$.....(5)

Where, μ_i is a random error term with a zero mean and variance ℓ^2 ; and Q_i^* is the observed response on the quantity of green mealies sales (MKTPAT =1), in which case Q Q_i *. The truncated estimation of Equation (2), with the inclusion of λ, gives consistent estimates, accounting for selectivity bias.

Table 4.1 below presents the variables used in the doublee- hurdle model and their expected signs:

Table 4.1 Description of variables used in the double-hurdle model

Variable names	Variable type	Measure	Expected sign
Dependent variables			
Market participation decision	Dummy	0= non-participant 1= participant	
Extent of market participation	Continuous	Quantity of green mealies sales	
Independent variables			
Age	Continuous	Age of household head in years	+/-
Gender	Dummy	1= male, 0= female	+/-
Farm size	Continuous	Size of land owned in Hectares (Ha)	+
Farming experience	Continuous	Years of farming experience	+
Member of a farmers' organization	Dummy	1= yes, 0= no	
Access to extension services	Dummy	1= yes, 0= no	+
Access to credit	Dummy	1= yes, 0= no	+
ICT use	Dummy	Use of ICTs for marketing of produce	+

The explanation of the variables used in the model (Table 4.1) is presented below:

Age: The age of the household head was captured as a continuous variable and used as a proxy measure of the farmers' experience in production and marketing. According to Rabbi *et al*. (2018), age positively affects market participation, in that older household heads have more experience in farming and marketing, which they have acquired over time. In contrast, Megerssa *et al*. (2020) highlighted that participation in the market declines with age, because younger people are more attached to technology and update their business minds more with marketing issues than older people. With this evidence, the age of the household heads was expected to have an indeterminate relationship with market participation and the extent of their participation in this study.

Gender: The gender of the household head was captured as a dummy variable that took a value of 1 if the household head was male, and 0 otherwise. Previous studies have presented differing findings on the effects of gender in market participation and the extent of market participation. The findings of a study conducted in Myanmar revealed that there was a positive relationship between male farmers and market participation in the rice markets (Kyaw *et al*., 2018). According to Dlamini and Huang (2019), female farmers are often more concerned about household self-sufficiency than their male counterparts, hence their limited market participation. However, in

contrast, Hlatshwayo *et al*. (2021) found that female-headed households are more likely to participate in the markets than their male counterparts. In present the authors' context, this is because the females are mainly involved in subsistence farming, while the males grow crops for a cash income to provide for the needs of the family. The gender of the household head was thus expected to have an indeterminate influence on farmer market participation and the extent of market participation.

Farm size: The farm size was measured in hectares (ha) as a continuous variable of how much agricultural land the household owned. According to Dlamini (2019) and Mashaya (2021), a significant and positive relationship exists between farm size and market participation. This is because a farmer with more land can allocate more land for production, which results in the sale of surpluses in the market. Hence, the farm size was expected to have a positive relationship with market participation and the extent of market participation.

Farming experience: Farming experience was measured as a continuous variable that measured the years of farming experience. This variable reflects the accumulation of farming skills and is tied to repeated transactions, which strengthens trust and creates the networks that a household requires to support market information exchange. Farming experience was expected to positively affect market participation and the extent of market participation.

Member of a farmers' organization: Being a member of a farmers'organization was measured as a dummy variable, with a value of 1 representing Yes (if the household head was a member of an organization) and a value of 0 representing No (if the household head was not a member of an organization). Yameogo *et al*. (2018), found a positive relationship between membership in a farmers' organization and farmers' market participation. According to the authors, membership in a farmers' group provides numerous benefits for farmers, including information resources that can help to improve their decision-making, which in turn leads to improved market participation. In this study, membership in a farmers' organization group was therefore expected to have a positive relationship with farmers' market participation and the extent of market participation.

Access to extension services: Access to extension services was measured as a dummy variable, with a value of 1 representing Yes (if the household head had access to extension services) and 0 representing No (if the household head had no access to extension services). Even though the extension system has been criticized for failing to cater for the needs of smallholder farmers, it has

remained the primary source of information for these farmers. Previous studies have found that a positive relationship exists between access to extension services and market participation (Maponya *et al*., 2015; Bayan, 2020). Therefore, in this study access to extension services was expected to have a positive relationship with market participation and the extent of market participation.

Access to credit: Access to credit was measured as a dummy variable, with the value of 1 representing access to credit, and 0 otherwise. Access to funding credit is a common problem for smallholder farmers in Africa and is a limitation that minimizes their contribution to the agricultural economy (Onumah and Meinjerink, 2012). To ensure long-term sustainability, smallholder farmers need adequate capital, which will enable them to buy high- quality seeds and fertilizers, thereby enabling them to produce high quality produce that matches the stipulated market requirements (Farmer's weekly, 2019). Therefore, in this study access to credit was expected to have a positive effect on market participation and the extent of market participation.

ICT use: ICT use was measured as a dummy variable that took the value of 1 if the farmer used ICTs for marketing and 0 otherwise. As expected, the more accessible market information is to the farmers, the higher will be the probability of their market participation and thus, the quantity of goods sold. ICT tools have a great potential to deliver diverse marketing information and promote access to markets for smallholder farmers, especially information on market prices and demand. This information enables these farmers to produce products that are in line with the market requirements and to capitalize on opportunities to participate in high-value markets (Lashgarara *et al*., 2011). With this evidence, ICT use was expected to have a positive relationship with market participation. Nwafor *et al*. (2020) shared similar findings in a study that examined the adoption of ICT-based information sources and market participation among smallholder livestock farmers in South Africa.

4.3 Empirical Results of the Effect of ICT Use on Smallholder Farmers' Market Participation and the Quantity of Green Mealies Sales

4.3.1 Descriptive statistics of farm-level socio-economic characteristics

Table 4.2 presents the farm-level socio-economic characteristics of selected smallholder farmers in the PSJ Local Municipality (n= 246). A t-test was used for the continuous variables, and a chi-square test was used for the categorical variables; these two tests were used to test whether the means of market-participants and non-participants were statistically different from each other.

Table 4.2: Descriptive statistics of selected farm-level socio-economic characteristics

Characteristics		Market participant (n= 191)	Non-market participant (n= 55)
		Mean	**Mean**
Age		58.24	54.01
Farm size		5.49	4.75
Farming experience		10.01	10.14
		Percentage	**Percentage**
Gender	Female	38.21	6.91
	Male	39.43	15.45
Membership in an organization	Yes	30.4	4.06
	No	29.68	35.77
Extension services	Yes	33.33	6.09
	No	44.30	16.28
Access to credit	Yes	8.53	4.06
	No	15.85	71.56
ICT-use	Yes	39.83	9.34
	No	37.80	13.03

Table 4.2 highlights the differences in socio-economic characteristics between market and non-market participants. The sample of 246 farmers revealed that 191 farmers participated in the markets and 55 farmers did not. Out of the 191 market participants, the average age of market participants was 58.24 (which is approximately 58 years), while the average age of the non-participants was 54.01(which is approximately 54 years). The results show that there was a statistically significant difference on household's age between market- participants and non-participants. The results also showed that there were statistically significant differences on the household gender; 38.21% of the market participants were females, while 39.43% were males. Among non-market participants, the male and female gender ratios were 6.91% and 15.44%,

respectively. The preceding statement is evidence of the of gender inequality in the agricultural sector.

The difference in farming experience was much the same between the market and non-market participants. The market participants had a larger mean farm size of 5.49 ha than the non-market participants, who had a mean farm size of 4.75 ha. With regard to membership in an organization, market participants also had a higher percentage (30.4%) than non-market participants (4.06%), and those who participated in the markets had more access to extension services (33.33%) than those who did not (6.09%). Those who participated in the markets also used ICTs (39.83%) more than their counterparts did (6.09%).

