The effect of digital technology in agriculture on market access and household food security among smallholder vegetable farmers in Ntfonjeni and Sidvokodvo communities of Eswatini.

Busile Glory Lukhele

Student no: 219087958

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Master of Agriculture (Food Security),

African Center for Food Security,

School of Agricultural, Earth, and Environmental Science

College of Agriculture, Engineering and Science

University of KwaZulu Natal

ABSTRACT

Many industries, big and small, including agriculture, are being affected by the 4th industrial revolution. The inclusion and adaptation of digital technology in agriculture can advance market participation and improve food security of smallholder farmers in developing countries. In Eswatini, rural households primarily participate in farming as a means of improving their livelihoods. However, there is still a research gap on the scope on the impact of digital technology in agriculture on market access and household food security among smallholder vegetable farmers in Eswatini. This study sought to assess the role of digital technology in agriculture among smallholder farmers in accessing markets and household food security in Eswatini. The study was conducted at Ntfonjeni and Sidvokodvo community in Eswatini. A mixed method approach was employed in the study. Purposive sampling was used to select a sample of 100 active long-term smallholder vegetable farmer. They were interviewed face to face using a questionnaire. Moreover, two extension officers were interviewed as key informants to understand their perception regarding the awareness and adoption of smallholder vegetable farmers on using digital technology when accessing markets. The data was analysed using SPSS version 28. Descriptives statistics revealed that there were more male famers (56%) compared to female farmers (44%), cabbage was the most grown vegetable. Moreover, results indicated that a normal phone (23.58%) was the most owned digital tool among farmers and phone calls were the common means used by farmers when advertising. Most farmers sold their produce at farm gate and the most common market were the local community members. Farmers received most of their market information from other agricultural cooperative members and through extension officers through phone calls. In addition, majority of, the farmers (36.7%) indicated that that they did not receive training on digital marketing. Mobile money was the most used digital platform for money transaction among smallholder farmers. Furthermore, most farmers received their farm credit from micro finance institutions, particularly Fincorp. Household Food Insecurity Access Scale (HHFIAS) score revealed that 24% farmers were food secure, 39% farmers were moderately food insecure, 31% farmers were mildly food insecure and 6% were severely food insecure. It was concluded that the use digital technology on market access had less impact on household food security. The policy makers and supporting organizations should develop programmes aimed to empowering social capital and human capital assets of the farmers through designing a ‘Siswati’ digital marketing platform. Campaigns that promote using of the digital platforms should create an awareness

amongst vegetable farmers. Moreover, vegetable farmers should be educated on the benefits and operation of digital technology platforms used for marketing and its benefits. Extension officers must ensure that vegetable farmers are not only trained on growing marketable vegetables but also understand the benefits of consuming a more diverse diet to improve their food insecurity status.

KEYWORDS: Digital technology, market access, smallholder farmer, food security.

PREFACE

The Research contained in this dissertation was completed by a candidate while based in the school of Agricultural, Earth and Environmental Sciences of the College of Agriculture, Engineering and Science, University of KwaZulu Natal, Pietermaritzburg Campus, South Africa. Under the supervision of Professor Joyce Chitja.

The contents of this work have not been submitted in any form to another university and except, where work for others is acknowledged in the text, the results reported are due to investigations by the candidate.

Signed [redacted] Date:23 January 2024

Busile Glory Lukhele (Candidate)

As supervisor(s) of the candidate we agree to the submission of this dissertation.

Signed… [redacted] Date: 23 January 2024

Prof Joyce Chitja (Supervisor)

DECLARATION 1-PLAGIARISM

I, **Busile Lukhele** declare that:

1. The research reported in this dissertation, except where otherwise indicated, is my original research.
2. This dissertation has not been submitted for any degree or examination at any other university.
3. This dissertation does not contain any other person's data, picture graphs or other information, unless specifically acknowledged as being sourced from other sources.
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Signed: [redacted] Date: 23 January 2024

Name: Busile Lukhele

As a research supervisor, I agree with the submission of this dissertation for examination:

Signed: [redacted] Date: 23January 2024

Name: Prof Joyce Chitja

DECLARATION 2- DRAFT PUBLICATION MANUSCRIPT

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Prof JM Chitja: Signature:…… [redacted] …….

Miss BG Lukhele Signature: [redacted]

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ABBREVIATIONS

AVC:	Agriculture Value Chain
DT:	Digital Tools
FANTA:	Food and Nutrition Technical Assistance
FAO:	Food and Agriculture Organization
FINCLUDE:	Financial Inclusion and Cluster Development Project
FINCORP:	Finance development Corporation
FPM:	Fresh Produce Markets
HIFAS:	Household Food Insecurity Access Scale
ICT:	Information and Communications Technology
MFI:	Micro Finance Institution
MoA:	Ministry of Agriculture
NAMboard:	National Agriculture Marketing board
SLF:	Sustainable livelihoods Framework
SNL:	Swazi Nation Land
USAID:	United States Agency for International Development