4.4 Main Uses of the Internet

In today's world, the Internet has formed an integral part of everyone's daily lives, making life much easier than before. It has improved the means of communication, fast-tracked transactions and provided fast and reliable information searching. Therefore, in a quest to determine the use of the use of ICTs for agricultural-related activities, this study modelled the primary uses of the Internet by smallholder farmers in Port St John's Local Municipality. Figure 4.1 shows the primary uses of the Internet by smallholder farmers in this Municipality:

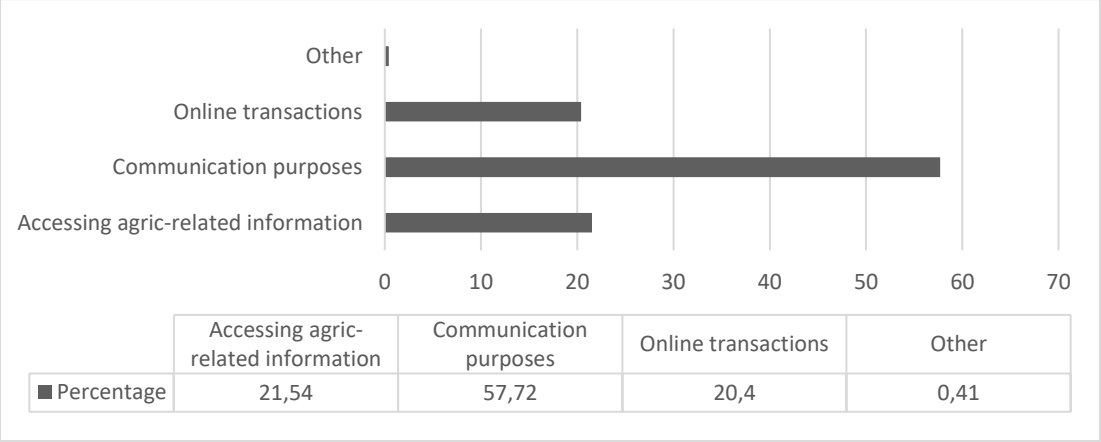

Figure 4.1: Main uses of internet by farmers in Port St John's Local Municipality

The results of Figure 4.1 shows that the internet was primarily used for communication purposes (57.72%), followed by accessing agricultural-related information (21.54%), online transactions (20.4%), as well as for other purposes at (0.41%). These results show that even though ICTs exist in rural communities, they are mainly used for communication purposes, which implies that

smallholder farmers still lack the knowledge and awareness regarding the use of ICT for agricultural-related information.

4.5 Marketing Outlets Used by Smallholder Farmers

Due to the limited market information that smallholder farmers receive in South Africa, they have faced many encounters when it comes to marketing their products in formal markets, and they end-up marketing their products in local or village markets (Mdlalose, 2016). These informal markets have been the downfall for these farmers, because they are mainly used by people in remote areas where poverty remains a predominant problem, with most people being unemployed and often lacking purchasing power. Figure 4.2 shows the marketing outlets used by smallholder farmers in Port St John's Local Municipality.

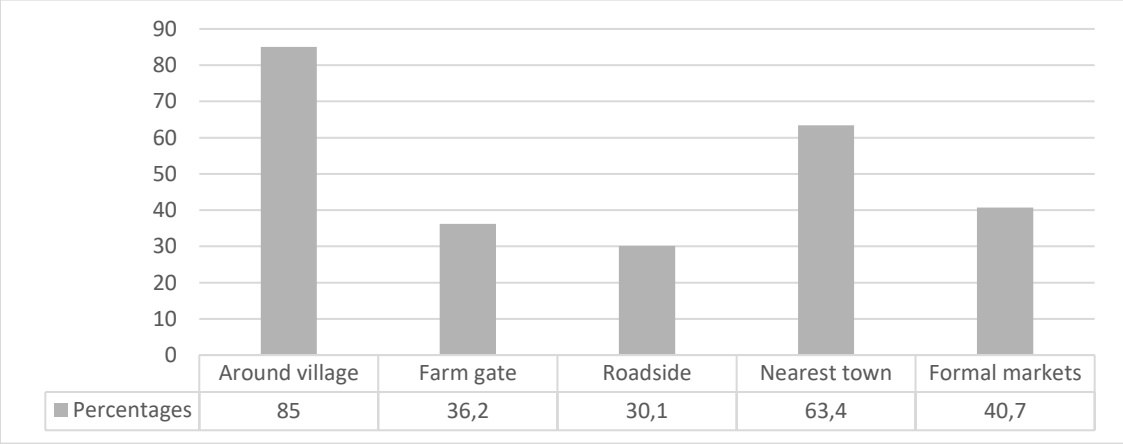

Figure 4.2: Marketing outlets used by farmers in Port St John's Local Municipality

The results of Figure 4.2 shows that the most used marketing outlets by farmers in the study area are around the villages (85%), followed by the nearest town (63.4%), formal markets (40.7%), farm gates (36.2%) and roadsides (30.1%). These results show that farmers sell most of their products in informal markets, which have always served as the 'backbone' for rural farmers. However, these markets do not benefit the smallholder farmers, as they are mainly dominated by people with a low purchasing power. Therefore, linking smallholders to formal markets remains a critical part of any long-term development or poverty reduction strategy. Unlike informal markets, formal markets offer remarkable prospects for growth to small-scale producers, as they provide a

connection to a reliable income stream, as well as prospects for accessing additional support services (Nwafor, 2020).

4.6 Effect of Identified Variables on Smallholder Market Participation

A Probit regression model was used to examine the effects of identified variables on smallholder market participation. Table 4.3 shows the results from the Probit model.

Table 4.3 Effect of variables including ICT use on smallholder market participation

Variables	Coefficient	Standard Error	(P>z)
1.Age	-0.000	0.007	0.924ns
2.Gender	-0.380	0.182	0.037**
3. Farm size	-0.004	0.007	0.595ns
4.Farming experience	0.008	0.017	0.625ns
5. Member of an organization	-0.726	0.239	0.002***
6. Extension services	1.284	0.242	0.000***
7. Access to credit	-0.023	0.040	0.555ns
8. ICT use	-0.482	0.205	0.0.19***
Constant	-0.739	0.584	0.206
LR chi^2 (9) = 40.04			
Prob> chi^2 = 0.0000			
Log likelihood = -143.33472			
Pseudo R^2 = 0.1227			

***,** and * represent level of significance at 1%,5% and 10%, respectively

Despite a male dominance of 56.1% in the total population, the results in table 4.3 shows that gender had a negative effect on market participation and was statistically significant at 5%. This implies that female-headed households are more likely to participate in markets than their male counterparts. Nwafor (2020) and Hlatshwayo *et al*. (2021) shared similar findings. According to Mathebula *et al*. (2017), females tend to participate more in agricultural activities because males migrate to the cities to look for jobs, in order to provide for their families. Qange and Mdoda (2020) shared similar findings. However, this could not be the reason in this present study, as a massive percentage of the sampled population consists of full-time farmers (96.3%). Apart from owning home gardens, most female farmers formed co-operatives that focused on poultry farming. They are usually involved in many activities, hence their increased market participation.

Being a member of a farmers' organization had a negative effect on smallholder market participation and was statistically significant at 1%, which implies that being a member of a farmers' organization decreased the probability of smallholder farmers participation in the market. This may be due to the ineffectiveness of the farmers' organization in providing market-related information to the farmers. Farmer organization constitute platforms where members have the

opportunity to share information. However, in most cases, the group meetings are only held once a month, thus disadvantaging farmers in the marketing of their products due to a lack of information sharing. These findings align with those of Yamego *et al*. (2018), who found a negative relationship between being a member of a farmers' organization and participation in the rice markets.

Access to extension services had a positive effect on market participation and was statistically significant at 1%, which implies that those with access to extension services are more likely to participate in the markets, compared to their counterparts. This shows that extension services are somehow doing a good job by linking farmers to the markets. In support of the preceding statement, during the field survey, a group of farmers from Ndimakude mentioned that they get assistance with regard to the marketing of their produce from the extension agents. The farmers said that, "whenever there are available market opportunities, the extension agents would come and combine their produce and sell it as one in the formal markets." Megerssa *et al*. (2019) revealed similar findings in a study that looked on smallholder market participation and its associated factors amongst vegetable producers in Ethiopia.

ICT use had a negative effect on market participation and was statistically significant at 1%, which implies that the use of ICTs for the marketing of agricultural products tends to decrease the probability of market participation. It must be noted that smallholder farmers have always had access to markets, but these markets do not produce ideal profit margins, in order for these farmers to grow in their farming businesses (Ngqangweni *et al*., 2016). Therefore, the aim has always been to link farmers to lucrative markets. Despite, a high percentage of farmers using ICTs for marketing their products, a high percentage of these farmers supply their products mostly to informal markets and not lucrative markets, hence the decreased market participation. These findings contradict those of Nwafor *et al*. (2019), who found a positive relationship between ICT use and market participation.