CHAPTER1: THE PROBLEM AND ITS SETTING

1.1 INTRODUCTION TO THE RESEARCH PROBLEM

Numerous studies have found that smallholder farming plays a crucial role on improved household food security status among the African rural communities particularly in the Sub Sahara region. In Eswatini, there are two types of land tenure namely land held in customary tenure, or Swazi Nation land (SNL) and land held by freehold tenure, or title deed land (TDL) (Phungwayo, Kushitor & Koornhof 2021). A majority of Eswatini smallholder farmers are predominantly found in the rural areas under the communal land tenure called Swazi Nation Land (SNL). There is not much overall commercialization of vegetable production on SNL since it practiced by subsistence farmers Mangwe *et al*. (2020). Approximately sixty-four percent of the kingdom of Eswatini population is situated in rural settlements which are affected by a high incidence of poverty (Dlamini 2020).

Vegetable cultivation presumably supports livelihood primarily through food provision, income generation, and employment because vegetables are preferred cash crops (Rai *et al.* 2019). Even though Eswatini has a wide range of marketing systems including farmer markets, cooperative markets, contract markets and corporate markets (Mangwe *et al*. 2020). Smallholder farmers are likely to prefer traditional markets due to minimum barriers and often deliver poor-quality vegetables to the market, which fail to sell (Louw& Jordaan 2017). Rugube *et al*. (2019) found that lack of skill and training on improving profitability of their vegetables was amongst challenges encountered by Shiselweni vegetable farmers of Eswatini.

Even though Eswatini government and supporting institutions for years had also tried implementing market linkage initiatives to promote food security and growth of smallholders, the success stories from these initiatives are limited (Dlamini- Mazibuko 2020). Nwafor, Ogundeji and Westhuizen (2019) highlighted that access to market information is considered a key institutional factor that affects participation of smallholders in markets. Therefore, incorporating digital technology in agriculture may address some of the challenges faced by the smallholder vegetable farmers on market access. Digital agriculture has emerged as a viable solution to addressing smallholder farmers' contextual challenges (Gumbi *et al*. 2023).

Digital agriculture is defined as "the use of digital technologies, innovations, and data to transform business models and practices across the agriculture value chain (FAO 2019). According to Tsan

et al. (2018), in agriculture, digitalization could be a game changer in boosting productivity, profitability, and resilience to climate change. Digital technologies can significantly reduce the costs of linking sellers and buyers; reduce inequalities in access to information, knowledge, technologies, and markets; potentially reduce scale economies in agriculture, thereby making small-scale producers more competitive (World bank 2019).

Moreover, there spread of digital technologies especially mobile phones comes with new opportunities for households in rural settings to achieve a varied set of development goals such as access to information, markets, and financial services (Aker *et al.* 2016). However, IFC (2018) augured that technology alone is not sufficient to create fully functioning markets. It must be complemented by appropriate government and regulatory policies. And it is highly dependent on infrastructure improvements, especially in energy and telecommunications.

In order, to obtain positive impact on digital technologies adoption, it is important for government to design programmes and strategies that will upgrade the infrastructure that supports digital technologies in farming. Moreover, it is imperative to empower the human and social capital of the smallholder farmers. This study aims to assess the impact of digital technology on market access and household food security among smallholder vegetable farmers of Eswatini.

1.2 PROBLEM STATEMENT

Most of the Swazi population is found in the rural areas of the kingdom. About 70% of the 1.25 million of the rural population is heavily dependent on agriculture for their livelihoods and employment opportunities (Ministry of Agriculture (MOA) 2016: Dlamini 2019). Eswatini is categorized as a lower middle-income country, the poverty rate is high and about a third of the population live below the national poverty line (Phungwayo, Kushitor & Koornhof 2021). Agriculture (smallholder farming) is viewed as an essential aspect of reducing poverty, unemployment and increase food security (Dlamini 2022). However, vegetable production on Swazi Nation Land (SNL) is practiced by subsistence farmers and less than 7 percent of all SNL are planted to rain-fed crop. This results in a shortage of locally produced vegetables and approximately 70% of consumed vegetables in the country are imported from South Africa (Rugube *et al*. 2019).

Eswatini smallholder vegetable farmers have constraints of market access. Often, Eswatini smallholder farmers lack adequate knowledge and skills on competency and consistency in market participation. Vegetables are among the crops that are being promoted by the Government of Eswatini through the Ministry of Agriculture for more than three decades (Mangwe *et al*. 2020) Vegetable crops are efficient to generate cash even from a small plot of land in a short period of time and helps farmers to improve their livelihood (Rai *et al.* 2019). This has led to an establishment of the national agricultural marketing board of Eswatini which provide technical support on production and marketing of agriculture produce. However, even with that effort a majority of vegetable farmers practice it in subsistence which results to low incomes obtained from vegetable sales. However, with the introduction and adoption of digital technology in smallholder agriculture in marketing access can help improve the production of vegetables. Digital technologies can significantly reduce the costs of linking sellers and buyers; reduce inequalities in access to information, knowledge, technologies, and markets; potentially reduce scale economies in agriculture, thereby making small-scale producers more competitive (World bank 2019).

This can be achieved through adopting simple digital marketing platforms to disseminate updated marketing information. Trendov, Varas & Zeng (2019) suggested that farmers and other actors need to be equipped with the skills to access and use mobile technologies and digital services and to interpret the information received. Dlamini & Worth (2019) found that one of the most popular ICT applications is e-learning can be used to enhance learning and expand access to information and knowledge within the agricultural sector of Eswatini. Moreover, Trendov, Varas & Zeng (2019) pointed out that web-enabled smartphones, mobile apps, social media, and digital engagement platforms have significant potential to improve access to information and services for those in rural areas.

The goal is to investigate the extent on how the use of digital technology in agriculture by smallholder farmers on market access influence household food security. This study therefore intends to provide information on the level of digital technology use among smallholder farmers in Eswatini and how it affects market access and subsequently food security. The study will make recommendations the relevant policy makers based on the findings.

1.3 GENERAL RESEARCH OBJECTIVE

The main objective is to assess the effect of digital technology in agriculture among smallholder farmers in market access and how it influences household food security.

1.3.1 Specific objectives:

- To examine the role of digital technology on market access by smallholder vegetable farmers.
- To determine the factors that affect the use of digital technology in market access.
- To assess the impact of digital technology on smallholder vegetable farmers' market access on food security.

1.4 HYPOTHESIS

- Smallholder farmers who use digital technology access the market.
- Smallholder farmers who have the knowledge on the use of digital technology incorporate it in their farming.
- Smallholder farmers who access the market are food secure.

1.5 IMPORTANCE OF THE STUDY

This study may assist the smallholder vegetable farmers and extension workers to understand the role of digital technology better to make informed decisions pertaining their farm operations. Badiane *et al*. (2019) stated that at its simplest, information and communications technology (ICT) enables farmers to digitize farm operations. Farm management applications can give farmers an overview of their farm processes at the touch of a button and expedite decision-making as a result. Moreover, the study may help policy makers to establish innovative policies, strategies and develop programmes that will intervene where there is a market failure. This will assist smallholder farmers to adopting new trends in agriculture using digital technology. Accenture strategy (2018) stated that it is imperative that digital strategies incentives are identified as this will encourage stakeholders to work towards realizing the value that digital Agri-tech can provide to society. It is therefore imperative that extension services and related entities offer continuity by developing supportive policies aimed to empower the smallholder farming. Thus, addition of incentives such as funding can assist in the adoption of digital Agri-technologies by providing space to experiment.

1.6 DEFINITIONS OF TERMS

Digital technology is the branch of scientific or engineering knowledge that deals with the creation and practical use of digital or computerized devices, methods, systems, etc.

Food security means that all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their food preferences and dietary needs for an active and healthy life. (CFS 2012).

Market access is the process to ensure that all appropriate patients would benefit, get rapid and maintained access to the brand, at the right price.

Small holder farmers are those farmers owning **s**mall-based plots of land on which they grow subsistence crops and one or two cash crops relying almost exclusively on family labour (FAO 2012).

1.7 STUDY LIMITS

The findings of this study will not be generalized on both regions but seek to contribute to knowledge of digital technology adoption among smallholder farmers in accessing markets and household food security.

1.8 ORGANIZATION OF THE DISSERTATION

The dissertation comprises of six chapters. The second chapter presents a review of literature of smallholder farmers on household factors that influence digital technology, digital infrastructure, access to market information, access to markets, access to financial credit, gender, and policies. The third chapter represents the methodology adopted in the study, explaining the data collection and analysis procedures executed. Chapters four and five entail presentation of the research results. Finally, six presents the conclusions and recommendations.

CHAPTER 2: LITERATURE REVIEW

2.1 INTRODUCTION

The chapter furthers details the theoretical grounding of this research. One of the theoretical frameworks guiding this study is the Sustainable livelihood framework particularly human and social capital assets on improving livelihoods outcomes of farmers through adopting digital technology in accessing markets. Livelihood analyses have made important contributions to broader research areas such as those concerned with development, the environment, and sustainability (Manlosa 2022). This review articulates accessing markets, financial services using digital technology tools and proper digital infrastructure can improve household food security through improved incomes. Furthermore, it aligns relevant policies which can improve digital technology adaptation among smallholder farmers.

2.2 THEORETICAL FRAMEWORK

This research adopts the Sustainable Livelihoods Framework. Basically, the SLF seeks to investigate how a person or community in a particular socio-economic and environmental situation, using a range of resources with given institutional rules and social norms, devises livelihood strategies for achieving a sustainable livelihood (Yaro 2004). The framework comprehends the impact of digital technology on the smallholder farmers' livelihood. The role of ICTs to enhance food security and support rural livelihoods is recognized and was officially endorsed at the World Summit on the Information Society (WSIS) 2003-2005 (Nie, Zang & Qu 2010). The framework shows how, in different contexts, sustainable livelihoods are achieved through access to a range of livelihood resources that are combined in the pursuit of different livelihood strategies (Scoones 1998). In this study, the Sustainable Livelihood Framework provided guidance in understanding the ways to which digital technology contributes to livelihood outcomes through use of the various livelihoods markets by facilitating access to markets and market information among smallholder vegetable farmers and how it impacts their household food insecurity. When small scale farmers have access to markets, they will have an opportunity of enhancing their livelihoods; hence, change their social and economic outlook (Mdlalose 2016).