4.7 Effect of Identified Variables on the Extent of Market Participation (measured as Quantity of green mealies sold)

Table 4.4 shows the results of the truncated regression model that was used to examine the effect of identified variables on the quantity of green mealies sales. The coefficient of the Inverse-Mills-Ratio (IMR) was insignificant in this model, which implies that any bias due to self-selection could be discounted.**Table 4.4: Effect of variables including ICT use on the quantity of green mealies sales**

Variables	Coefficient	Standard Error (SE)	Significance (P>z)
Age	11758.27	6517.321	0.071*
Gender	359265.1	165966.5	0.030**
Farming experience	1252.371	2635.869	0.635^{ns}
Member of an organization	389208.9	380146.4	0.306^{ns}
Extension services	-80954.75	93714.86	0.388^{ns}
Access to credit	-28144.4	64797.69	0.664^{ns}
ICT use	-219189.8	95202.8	0.021**
Invmills	139154.6	187156.7	0.457^{ns}
Constant	-1034180	708171.2	0.144
Sigma	**104110.9**	**28484.18**	**0.000*** **

Note: ***, ** and * represents significance level at 1%, 5% and 10%, respectively

The age of the farmer had a positive effect on quantity of green mealies sales and was statistically significant at 10%. The positive coefficient implies that older farmers are more likely to sell more green mealies in the markets, as opposed to the younger farmers. This may be because age is associated with the years of farming experience. Therefore, older farmers may have accumulated experience over time, and they may have built strong networks with retailers and traders, which makes it easier for them to seize the available market opportunities. The results of this study complement those of Beadgie and Reddy (2020), who found a positive relationship between age of the farmer and quantity of maize supplied to the market.

A gender analysis can aid in a better understanding of the developments in African development systems, particularly in agriculture. Some agricultural products are believed to be best suited for sale by a specific gender (Akanle *et al.*, 2019). Gender had a positive effect on the quantity of green mealies sold and was statistically significant at 5%, which implies that the male farmers tend to sell more green mealies in the market than their female counterparts. This could be because male farmers produce mainly cash crops, while female farmers usually produce food crops, such as cabbage and spinach. Therefore, male farmers produce enough green mealies to supply the

markets, unlike the female farmers. Similar findings were found in Uganda and southern Ethiopia (Sebatta *et al*., 2014; Gebre *et al*., 2021).

The farm size had a positive effect on the quantity of green mealies that were sold and was statistically significant at 1%. This implies that farmers with a larger farm size tend to sell more quantities of green mealies in the market, as opposed to their counterparts. This is because a larger farm holds greater opportunities for increased surplus production and the subsequent quantity sold, unlike small farms. These results align with those of Beadgie and Reddy (2020) who found a positive relationship between the area of maize grown and the quantity of maize supplied to the market.

As in the first stage of the model, in this stage, ICT use had a negative effect on quantity of green mealies sold and was statistically significant at 1%, which implies that a negative relationship exists between ICT use and the quantity of green mealies sales. This may be because of the low usage of ICT applications for farming in the study area. The ICT applications provide farmers with better and timely production information, which could enable them to produce products that are in line with the market demand and thus lead to an increased surplus (Minkoua Nzie *et al*., 2018) The results suggest that the farmers are using ICTs for activities beyond farming.

4.8 Conclusion and Recommendations

This paper examined the effect of ICT use on smallholder market participation and the quantity of green mealies sales in the Port St John's Local Municipality of the Eastern Cape Province, South Africa. The results showed that the gender of the household head, being a member of a farmers' organization, access to extension services, as well as ICT use were statistically significant with regard to smallholder market participation, while, age, gender, farm size and ICT use were statistically significant with regard to the quantity of green mealies sold. Based on the findings of the study, ICT use had a negative and statistically significant effect on both smallholder market participation and quantity of green mealies sold. It can therefore be concluded that farmers in the study area lack a knowledge of ICT-based MIS for use in farming, which could help them to market their products in formal markets and to realize profits. This study did not explore where they are using the ICTs to positive effect.

Therefore, it is important in this study not to make recommendations that are based only on ICT use, but also on some factors that influenced smallholder market participation and the quantity of

green mealies sold. The study recommends the following: (a) increasing extension support services; (b) utilizing the existing ICT platforms to provide adequate market information to farmers; (c) strengthening the farmer organizations in the area, which will improve the collective bargaining power of the farmers, as well as their access to formal markets. In addition, because most of the farmers lack a knowledge of ICT-based MIS, the government and other agricultural stakeholders should find ways for farmers to be trained and informed about existing ICT applications and services that could help them in accessing timely and reliable market information.

CHAPTER FIVE: EFFECT OF MARKET ACCESS ON THE WELFARE OF SMALLHOLDER FARMERS

Abstract

Despite several programmes being initiated to link smallholder farmers to markets, the lack of market access persists. By nature, smallholder farmers are already entrepreneurial in that they produce more than they eat and sell their surpluses to informal markets for income. However, these informal markets do not meet resource-poor farmers' needs because they are mainly dominated by people who have a low purchasing power. Therefore, smallholder farmers require unlimited access to formal markets, in order for them to be integrated into the mainstream economy. For many years, the emphasis has been on identifying the barriers that smallholder farmers face with regard to market access and to develop strategies to link them to the markets. However, little attention has been paid to the effects of market access on their rural livelihoods. In order to determine market access impacts on smallholder farmers' livelihoods, this study assessed the effect of market access on the welfare of smallholder farmers in the Port St John's Local Municipality of the Eastern Cape Province, in South Africa.

A sample of 246 households was randomly selected by using structured questionnaires. The descriptive statistics were used to analyze the farm-level characteristics, while propensity score matching was used to assess the effects of market access on the welfare of smallholder farmers (measured as household income). Amongst the variables tested against market access, it was found that marital status, being a member of a farmers' organization, as well as access to market information, negatively and statistically affected their market access, while access to extension services, positively and statistically affected their market access. When analyzing the outcome by using the propensity scores derived from factors affecting market access, market access was found to have a positive and significant effect on smallholder farmers' household income. Therefore, the study recommends the revitalization of the existing market access programmes, to ensure the improved market access of smallholders as a pathway to enhancing rural livelihoods.

Keywords: smallholder farmers, market access, informal markets, rural livelihoods

5.1 Introduction

For the vast majority of the world's poor, smallholder farming provides both food and a means of livelihood (Yobe *et al*., 2019). Therefore, alleviating global poverty requires the boosting and stabilization of farm incomes and food production in emerging nations (Noack and Larsen, 2019). The involvement of smallholder farmers in formal markets can contribute significantly to their agricultural productivity and income growth, which, in turn, can enhance food security, poverty reduction efforts, and overall economic growth (Wegren, 2018; Kamara *et al*., 2019; Meemken and Bellemare, 2020). However, the smallholder sector has hardly enjoyed the necessary policy and institutional support that will allow them to thrive (Fan and Rue, 2020).

Without a doubt, smallholder farmers are, by nature, already entrepreneurial in that they produce more than they eat and sell their surpluses to informal markets for profit and gain (von Loeper *et al*., 2018). Access to relevant markets remains a problem for smallholder farmers across the globe and without it farmers are not motivated enough to increase the yields of products they will not be able to sell (Olwande *et al*., 2015). The existing literature has highlighted that unlimited market access to formal markets must be available for smallholder farmers to be integrated into the mainstream economy (Seng, 2016). Commercialization prospects, at the local and national level, and finding ways to increase the incomes of smallholders and reduce poverty have remained central to policymakers in many developing countries (Muricho *et al*., 2017; Rabbi *et al*., 2019; Taku- Forchu, 2019). However, in the absence of critical support functions, such as infrastructure and service provision, smallholder farmers struggle to shift from subsistence to more productive forms of exchange (Ripley, 2017). Following the market liberalization reforms undertaken by the government of South Africa in the mid-1990s, the agricultural markets have not worked in favour of smallholder farmers, to date (Macdonald, 2019). They still struggle to participate and to remain competitive in the food value-chains that currently maintain capital funds. Therefore, failure to participate in these value-chains excludes farmers from the capital markets and the general struggle for economic survival (von Loeper *et al*., 2016).