2.2.1 Human capital

The attitude and adoption of the digital technologies amongst smallholder vegetable farmers on marketing their vegetables will be largely influenced by their human capital. Human capital is

critical for the development and management of ICTs (National Information and Communication Infrastructure). Limited access to production knowledge, inputs and financial credit can curtail growth and adaptability of any farmer to climate and other challenges, regardless of scale (Rangarajan & Chitja 2019). Therefore, to achieve a successful goal of ensuring smallholder vegetable farmer dominate the agricultural markets, empowering the human capital should be a prerequisite. Farmer groups formed based on strong goals and supported by skilled human resources who have good managerial abilities in building partnerships and expanding the market and have assets from members as initial capital tend to develop quickly and successfully. (Tan & Mailena 2020). Thus, education is an important human asset that determines farmers' ability to make critical commercialisation decisions (Phiri 2020). Nie, Zhang & Qu (2010) It is well known that the roles of ICTs relate to long term capacity building through education, training. Economists have found that when countries strongly invest in human capital, this investment ultimately facilitates technology adoption (Bach, Shaffer & Wolfson 2013). Empowerment of farmers or farming communities is an important effort to improve their abilities and carried out through the farmer groups as institutions that organize farmers who are members of the groups (Tan & Mailena 2020). It is therefore imperative to ensure that the digital content is understandable and practical (FAO 2013). Adaptation of content to local needs, languages and contexts remains challenging, hence appropriate information resources (i.e., content) and trusted intermediaries are necessary for the success of e-agriculture initiatives (FAO 2015). The use of digital technologies allows rural folks to engage in many activities, something that can be translated into improved income earning and cost savings (Shaibu & Zakaria 2018).

2.2.1.1 Digital literacy

The exciting digital innovations designed to address marketing challenges encountered by smallholder vegetable farmers can be in vain unless their digital literacy level is taken into account. The primary factor influencing the uptake of digital solutions by vegetable smallholder farmers is digital literacy or skills (Gumbi *et al*. 2023). Digital literacy in this context describes the ability to understand and operate the tools and services presented by digitalization (Abdulai 2022). Older smallholder vegetable farmers may be reluctant to adopt digital marketing due to combination of unfamiliarity with technology and lack of self-efficacy intimidates them because the lack technology-operation skills Ireri *et al.* (2021). Despite the decrease in the cost of mobile devices

and connectivity, android operating systems proficiency in running non-textual apps functional for low-literate communities are still difficult for low-income people to attain (Moonsammy 2020). Kos & Kloppenburg (2019) argued that there are functional limitations to technology uptake, such as low literacy rates, and poor mobile and logistics networks in rural areas linking farmers to markets. It may be necessary for agri e-commerce businesses to educate farmers on the use of their service (GSMA 2019). Burnman *et.al*. (2019).

Personal attributes are the fundamental factors that affects the farmer's perception and attitude towards digital adoption. It is therefore critical to assess the human capital of the targeted group when designing digital technology solutions. Knowledge/skills impact digital adoption, farmers must know that a certain technology exists, believe it will help them (demonstration of effectiveness), and learn how to use it. In addition, education is important to manage the business as well as in the utilization of ICT Okello *et al*. (2020).

2.2.2 Social Capital

Social interactions are at the core of the human experience (Becker 2020). Small-scale farmers have different freedoms to convert resources influenced by their social and environmental conversion factors as well as what resources or structural opportunities they have access to (Smidt & Jokonya (2020). Dasgupta (2002) describes social capital at individual level as a system of interpersonal networks which enhances entrepreneurship skills, cooperation, collaboration, and coordination. People within the same social network greatly influenced decisions and activities of one another and generally shared the benefits acquired through group participation (Baluka 2015). A small-scale farmer is said to have a capability or opportunity when they can convert their resources into functioning (Smidt & Jokonya 2020). Telecommunication services are particularly advantageous for farmers because they support real time communication and two-way flows of information. Aku *et al*. (2018) stated that social capital can be achieved through bonding, bridging, and linking; and influenced by depends on several factors such as easy access to market information with digital technologies. In addition, Nie, Zhang & Qu (2010) enhanced communications (facilitated via mobile telephony and Internet, for example) can serve to reinforce the linkage with family members and governors, this can assist farmers to establish new networks which can also help to build sociopolitical assets.

Shaibu & Zakaria (2018) found that digital technologies enabled rural folks to overcome vulnerabilities related to social exclusion apart from the important role it played in saving time and cost associated with travel. Hence, Kos & Kloppenburg (2019) augured that smallholder farmers willingness to adopt- or get access to technology is greatly dependent on their social network and social norms. Siaw *et al.* (2020) stated that through internet use, receiving household remittances becomes easy and convenient. Thus, credits, remittances, and other financial aids received through internet use helped to improve household income. The use of ICT also helps in transforming agriculture sector into the modern digital agriculture to further improve social and economic benefits of smallholder vegetable farmers Siaw *et al*. (2020) The use of the internet could enhance the quality of household life with access to buy goods and services, marketing, and selling of products online and by making online payments. Moreover, Quan-Haase *et al.* (2002) internet helps to increase the existing patterns of social contact and civic involvement.