5.2 Programmes Initiated to Link Smallholder Farmers to Markets

In closing the gap between farmers and markets, many efforts have been devoted to promoting systems that will help to transition from production to market. In the late 1980s, a Farmer Support Programme was implemented in South Africa, to provide farmers in the former homelands with the support required for successful agricultural production and better linkage to remunerative markets. According to Sikwela and Mushunje (2013), the program did indeed bring about a change in the farmers' livelihoods, as it led to the improved income of smallholder farmers in the Eastern Cape and the KwaZulu Natal Province. Similarly, if one was a member of a farmers' organization in Tanzania, it also led to an increased income for vegetable farmers (Aku *et al*., 2018).

Contract farming, a preharvest agreement between farmers and buyers, which mitigates the prevalent market failures, was also implemented in the developing economies. This way of linking farmers to markets has also led to improved welfare outcomes among the rural communities. According to Meemkena and Bellemare (2020), the results in six African countries (Bangladesh, Côte d'Ivoire, Mozambique, Nigeria, Tanzania and Uganda) revealed that smallholder households participating in contract farming obtained an income that was about 10% higher than that of their counterparts. With the sudden proliferation of Information and Communication Technologies in the developing economies, the agricultural sector has also incorporated ICT-based MIS in the day-to-day running of their businesses to provide farmers with market information and thus to improve market access (Folitse *et al*., 2019; Ameru *et al*., 2018).

For many years, the emphasis has been on identifying the barriers or constraints to smallholder farmers 'market access and to develop strategies to link them to the markets. However, little attention was paid to the effect of market access on rural livelihoods. Therefore, this portion of the study assessed the effect of market access on the welfare outcomes of smallholder farmers in the Port St John's Local Municipality of the Eastern Cape Province, in South Africa.

5.3 Material and Methods

5.3.1 Data collection

As described earlier in section 3.2.1.

5.3.2 Data analysis

Data from the field were edited, coded, and cleaned to ensure reliability, uniformity, and accuracy. This study made use of STATA software to process and analyze the data. Descriptive statistics were used to analyze the farm-level characteristics of the sampled households, while the Propensity score matching (PSM) was used to assess the effects of market access on the welfare of smallholder farmers in the PSJ Local Municipality.

5.3.3 Propensity score matching

5.3.3.1 Conceptual framework

Market access reflects an important part in providing greater income for smallholder producers through various channels. There is a general agreement that improving market access of smallholder farmers will engender the accrual of greater investment, which enhance productivity and income, and consequently will improve the livelihood of the farmers, especially in rural areas (Sehar, 2018). Limited or poor access to the markets by smallholder farmers is a problem at both micro and meso–levels. At both levels, high transaction costs are the major cause of poor functioning of the markets. High transaction costs make input and output markets to fail at micro-level and impedes efficient functioning of the markets at meso-level by retarding the flow of price information between local/village and regional markets. This study therefore centers on the theory of Transaction Cost Economics (TCE), which is part of the New Institutional Economics (NIE) (Hubbard and Weirer 1991; Clague 1997; Poulton *et al*.,1998). Transaction cost theory seeks to explain the significance of market and non-market institutions in economic exchange (Williamson, 2000; Menard, 2005). This theory recognizes that markets are driven by transaction costs created by information asymmetry. The higher transaction costs facing smallholder farmers stem from the higher costs of searching for and screening of exchange partners, negotiating the sale of output or purchase of inputs, monitoring and enforcing the terms of exchange and costs of renegotiating or adjusting to changes in market environment. Provision of market information in a costless manner improves market exchanges for the smallholder farmers. It therefore allows the farmers to increase net income by reducing the costs. In the analysis of agricultural marketing in South Africa, this

theory can be helpful when estimating the impact of market access initiatives on the welfare of smallholder farmers. Farmers that have access to markets are hypothesized to increase income from their farming activities and in turn this is expected to provide greater incentives to smallholder farmers to participate in the market.

5.3.3.2 Empirical framework

This study employed Propensity Score Matching (PSM) to assess the effects of market access on welfare of smallholder farmers. One of the primary problems that is faced when using observational data is selection-bias. This means that the responses of individuals who experience a certain treatment often vary from those of individuals that don't in systematic ways that we haven't addressed or accounted for and for which there are no bias-estimates. Therefore, the propensity score matching which was introduced by Rosenbaum and Rubin (1983) aims to minimize the potential bias resulting from the selection problem by using non-experimental data. According to Pan and Bai (2015), four steps are followed when using the PSM, namely: (a) the estimation of the propensity scores either by using a logistic or Probit model; (b) matching of the propensity scores, in order to have a comparison group; (c) evaluating the quality of the matching and (d) evaluation of the outcome.

The PSM can be expressed as follows:

$$p(X) = \Pr(D_i = 1|X) = E(D_i|X) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where $D_i = (0,1)$ is the dummy for market access and X is the vector of household characteristics. The conditional distribution of X, given the propensity score p(X), is similar in both groups, namely, of those with market access and those without market access. After estimating the propensity scores, the average treatment effect on the treated (ATT) can then be estimated as:

$$ATT = E(Y_{1i} - Y_{2i}|D_i = 1) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots... (2)$$

$$ATT = E[E(Y_{1i} - Y_{2i}|D_i = 1, P(X))] \quad \ldots\ldots\ldots\ldots\ldots\ldots.. (3)$$

$$ATT = E[Y_{1i}|D_i = 1, P(X)) - E(Y_{2i}|D_i = 0, P(X))] \quad \ldots\ldots\ldots\ldots\ldots (4)$$

where Y_{1i} is the expected household income if household i has access to the markets; Y_{2i} is the expected household income of household i without access to the markets; Di = (0,1) is the dummy for market access and X is the vector of the household characteristics.

5.3.3.3 Empirical estimation

To analyze the factors affecting market access of smallholder farmers and to estimate the propensity score Pr(X) = Pr (D =1X) for assessing the effect of market access on smallholder household income, the study made use of a Probit model (Wooldridge, 2002).

Table 5. 1: Description of variables used in the Probit regression model

Dependent variable	Definition	Unit of measurement	Expected sign
Market access	Market access or no market access	1= yes, 0= no (dummy)	
Independent variables			
1. Age	Age of household head in years	Continuous (years)	+/-
2. Marital status	Marital status of the household head	0= married, 1= single, 2= divorced/ widowed (categorical)	+
3. Member of an organization	Membership to a farmer organization group	1= yes, 0= no (dummy)	+
4. Extension services	Access to extension services	1= yes, 0= no (dummy)	+
5. Market information	Access to market information	1= yes, 0= no (dummy)	+
6. Distance to markets	Distance to the nearest market	Continuous (ha)	-
7. Farming experience	The number of years of farming experience of the household head	Continuous(years)	+

The explanation of the variables used in the model (Table 5.1) is presented below:

Age: Age was measured as a continuous variable that presented the age of the household head in years. Age can determine a farmers' experience of the production and marketing of agricultural products. Older and more experienced farmers can make sound marketing decisions as compared to the younger farmers (Rangoato, 2018). Therefore, age was expected to have a positive effect on market access.

Marital status: Marital status was measured as a categorical variable, with the value of 0 representing married household heads, 1 representing those who are single and 2 representing those who are divorced or widowed. According to Mdoda (2017), the marital status serves as an indication of stability. A married household head is more likely to access the markets, compared to single and divorced ones. Therefore, marital status was expected to have a positive effect on market access.

Farming experience: The farming experience was captured as a continuous variable that represented the number of years of farming experience of the household, which is expected to have a positive relationship with market access. More experienced farmers may have developed social

capital and may have more marketing experience as opposed to their counterparts (Musara *et al*., 2018). Therefore, farming experience was expected to have a positive effect on market access.

Distance to markets: The distance to the markets was captured as a continuous variable that measured the distance between the farm and the market- place in kilometers. Previous work has noted that distance had a negative relationship with market access (Baloyi, 2010; Dangia *et al*., 2019). Therefore, the distance to the markets was expected to have a negative effect on market access.