2.3 THE ROLE OF DIGITAL TECHNOLGY IN SMALLHOLDER FARMING

Adoption of digital technology in smallholder agriculture can help solve high poverty rate and improve household food security in rural communities through commercialization of their farming. Low market participation and market failure observed among vegetable farmers have been a concern in most of the Sub Sahara countries. Mushi *et al.* (2022) stated that market access is one of the critical components in e-agriculture initiatives in India. This has led to many scientists and organizations to use different approaches that enable digital technology by smallholder farmers to increase productivity and income Mushi *et al*. (2022).

Digital technologies are help in overcoming traditional hurdles encountered in vegetable markets that are dominated by smallholder farmers Akhter *et al.* (2024). The advent of digital technologies in sub-Saharan Africa, particularly mobile phones, has opened up new opportunities for rural households to fulfill a variety of development goals, including access to information, markets, and financial services (Aker and Ksoll, 2016: Hassan *et al*.2022). Incorporating Information Communication Technology ICT in smallholder agriculture has revealed positive outcomes pertaining market information and market access of farmers. Ireri *et al.* (2021) stated that ICTs could provide a unique opportunity to facilitate agricultural related technological adoption and access, provision of information on markets and market prices, weather, transport and agricultural techniques.

The smallholder farmers are often sidelined in agriculture transformation because of their setting which is mainly rural areas. However, ICTs play an important role in facilitating agricultural growth because they increase the efficiency of market especially by using mobile technologies greatly reduces search costs, as stipulated by the search theory Ireri *et al*. (2021). Moreover, digital technology is an essential tool for improving access to finance and the commercialization of smallholder agriculture Mushi *et al.* (2022).

2.3 COMMON DIGITAL TECHNOLOGIES USED BY SMALLHOLDER FARMERS

Over the years many sectors including the agriculture have incorporated digital technologies as a solution to improve productivity and performance. Particularly in agriculture, digital technologies are being developed and adopted across the agro-food system, from farm to fork Rotz *et al*. (2019). The increasing Indian population demands an increased vegetable production which requires employing digital technologies in farming Akhter *et al*. (2024). Simple digital technologies aimed to disseminate market information are required by smallholder vegetable farmers.

The intensifying of technology particularly ICT in African continent has increased ownership of cellphones among farmers. Radio is among the most widely used media for disseminating information to rural audience across Africa together with mobile phones, coupled with SMS has also been commonly widespread use among African farmers (Silvestri *et al.* 2021; Hudson *et al*., *2017*; Sousa *et al* ,2016; Sullivan 2011). Using ICT to disseminate information in agriculture is cost-effective, time-saving, and quick method Akther *et al*. (2024). The use of ICTs adds a new dimension in delivering advanced and real-time information to the farmers Silvestri *et al.* (2021).

Most studies discovered that mobile phones were the most extensively used instrument for communication and accessing agriculture- related information, particularly for marketing products (Liaghat & Balasundram 2010: Akther *et al.* 2024). Okello *et al.* (2012) found that Kenyan smallholder agripreneurs commonly of mobile phones because the content and features are more convenient and easier to understand among the youth.

Dlamini & Worth (2019) found that a majority of smallholder farmers owned cell phones, as a technology for disseminating information within the sugar industry in Eswatini. However, gap of access for the poorest (sparse coverage in rural areas, difficulty to use SMS for illiterate user and

cost). Shaibu & Zakaria (2018). The increment in the cost of using digital technology which include maintenance, power, and call credit, significantly influence the people of Pru district to adopt digital technology in their livelihood. Dlamini and Worth (2019) found that Eswatini sugarcane farmers had regular phones which are cheaper and easy to operate, whereas smart phones are expensive and require a certain level of skill to operate them.

2.4 DIGITAL TOOLS AFFORDABILITY

The widespread of digital technologies in the past three decades has resulted rapid ICTs innovations with new or updated inventions. This has led to reduced prices of basic ICTs. Okello *et al.* (2020) observed that accessibility of the ICT tools is more likely to influence the use of radio and TV. This could be due to low operational costs required by radio and television. More research findings have shown that most smallholder farmers own a mobile cell phone. Krell *et al*. (2020) pointed out that although mobile phone ownership and use have been expanding across communities and throughout Kenya irrespective of wealth, smartphone ownership is the factor that separates the wealthy from the poor in m-service use.

Many ICT tools such as mobile phone, television, radio, and computers are associated with constraints to their use (Ugochukwu, Carlu & Abiodun 2020). To ensure that smallholder vegetable farmers can adopt digital technologies when marketing their produce, affordable digital tools and digital marketing platforms should be designed. It has been observed that some of the challenges that make these digital solutions unsuitable for smallholder farmers' contexts are the costs of service (Gumbi *et al.* 2023). The barriers can be associated with prices data costs, airtime costs and electricity costs.

2.5 DIGITAL INFRASTRUCTURE

Digital infrastructure should be a prerequisite when introducing agricultural digital technologies services in communities. Abdulai (2022) pointed out that for digitalization to work, the regional electricity, roads, telecommunication, and internet infrastructure are as essential as the availability of phones at the individual level. Moreover, San *et al*. (2019) highlighted that digital tools can improve market efficiency, transparency, aggregation, and integration, but parallel investments in physical infrastructure (e.g., roads and electricity) are still needed to deliver inputs to farmers and to deliver farm products to market. It is therefore a great need to observe and understand the physical distribution of smallholder farmers. Atanga (2020) however, found that limited digital

infrastructure, connectivity, high cost of data and lack of technical capacity of farmers are the challenges limiting farmers from fully accessing or benefiting from digitalization. Thus, smallholder farmers located in remote rural areas are subject to weak market linkages owing to inadequate infrastructure, bad road network, and expensive transport options (World Bank group 2017). Gumbi *et al*. (2023) supported that challenges of digital infrastructure include land tenure issues, telecommunication and electrical infrastructure, and remote location are often experienced by smallholder farmers.

FAO, European Union and CIRAD (2022) found that Eswatini digital infrastructure is relatively underdeveloped, mainly because of the lack of competition and private investment. Hence, sparsely populated areas require logistic service providers and networks to enable physical exchange of produce and/or services (Shakhovskoy, Saab & Colina 2021).

2.5.1 Internet access and availability

Good quality, reliable and cost-effective broadband services play an important role in level of digital adoption among smallholder farmers. Adarkwah (2021), although Sub-Saharan Africa is one of the largest regions in the world, World Bank report indicates that access to internet or technology is a great challenge; only 25% of the population has access to internet and only 0.44% have access to a fixed broadband (Gangwar & Bassett 2020). Towsend *et al*. (2019) augured that some technologies are best suited to environments with both high mobile coverage and high internet connectivity such as distributed ledger technologies for value chain traceability. Heike and Muhammadou (2020) supported that not only the reach of mobile networks is important but also their speed and usage costs. However, existing solutions are very expensive hence, many farms and rural areas do not have quality internet access (Chandra & Collis 2021). Lack of regulation of data and internet costs policies on the mobile service providers can lead to surge of costs which can hinder the poor on benefiting the services and prolonging digital divide.

Atanga (2020) found that high costs of data connection for small-scale farmers in Uganda may risk the technology of its sustainability in rural communities since farmers may not be able to keep up with the cost. High internet costs can contribute to limited participation in online marketing platforms. Chandra & Collis (2021) emphasized that farmers need low-cost Internet connectivity on their devices. Many average people access the internet on their mobile phone and a typically with a “pre-paid” plan as post-paid plans are too expensive (Henry 2018).

Awuor & Rambim (2022) has recognized the impact of agricultural development through digitization whereby smallholder farmers in Kenya are now able to identify new market opportunities for their crops and access new input technologies, which was otherwise difficult and expensive to obtain through accessing ICT agriculture innovation programmes. Krell *et al.* (2021) however argued that smartphone ownership is a metric of individual wealth and assets that is significantly related to (mobile phone services) m-service use among the Kenyan farmers.

Eswatini network coverage has also shown an improvement over the years. There are mainly three registered broadband service providers in the country namely, Eswatini MTN, Eswatini Mobile and Eswatini Post and Telecommunications (EPT). Dlamini & Worth (2019) found that smallholder sugarcane farmers and their extension officers reported that they have access to cellular networks almost everywhere within the sugar industry of Swaziland, the only difference reported was the strength of the cellular network as some places had weaker connections than others. Eswatini MTN which is one of the leading mobile networks has continued to deploy updated networks aimed at upgrading the internet broadband services. However, Mpofu & Tfwala (2021) augured that the availability of high-speed broadband or cellular internet connection is rare outside the city areas of the Kingdom; there is high instability of internet connectivity in the rural areas.

2.5.2 Availability of transport

The geographical location of the majority smallholder farmers has significant influence on the extent of market participation. Large numbers of smallholder farmers in Sub-Sahara are located in far distant rural areas with pitiable transport channels and devastating market infrastructures (Otekunrin *et al*. 2019). According to Aku *et al*. (2018), the longer the distance to the marketplace from a farmer's premises, the more difficult and costlier it will be to access the market. Moreover, poor roads also make it very difficult for farmers to access market information from extension agents (Manda *et al*. 2020). Hence adequate and well-functioning transport infrastructure reduces the cost of input delivery, food storage, and farm-to-market transport Kim *et al.* (2020).