Member of a farmers' organization: Membership in a farmers' organization was measured as a dummy variable, with a value of 1 representing Yes (if the household head was a member of an organization) and a value of 0 representing No (if the household head was not a member of an organization). According to Aku *et al*. (2018), this is because strong farmers' organizations effectively are a bridge between the farmers and market access, they improve their access to markets, as well as their livelihoods through increased incomes. Therefore, membership in an organization was expected to have a positive effect on market access.

Access to extension services: Access to extension services was measured as a dummy variable, with a value of 1 representing Yes (if the household head had access to extension services) and 0 representing No (if the household head had no access to extension services). Extension services serve as an important source of information and advice for smallholder farmers. According to Mmbando *et al*. (2014), agricultural extension services are expected to improve access to production and marketing information, and to improve the technical skills of smallholders. Therefore, access to extension services was expected to have a positive effect on market access.

Access to market information: Access to market information was captured as a dummy variable, with a value of 1 representing a household head with access to market information, and 0 representing a household head without access to market information. Access to timely and relevant market information is of paramount importance to farmers, as it paves the way for making informed decisions and improving their economic welfare (Hailu, 2017). According to a growing body of literature, resource-poor farmers find it difficult to participate in formal markets and there is often no linkage between these farmers and the markets in which they sell due to lack of market information (Yohannes, 2017; Musungwini, 2018). Therefore, access to market information was expected to have a positive effect on market access.

5.4 Empirical Results of the Study

5.4.1 Descriptive statistics of farm-level socio-economic characteristics

Table 5.2 presents the farm-level socio-economic characteristics of selected smallholder farmers in the PSJ Local Municipality (n= 246)

Table 5.2: Descriptive statistics of selected farm-level socio-economic characteristics

Characteristics	Description	Frequency	Percentage%
Gender	Male	138	56.1
	Female	108	43.9
Marital status	Single	53	21.5
	Married	150	61.0
	Other	43	17.5
Educational level	No formal education	14	5.7
	Primary education	75	30.5
	Secondary education	128	50.0
	Tertiary education	34	13.8
Access to agricultural market information?	Yes	198	80.5
	No	48	19.5
Extension services	Yes	97	39.4
	No	149	60.6
Access to credit	Yes	31	12.6
	No	215	87.4
Member of farmer organization	Yes	85	34.6
	No	161	65.4
		Mean-Value	
Age		56.74	
Farm size		5.33	
Farming experience		11.46	
Quantity sold cabbage		17885.83	
Quantity sold spinach		6485.01	
Quantity sold Mealies		28945.73	

5.4.2 Crops grown, and livestock kept by smallholder households

Table 5.3 provides a clear view of the type of crops grown and livestock kept by farmers in Port St John's Local Municipality.

Table 5.3: Crops grown, and livestock kept by smallholder households in the PSJ Local Municipality

Vegetables	Response	Frequency	Percentage%
Cabbage	Yes	126	51.2
	No	120	48.8
Spinach	Yes	97	39.4
	No	149	60.6
Green mealies	Yes	74	30.1
	No	172	69.9
Carrots	Yes	74	30.1
	No	172	69.9
Potatoes	Yes	25	10.2
	No	221	89.8
Livestock			
Chickens	Yes	27	11
	No	219	89
Pigs	Yes	22	8.9
	No	224	91.9
Goats	Yes	18	7.3
	No	228	92.7
Sheep	Yes	17	6.9
	No	229	93.1

According to Sipoko (2014), PSJ is characterized by eutopic brown soils and megalithic soils, which are suitable for intensive cultivation and vegetable gardening. The results presented in Table 5.3 show that in the crops grown in the PSJ Local Municipality, the leading crop is cabbage (51.2%), followed by spinach (39.4%) green mealies and carrots (30.1%), and potatoes (10.2%). Cabbage is a popular vegetable with gardeners for two reasons: firstly, it is very nutritious, so it supplements the dietary needs of the households very well, and secondly, it is easy to grow. The results for the various forms of livestock that are kept, are as follows: chickens (11%), pigs (8.9%), goats (7.3%), and sheep (6.9%). Although the Eastern Cape Province is a leading livestock province, the results show that, crop production remains the primary source of income for the rural households in PSJ Local Municipality.

5.4.3 Challenges faced by smallholder farmers when marketing their products

For the longest time, smallholder farmers have faced difficulties when it comes to marketing their products to formal markets. Figure 5.1 shows the challenges faced by smallholder farmers in Port St John's Local Municipality when marketing their products.

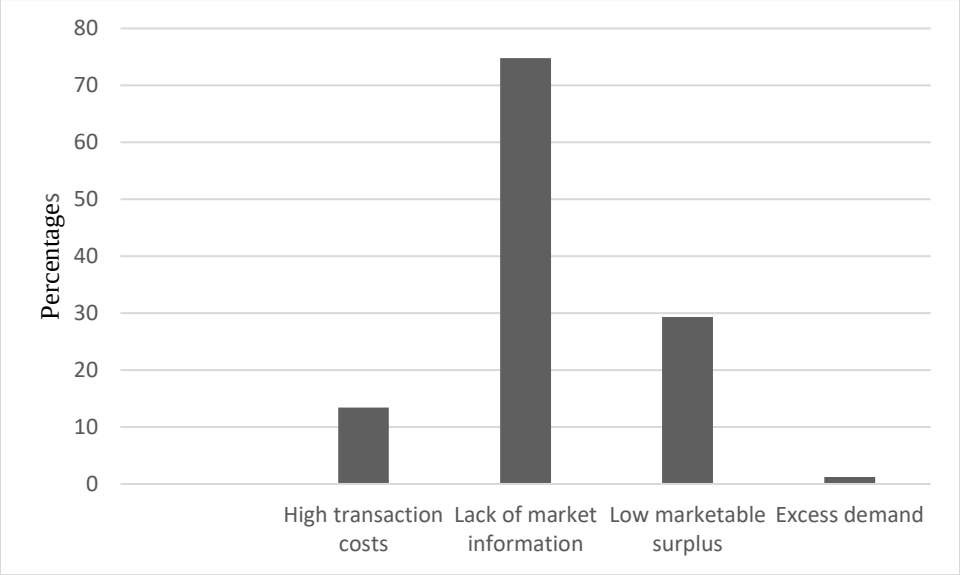

Figure 5.1: Challenges faced by smallholder farmers when marketing their products

Despite higher market demand for their products, smallholder farmers sell less of their products, not because they do not meet the stipulated market demand, but because they lack access to relevant market information (Msoffe and Ngulube, 2016). This was evident in the survey results in Figure 5.2, which showed that the lack of market information was a major challenge amounting faced by 74.8% of the sampled farmer population. This is because the most used source of information for farmers in the study area is word of mouth, which is usually obsolete information; this makes it only viable for them to trade in informal markets, where the low-income earners dominate. Musungwini (2018) found similar findings in a study conducted in Zimbabwe, where 90% of the farming households cited the "absence of market information" as a challenge that they face when marketing their products.

5.4.4 Market participation of smallholder farmers in PSJ Local Municipality

Hlatshwayo *et al.* (2021) highlighted that in developing countries such as South Africa, market participation can result in enhanced sustainable agriculture, economic growth as well as reduced poverty and inequality. Table 5.4 shows the market participation of smallholder farmers in PSJ Local Municipality.

Table 5.4: Market participation of smallholder farmers

Description	Response	Frequency	Percentage (%)
Do you always find a market for your product?	Yes	92	37.4
	No	153	62.2
If No, what happens to unsold produce?			
Loss to spoilage	Yes	111	43.1
	No	135	54.9
Used for home consumption	Yes	86	35
	No	160	65
Sell at giveaway prices	Yes	81	32.9
	No	165	67.1
Store and sell later	Yes	25	10.2
	No	221	89.8
Donate	Yes	18	7.3
	No	227	92.3

According to Ezihe *et al.* (2017), the exceptional role played by smallholder farmers in development of agriculture in Africa creates a high economic interest. Most of the rural poor use food crops to supplement their dietary needs and to generate income. Therefore, linking smallholders to formal markets remains mandatory, in order to reduce food losses and to improve rural livelihoods. The results in Table 5.4 shows that only 37.4% of the sampled population had access to the markets, and that most of the unsold produce is lost to spoilage. These food losses tend to reduce the availability of food crops and the income that is generated from selling these products (Tadesse *et al.*, 2018).