The majority of farmers in Swaziland are in remote rural areas that are far from towns and consumers, this leads to high search and transport costs (Dlamini 2019). Rural roads in Eswatini are often in a poor state and not regularly maintained, especially in rural areas (FAO, European Union and CIRAD 2022). This affects the quality of vegetables transported to markets places

which are often located in the towns and cities of the country. Dlamini *et al*. 2020 found that long distance and load conditions contributed to the inevitably unguaranteed value of the deliveries to the markets among Swaziland baby vegetable smallholder vegetable farmers. As means of mitigation the situation Eswatini NAMBoard has refrigerated trucks and a tractor allocated for the fresh produce market and the farmer support and development unit, (NAMBoard annual report 2019). However, this initiative benefits only a fraction of smallholder farmers who are contracted with the marketing board, the rest must seek other alternative of transporting their vegetables. Their vehicles not suitable for transportation of fresh produce and poor road conditions can drastically reduce the quality of the produce being transported (Mdlalose 2016).

2.5.3 Electricity supply

For a country to avoid drawbacks on digital technologies adoption, electrification of all the areas should be prioritized and implemented. ICTs require power which enable to operate. According to Okello *et al*. (2020), electricity enhances power availability which stimulates the use of mobile phones, having the added advantage of internet availability and facilitating communication hence providing a more convenient and easier to access technical, market and financial information However (Irechukwu & Mushi 2020), highlighted that overall rural electrification rate (RER) in Africa is still low to date. Lack of power discourages the establishment of processing plants in rural areas, which would offer prospects for farmers to improve the value of their products and their incomes (FAO, European Union and CIRAD 2022). Significant efforts aimed to resolving low rural electrification rates have been seen in some countries. Irechukwu & Mushi (2020) pointed out that several countries in Sub-Saharan Africa have tried to address this problem however is at large costs due to the nature of dispersed rural load centres, low load demand, and low population density. Ehimen *et al*. (2023), supported stating that even though improving energy access through decentralization (especially to poorer rural communities) appears to be a high-priority policy issue in Malawi unfortunately, lack of resources to afford digitalizing of such electrification goals has led 86% of the population still not having access to electricity.

The Eswatini government initiative on designing projects targeting rural electrification has yield a positive outcome. Myeni (2018) reported that the infrastructure development in Swaziland has been so successful, with 70 percent of the rural communities having access to the use of electric power and about 60 percent with potable water supply through operation of the Regional

Development Fund (RDF). The rural electrification strategy involved the establishment of communal schemes, whereby community members would form a group and share the subsidized electrification cost. Swaziland which has seen a number of rural areas being provided with affordable electricity (Dlamini & Worth 2019). The availability of electricity and mobile cellular network within the sugar industry of Swaziland has made the sugar industry ready for the implementation of most ICT programmes, especially the use of cellular phones (Dlamini & Worth 2019).

2. 5. 4 Land and water

The limitation of natural resources such as land and water have been known to be the common challenge faced by smallholder farmers. Land tenure security is critical to on farm entrepreneurship development (Wale, Chipfupa & Hadebe 2021). Land productivity is largely influenced by access to reliable water sources, especially under predominantly rainfed condition by significant climatic variability (Langyintuo 2020). The land area owned is expected to influence the market participation and the household consumption (Kimty 2016).

The different land tenure systems serve as a basis of productivity of farmers. In Swaziland, about 50% of the land is used for grazing ruminants; 2% of the land is used for subsistence agriculture and 6% used for large scale farming in Tittle Deed Land (Technology Assessment Report 2016). Smallholder farmers in Eswatini are predominantly concentrated in the communal land tenure and they primary practice subsistence farming. Sithole *et al*. (2014) pointed out that most Swazi households depend on rainfed agriculture for food production, which limits the output because of the unreliable rainfall in the country. The cultural and traditional norms can greatly affect the decision making regarding on the eligibility of granting of land of an individual. Dlamini (2019) elaborated that women hardly own land in Eswatini, where land policy permits women to acquire land only through their male relatives, who represent them during the *kukhonta* process (acquiring land through the chief). This hinders the production process, as land is the primary factor of production (Dlamini 2019). Their limited access to land in many African communities, young women in rural areas often do not feel they have strong enough incentive to learn to apply ICT tools in their farming activities (Lohento & Ajilore 2015).

2. 6 ACCESS TO MARKET INFORMATION

Poor access to timely updated market information among farmers can lead to poor decision making including producing less demanded vegetables, sub-standard vegetables which do not meet market requirements. This may lead reduced sales and consequently a loss. In most cases, smallholder farmers do not have access to such vital information (Mdlalose 2016). Okello *et al*. (2020), stated that having market information enables farmers to position themselves in a manner that helps them combat negative anticipated market trends such as an increase in input prices and facilitates them to capitalize on favorable market trends such as an increase in output prices. In addition, Megeressa *et al*. (2020) stated that although Ethiopian farmers are producing more of surplus vegetables, they are not much linked with markets and thus why their opportunity to diversify their livelihoods from vegetable production is very much limited.