5.5 Probit Regression Model for Factors affecting Smallholder Market Access

To generate the propensity scores for the matching process, the probability of the access of smallholder farmers to the markets was estimated using the Probit regression model (Table 5.5).

Table 5.5 Factors affecting smallholder farmers' access to markets

Variable	Coefficient	Z	P>|z|
Age	0.00	0.26	0.795 ^{ns}
Marital status	-0.18	-1.17	0.082*****
Farming experience	0.02	1.07	0.285 ^{ns}
Distance to markets	-0.00	-0.35	0.726 ^{ns}
Extension services	1.14	4.81	0.000*******
Member of an organization	-0.61	-2.58	0.010*******
Access to market information	-0.97	-1.99	0.047*******
Constant	0.04	0.63	0.530

***: significant at 1%, **: significant at 5%, *: significant at 10%

The results presented in Table 5.5 show that marital status had a negative effect on market access and that it was statistically significant at 10%. This may be because a single household head becomes the sole bread winner of his/her household, therefore the person is always looking for additional streams of income. These results are similar to those of Adeoye *et al*. (2018), who found a negative relationship between marital status and market participation, but they were contrary to those of Segage *et al*. (2018), who found a positive relationship between marital status and market participation.

For long time, the extension system has serviced rural farming communities and has been entrusted to overcome information asymmetry among smallholder farmers (Ncube, 2017; Maulu, 2017; Loki *et al*., 2021) Access to extension services had a positive effect on market access and was statistically significant at 1%. This implies that those with access to extension services tend to access the markets more than their counterparts.

The formation of farmer support groups has been advocated as a solution for linking smallholder farmers to lucrative markets (Aku *et al*., 2018; Pingali et al., 2019; Bizikova *et al*., 2020). Being a member of a farmers' organization had a negative effect on smallholder market access and was statistically significant at 1%. This implies that those who are members of a farmers' organization tend to have limited market access, compared to their counterparts; therefore, membership in a

farmers' organization does not always guarantee improved market access and, in most cases these groups tend to be ineffective.

Okello *et al*. (2020) noted that despite the benefits of having access to the markets, smallholder market participation in lucrative markets remains constrained by market imperfections and market failure, the common cause of which is lack of adequate market information. Access to market information had a negative effect on market access and was statistically significant at 1%. These results align with those of Adeoye *et al*. (2018), who found that there was a negative relationship between access to market information and market participation.

5.6 The Effect of Market Access on the Household Income of Smallholder Farmers

The effect of market access on the household income of smallholder farmers was assessed by using the Average Treatment Effect (ATT) (Table 5.6). To compute the ATT, three alternative matching methods (the nearest neighbor matching, radius matching method and the kernel matching) were used. The analysis was based on the implementation of a common support, so that the distribution of the treated and controlled units were located in the same domain.

Table 5.6 Average treatment effects for the household income of smallholder farmers

Matching method	Treated	Control	ATT	t-test
Nearest neighbor matching	153	57	23614.26	1.85
Radius matching	153	90	23123.80	2.43**
Kernel matching	152	90	22472.99	2.23**

Note: ** represents significance level at 5%

The results in Table 5.6 shows that both the radius and kernel matching estimators yielded similar results. This implies that market access has a positive and statistically significant effect on the household income of smallholder farmers. More specifically, the results imply that those with access to the markets tend to have higher income than those without market access. These findings align with those of Aku *et al*. (2018) who found out that vegetable producers who had access to markets via producer's groups had more income as compared to their counterparts.

5.7 Test of Matching Quality

To evaluate the reliability of the above reported estimates further, the balancing tests based on nearest neighbor were conducted, and the results are presented in Table 5.7.

Table 5.7 Results of matching quality test after matching

Variable	Means		% Bias	t-tests	
	Treated	Control		T	p>t
Age	57.70	56.71	-0.94	-0.58	0.71
Marital status	1.92	2.22	0.29	0.72	0.10
Farming experience	7.96	7.16	-0.80	-1.16	0.87
Distance to markets	37.12	38.80	1.67	0.33	0.36
Extension services	1.69	1.40	-0.30	-4.85	1.00
Member of an organizations	1.49	1.44	-0.50	-0.85	0.80
Access to market information	1.96	1.81	0.50	0.96	0.16

According to Caliendo and Kopeinig (2008) valid matching is achieved when there are no significant differences between the treated and control groups. The results in Table 5.7 indicate that there were no statistically significant differences after matching, between those with market access and those without. Furthermore, Peikes *et al*. (2008) highlighted that for matching to be declared successful the results in the bias must be less than 20% for all covariates in the model. The standardized differences (% bias) for the mean values of all the covariates between those with market access and those without, are below 20%, which implies that the balancing requirement is adequately satisfied.

5.8 Determinants of Household Income among the treated group

To investigate the extent to which the treatment effect on the household income differs among the treated group (that is, those with market access) the ordinary least squares regression was estimated, and the results are presented in Table 5.8.

Table 5.8: Determinants of household income among those with market access

Variable	Coefficient	Standard error	t	P> t
Age	630.76	379.10	1.66	0.098*
Marital status	-16849.76	5600.65	-3.01	0.003***
Farming experience	2096.43	1010.10	2.08	0.039***
Distance to markets	-164.70	137.48	-1.20	0.232ns
Extension services	17371.61	12511.54	1.34	0.180ns
Member of an organization	6497.06	12932.41	0.52	0.604ns
Access to market information	-1516.65	12136.72	-0.12	0.901ns
Constant	87108.12	36920.98	2.36	0.019
F	30.20			
P	0.00			
R-squared	0.504			
Adjusted R- squared	0.544			

Based on the results in Table 5.8 the R-square is 50.4%, and it is an acceptable level, implying that the model's estimates fit the data. The adjusted R-square is 54.4%, with a p-value of 0.000 indicating a strong correlation between household income and the explanatory variables. The results in Table 5.8 shows a positive and statistically significant relationship between the age of the household head and household income. The relationship is also the same between farming experience and household income. This implies that, household heads who are older and with more years of farming experience tend to have higher income. Age is often associated with experience. According to Musara *et al*. (2018) farmers with more farming experience may have developed social capital and may have more marketing experience, hence the higher income. The results also show a negative and statistically significant relationship between household's marital status and household income. This suggests that single-headed households tend to have higher incomes than the married ones. This may be because, unlike married household heads, who have financial

support from their spouse, a single-headed household has no one to share the responsibilities with, so the household is always looking for other streams of income, hence the higher income. The findings align with those of Marius (2017) who found out that those who were single had higher income than the married ones. In the present author's context this was mainly because, the single-headed households have less dependents as compared to the married ones.

5.9 Conclusion and Recommendations

This chapter assessed the effect of market access on the household income of smallholder farmers. Firstly, it investigated the factors that affect smallholder farmers' market access, and later, assessed the effect of market access on the household income of smallholder farmers. Based on the empirical results of this study, market access has a positive and statistically significant effect on household income of smallholder farmers. Based on these findings, the study has identified the need to improve the market access of smallholder farmers, starting with improving the factors that negatively affect market access in the study area. Therefore, the study recommends the revitalization of the existing market access programmes, in order to ensure the improved market access for smallholder farmers. This includes the regular auditing and monitoring of farmer organizations, to ensure their effectiveness and to enhance the market access and bargaining power of smallholder farmers. It is also recommended that adequate market information be provided to the smallholder farmer, through existing sources such as extension officers, and farmer associations.

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter provides an overall summary of the study, stating the main aim of conducting the study. It proceeds by summarizing the study's findings in relation to its empirical chapters and making recommendations based on the study results.

6.2 Overview of the Study

Smallholder farmers produce about 80 percent of the developing world's food and play a tremendous role in poverty alleviation and ensuring food security. The world's population is expected to double by 2050; hence more food will be required. Therefore, there is a greater need for better contribution from smallholder farmers; however, this will be difficult as they still face high transaction costs and information barriers that limit their optimal production and marketing, resulting in limited welfare outcomes.

The smallholder farmers producers' goal is to make sales at each harvest but they face marketing bottlenecks. They are poorly equipped to make sound marketing decisions, partly due to a lack of access to market information. In the absence of reliable and accurate information, these farmers fail to plan their marketing strategies. With the sudden proliferation of modern technology, a number of ICT-based MIS interventions have been introduced to increase agricultural commercialization by improving efficiency at marketing in the last decade. In South Africa, several farming ICT applications have been launched to help close farmers' information gaps. These information platforms include the FarmBoek, ARC Hub, Khula farming application, Mobile Agribiz, etc. However, despite the widespread ownership of mobile phones in South Africa, with most rural farmers owning ICT tools, the extent to which these ICT tools can aid smallholder farmers' market participation and welfare remains unexplored. Therefore, the study's overall objective was to examine the effect of ICT-use in enhancing market participation and household welfare outcomes among smallholder farmers in the Port St John's Local Municipality, Eastern Cape Province, South Africa.

Firstly, the study sought to evaluate factors influencing smallholder farmers' ICT use for accessing market information. Secondly, the study examined the effect of ICT use on smallholder farmers' market participation and quantity of green mealies sales. Lastly, the study assessed the effect of market access on smallholder farmers' welfare. Data were randomly drawn from a sample of 246

households using a structured questionnaire. Data analysis involved both descriptive and econometric techniques. Descriptive statistics involved frequencies, percentages, and mean values. While, the econometric analysis made use of the binary logistic regression model, double hurdle model and the propensity score matching.

6.3 Conclusion

The study finds that farmers in the study area use ICTs in accessing market information; with the mostly used ICT tool being mobile phones. However, the market information is mainly accessed through interactive voice (i.e., via phone calls) and not the other services available through ICTs. The findings also showed that the variables that influence smallholder market participation and quantity of green mealies sold are similar, with ICT use negatively and statistically significant in both the first and second stages of the double hurdle. This shows that farmers in the study area still lack awareness of the existing ICT applications and services that could assist them in marketing their products. The results of the study also showed that a positive and statistically significant relationship exists between smallholder market access and household income. Which implies that, access to markets does lead to improved household welfare for farmers in the study area.

6.4 Policy recommendations

The study recommends that investment should be on campaigns that create awareness about ICT use in agriculture. Farmers need to embrace the knowledge that not only can the mobile device be used for communication purposes, but it can also cater to their agricultural needs. Smallholder farmers must be familiarized with the use of ICT applications and services to assist them in tapping the most lucrative markets and sell more of their products. The awareness campaigns should also focus assisting farmers with interpreting marketing information, as supply of marketing information alone to farmers is not sufficient for transforming their marketing strategies. The study further recommends for the revitalization of the existing market access programmes in order to ensure the improved market access for smallholder farmers. This includes the regular auditing and monitoring of farmer organizations, to ensure their effectiveness and to enhance the market access and bargaining power of smallholder farmers.

6.5 Areas for future research

This study provided an overview of the effect of ICT use in enhancing market participation and welfare outcomes amongst smallholder farmers in the Port St John's Local Municipality. The unpopular use of ICT tools for conducting agricultural activities has been identified as a significant issue amongst the smallholder households of Port St John's Local Municipality. Due to time and resource constraints, this study could only collect data for one municipality in the Eastern Cape Province. Therefore, future research should include smallholder farmers from different municipalities in the province for the results to be more robust.

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APPENDICES

APPENDIX 1: Ethics Approval Letter

UN IVERSITY OF KWAZULU-NATAL INYUVESI

YAKWAZULU-NATALI

29 March 2021

Miss Zodidi Cebiso (220112618)
School Of Agri Earth & Env Sc
Pietermaritzburg Campus

Dear Miss Cebiso,

Protocol reference number: HSSREC/00002467/2021
Project title: The Effect of ICT use in enhancing market participation and household welfare outcomes among smallholder farmers in the Eastern Cape Province, South Africa.
Degree: Masters

Approval Notification — Expedited Application

This letter serves to notify you that your application received on 08 December 2020 in connection with the above was reviewed by the Humanities and Social Sciences Research Ethics Committee (HSSREC), and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol, i.e , Questionnaire/interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach, and Methods, must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number. PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

This approval is valid until 29 March 2022.
To ensure uninterrupted approval of this study beyond the approval expiry date, a progress report must be submitted to the Research Office on the appropriate form 2 - 3 months before the expiry date. A close-out report is to be submitted when the study is finished.

All research conducted during the COVID-19 period must adhere to the national and UKZN guidelines.

HSSREC is registered with the South African National Research Ethics Council (REC-040414-040).

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd

Humanities and Social Sciences Research Ethics Committee
Postal Address: Private Bag X54001, Durban, 4000, South Africa
Telephone: +27 (0)31 260 8350/4557/3587 **Email**: hssrec@ukzn.ac.za **Website**: http://research.ukzn.ac.za/Research-Ethics

Founding Campuses: Edgewood Howard College Medical School Pietermaritzburg Westville

APPENDIX 2: Consent form

INDIVIDUAL INFORMATION SHEET AND INFORMED CONSENT FORM

Title of Study: The Effect of ICT use in enhancing market participation and household welfare outcomes among smallholder farmers in the Eastern Cape Province, South Africa.

Dear participant,

My name is Cebiso Zodidi, a master's student at the University of KwaZulu Natal. I am researching the effect of ICT use in enhancing market participation and household welfare outcomes among smallholder farmers in the Port St John's Local Municipality, Eastern Cape Province, South Africa. The region became of interest for research purposes due to its success stories on projects aimed at uplifting the livelihoods of rural farmers. Hence, the research aims at investigating the effect of using ICTs on the market participation and household welfare of rural farmers. Therefore, you are cordially invited to participate in this study. Please be advised that **your participation is voluntary,** and you can also withdraw your participation in the study if you feel uncomfortable. The choice of whether to participate or not is yours. However, we would appreciate it if you do share your thoughts with us. Should you take part in the study, please be advised that the study procedure will be as follows: step1 you will be expected to sign a consent form, step 2 an enumerator will hand you a questionnaire and take you through all the sections until everything is clear, step3 you can commence with answering the questions. The duration of your participation is expected to be at least 45minutes.

Any information shared will remain confidential, meaning that your name and address will not be linked in any way to the answers you give. We study and report on the answers given by all the people we interview and not on an individual basis. The research data will be anonymous, with all personal respondent information removed, and archived at the University. The study has zero risks involved. The study will provide no immediate benefits, but we hope that the results of this study will be of great help to all relevant stakeholders and will help tackle the challenges facing smallholder farmers. In the event of any problems or concerns/questions, you may contact the researcher at **071 2652 720 or email: cebisozodidi@gmail.com/ 220112618@stu.ukzn.ac.za** or the UKZN Humanities & Social Sciences Research Ethics Committee; contact details are as follows:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus Govan Mbeki
Building
Private Bag X 54001
Durban
4000

KwaZulu-Natal, South Africa

Tel: 27 31 2604557- Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

INFORMED CONSENT FORM

I *(name of participant)*
……. have been informed
about the study titled: The Effect of ICT use in enhancing market participation and household welfare outcomes among smallholder farmers.

I understand the purpose, procedures, and risk-benefit ratio of the study.

I have been allowed to ask questions about the study and have had answers to my satisfaction.

I declare that my participation in this study is entirely voluntary and that I may withdraw at any time without affecting any procedurals that I would usually be entitled to.

I understand that if I have any further questions/concerns or queries related to the study, I understand that I may contact the researcher at **071 2652 720 or email:cebisozodidi@gmail.com/ 220112618 @stu.ukzn.ac.za.**

I understand that if I have any questions or complaints about my rights as a study participant, or if I may have concerns about any aspect of the study or the researcher/s then I may contact:

HUMANITIES & SOCIAL SCIENCES RESEARCH ETHICS ADMINISTRATION

Research Office, Westville Campus Govan Mbeki Building
Private Bag X 54001
Durban
4000

KwaZulu-Natal, SOUTH AFRICA

Tel: 27 31 2604557 - Fax: 27 31 2604609

Email: HSSREC@ukzn.ac.za

_____ _____

Signature of Participant **Date**

Additional Consent

Consenting for Audio Recording– when necessary
YES / NO
Use of photographs for research purposes
YES/NO

_____ _____

Signature of Participant **Date**

_____ _____

Signature of Witness **Date**

_____ _____

Signature of Translator **Date**

APPENDIX 3: Questionnaire

School of Agricultural, Earth and Environmental Sciences

College of Agriculture, Engineering and Science

University of KwaZulu-Natal

Pietermaritzburg

Questionnaire number……

Date of interview……....

The Effect of ICT use in enhancing market participation and household welfare outcomes among smallholder farmers in the Eastern Cape Province, South Africa.

Dear participant

I am a Masters' student at the University of KwaZulu Natal, conducting a study on the Effect of ICT use in enhancing market participation and household welfare outcomes among smallholder farmers. Participating in the research will help me better understand the popularity of ICT use among smallholder farmers and what effect ICT use has on smallholder farmers' market participation. Your partaking in this research is voluntary, and should you wish to discontinue participation in the research, you may do so. The information provided here will be treated as **STRICTLY CONFIDENTIAL**. There will be no mention of names in the final report. The data gathered by this tool will be used solely for the purpose of this intended evaluation and nothing else.

I. Smallholder Household Demographic information

(Please tick your answer)

Number	Household characteristics	Response
1.1	Gender of household head	◯ Male ◯ Female
1.2	Age of household head	_____ (Years)
1.3	Marital status of household head	◯ Single ◯ Married ◯ Others (*specify*) _____
1.4	Educational level of household head	◯ no formal education ◯ primary ◯ secondary ◯ tertiary
1.5	No. of years in school of household head	_____ (Years)
1.6	Total household size	_____
1.7	Farm size	_____ (Hectares)
1.8	Farming experience of household head	_____ (Years)
1.9	Occupation of household head	◯ Fulltime farmer ◯ Part-timer farm ◯ Other(*specify*) _____
1.10	Source of income	On-Farm income: ◯ Cropping R _____ ◯ Livestock R _____ ◯ Other R _____ Off-Farm income: ◯ Employment R _____ ◯ Trading R _____ ◯ Remittances R _____ ◯ Grants R _____

II. Institutional Factors of smallholder household

1.Which of the following ICTs do you own? (*please tick*). Also, indicate when you started using them.

			Year
i.	Radio		
ii.	Television		
iii.	Computer		
iv.	Mobile phone		
v.	Telephone		
vi.	Other (*specify*) _____		

2. Do you have access to the internet? 1. Yes ◯ 2. No ◯

3. If Yes, what do you use the internet mainly for? 1. Accessing agricultural-related information

◯ 2. Communication purposes ◯ 3. Online transactions ◯ 4. Other (*specify*) _____

3. What is the most significant technology you have learnt from the ICT tools you own? (*specify*) _____

III. Access to ICT-based market information services

1. Do you have access to agricultural market information? 1.Yes ◯ 2. No ◯

2. If yes, which of the following sources of information do you use?

i. Extension officers ◯
ii. Word of mouth (from neighbors/ family members)◯
iii. Traders ◯
iv. Newspapers ◯
v. Others (*please specify*) ————

3. From those mentioned above, which is the most reliable source of information? ————

4. Why is this the most reliable source of information ?

i. Is it convenient to access anytime and anywhere? ◯
ii. Cheaper to use? ◯
iii. Is the information reliable and timely? ◯
iv. Relevant to anyone even to the illiterate? ◯
v. It does not require a telecommunication network to operate? ◯

5. Do you use any ICT tools to access market information? 1.Yes ◯ 2. No ◯

6. If Yes, which of the following ICT tools do you use ?

i. Radio ◯
ii. Television ◯
iii. Mobile phone ◯
iv. Computer ◯
v. Others (*please specify* ————

7. What kind of information do you usually have access to?

i. Market price information ◯
ii. Market demand ◯
iii. Availability of buyers ◯
iv. Others (*specify*) ————

8. Did you use any of this information to sell crops/ livestock? 1. Yes ◯ 2. No ◯

9. To what extent do you trust information from these ICT tools?

i. To a small extent ◯
ii. To some extent ◯
iii. To a moderate extent ◯
iv. To a great extent ◯

10. How often do you use ICTs to access the following: (*please tick*)

	Everyday	Once a week	Once a month	Once a year	Other(*specify*)
i. Market price information					
ii. Market demand					
iii. Availability of buyers					
iv. Other (*specify*)					

11. Do you make use of an agricultural App in your farming business? 1. Yes ◯ 2. No ◯

12. If Yes, which Apps do use? (*please specify*) _____

13. How did you find out about the App(s) mentioned above? 1. From extension agents ◯ 2. Friends/ family ◯ 3. Other farmers ◯ 4. Social media platforms ◯ 5. Other (*specify*) _____

14. What effect has ICT use had on the marketing of your products?

i. Saved time and reduced costs ◯
ii. Provided better connectivity with the markets ◯
iii. Empowered negotiations with wholesalers, traders, and transport providers ◯
iv. Increased income ◯
v. Other (*please specify*) _____

15. On a scale of 1-5 where **1=** very likely, **2=** likely, **3=** neutral, **4=** unlikely and **5=** very unlikely. How likely are you affected by the following factors when using ICTs? (*please tick*)

Factors	**Very likely**	**Likely**	**Neutral**	**Unlikely**	**Very likely**
Lack of digital skills					
High cost of ICTs					
Poor network coverage					
Limited internet access					
Limited electricity supply					
Poor device					
Other (*specify*) _____					

IV. Market participation

1. Did you sell any of the crops you produced last season? 1. Yes ◯ 2. No ◯

2. If yes, please fill in the table below

Crops grown 1= Cabbage 2= Spinach 3= Potatoes 4= Carrots 5= Maize 6= Other _____	Season 1= Summer 2= Winter	Harvested area (ha)	Quantity harvested (kg, heads, sacks)	Qty Sold (kg, heads, sacks)	Price/ kg (R)	Total (R)	Qty consumed	Qty donated

3. Did you sell any of the livestock you own or livestock products you produced last season? 1= Yes 2= No

4. If yes, please fill in the table below:

Livestock 1= Dairy cattle 2= Sheep 3= Goats 4= Pigs 5= Chickens 6= Other _____	No. of livestock owned	Quantity produced	Quantity sold	Price (R)	Total (R)	Qty consumed	Qty donated

5. If, no to both number **2&3** what was the reason?

i. Did not produce a surplus ◯
ii. There was no reliable market ◯
iii. Prices offered were too low ◯
iv. High-quality requirements ◯
v. Other (*please specify*) _____

6. How is the produce price formulated? 1. Set the price ◯ 2. Negotiate price ◯ 3. Buyer set the price ◯ 4. Market driven ◯ 5. Other(*specify*) _____

7. Where do you usually sell your products?

i. Around village ◯
ii. Farmgate ◯
iii. Roadside ◯
iv. Nearest town ◯
v. Formal market ◯
vi. Other (*specify*) _____

8. Which of the following challenges do you usually face when marketing your products?

i. High transaction costs ◯
ii. Lack of market information ◯
iii. Low marketable surplus ◯
iv. Other (*specify*) _____

9. How does produce reach the markets?

i. Transported with own vehicle ◯
ii. Hired transport (individual) ◯
iii. Hired transport (groups) ◯
iv. Public transport ◯
v. Other (*specify*) _____

10. Distance to market place (km) _____

11. Nature of road used when transporting produce? 1. Gravel road ◯ 2. Tarred road ◯ 3 Other (*specify*) _____

12. Do you always find a market for all your products? 1. Yes ◯ 2. No ◯

13. If No, what happens to unsold produce?

i. Lose to spoilage ◯
ii. Use for home consumption ◯
iii. Sell at giveaway prices ◯
iv. Store and sell later ◯
v. Other (*please specify*) _____

V. Institutional support services (*please tick*)

1. Are you a member of any organization?

Yes	Name of organization	No	Reason

2. If yes, how many years have you been a member? _____

3. Why did you join the organization? _____

4. How frequent do you meet in a month? _____

5. How has being a member of the organization assisted you in marketing your products? _____

6. Do you have access to extension services? 1. Yes ◯ 2. No ◯

7. If yes, which organization renders the services?

i. Government ◯
ii. NGOs ◯
iii. Private companies ◯
iv. Others (*please specify*) _____

8. Do you have access to credit? 1. Yes ◯ 2. No ◯

9. If yes, which financial institutions provide you with credit? 1. Informal institutions ◯

2. Formal institutions ◯ 3. Both ◯ 4. Other (*please specify*) _____

THANK YOU FOR YOUR COLLABORATION!