The infusion of digital technologies can help minimize the challenges encountered by smallholder farmers in agriculture. Hence, Ugochukwu, Carlu & Abiodun (2020) stated that the utility of ICTs for providing market information to rural smallholder farmers is growing rapidly and access to reliable information and sources is considered crucial for beneficial market interaction. In order for farmers to adopt these, they need to have positive perceptions towards the technology's utility (Dlamini 2020). Piloting of new digital market information platforms should be a prerequisite. This will enable the design and implementation of the digital marketing platforms that suite that particular context. Digital information can connect farmers to new input markets by providing transparent information on local market prices and reputed brands and suppliers (Rajkhowa & Qaim 2021). To obtain positive impact on disseminating information using digital technologies, ownership of the basic ICTs among farmers is essential. Townsend *et al*. (2019) elaborated that increased access to information about market prices via mobile phone can increase farmers' bargaining power in traders on farm gate product sales. Thus, the degree in market orientation goes along with the interest in getting more detailed market information, through more personal media and higher willingness of the farmer to pay for it. Improves the level of market orientation of any enterprise (Shaibu & Zakaria).

One of Eswatini National Agricultural Marketing board NAMboard's responsibilities is dissemination of the following market related information to farmers: price trends, innovative production, future demands, changes in consumer preferences, and training opportunities

(NAMboard annual report 2019). Market information enables smallholder vegetable farmers to align their production as well as their marketing systems in tandem with the demands of NAMBoard (Mangwe *et al*. 2020).

2.7 ACCESS TO MARKETS

Numerous studies have found that over the years access to consistent and profitable markets has remained to be the outmost burden in smallholder agriculture. DAFF (2012) pointed out that smallholder Farmers in South Africa lack reliable markets. African Leafy Vegetable (ALV) smallholder famers in South Africa tend to sell locally reason being that neighbouring village markets absorb small percentage because these neighbouring markets also supply ALVs (Mahlangu *et al*. 2020). This is due to limited resources place them at a disadvantage which consequently affects their economies of scale compared to commercial farmers. Many smallholder farmers rely upon direct sales to neighbours or through local farmers' markets and poor market linkages substantially increase transaction cost and post-harvest losses (World bank group). Mahlangu *et al*. (2020) observed that Limpopo African Leafy Vegetable (ALV) farmers sold their products to three output markets, namely, locally and neighbouring villages, and in town (hawkers). In addition, Kim *et al.* (2020) highlighted that when they do sell their produce, farmers struggle to secure sufficiently high prices and lose substantial value to various intermediaries between the farm gate and the end buyer. A smallholder farmer can access the market either by selling to a buyer at the farm gate or physically transporting the produce to the marketplace using available means (Otekunrin, Momoh & Ayinde 2019). Recommended are improvements to the cold chain logistic system to preserve the value and shelf life of the harvest (Dlamini *et al*. 2022).

Eswatini has a wide range of marketing systems including farmer markets, cooperative markets, contract markets and corporate markets Mangwe *et al.* (2020). However, with that said Simelane, Terblanche & Masarirambi (2019) found that there is a general poor performance of horticultural smallholder farmers in Eswatini. To mitigate this issue the ministry of agriculture in Eswatini established National Agricultural Marketing board (NAMboard). Its function is to assist farmers to make informed decisions regarding production according to market requirements including product specifications, varieties, planting schedule, and profitability of selected crop (NAMboard annual report 2019). However, only contracted smallholder farmers wo has commercialized their

agricultural output are able to benefit from NAMBoard services. The majority of farmers in Eswatini are smallholders, are faced with high production and transaction costs (Mangwe *et al*.2020). The lack of market orientation impacts entrepreneur skills among Eswatini smallholder farmers. This causes over production of same vegetables in a planting season which leads to market saturation and farmers are compelled to reduce prices. Upon receiving less income demotivated vegetable farmers resort to subsistence farming and selling the surplus informal markets which include the local community and vendors. The traditional markets found in most towns of Eswatini receive vegetables from local vendors who buy at the farm gate and deliver to the markets (Mangwe *et al*. 2020).

2.7.1 Social media market platforms

The surging of social media platforms all over the world has brought a great opportunity to the big market players by linking their buyers with new products through cost effective advertising strategies. These platforms (e.g., Facebook, Instagram, TikTok, YouTube, Twitter) connect users to other users through social networks and the users consumer the content other users create (Munsuwamy *et al*. 2021). Social Media platforms are a distinct business model that represents a departure from traditional businesses, which are often referred to as "pipeline" businesses *(*Shakhovskoy, Saab & Colina 2021).

Young farmers in Kenya use such social media as Facebook and Twitter, along with other ICT applications, to create a virtual marketplace where sellers and buyers of agricultural produce interact and conduct transactions (Lohento & Ajilore 2015). There is, however, contradictory evidence about how useful ICTs are or can be for addressing vulnerability, with some studies finding positive effects and others no impact (Krell *et al.* 2021). The development of mobile applications (apps) for agricultural development has been driven partially by young people.

One of the main challenges is the trust factor that must be overcome for buyers to turn to new ICT-enabled forums as an alternative to their relationship-based trade here are often not accepted or understood grading standards for many of the agricultural products that smallholders produce, meaning that buyers often do not know the exact quality of the crop until they see it for themselves USAID (2013).

2.7.2 Digital marketing platforms

In pursuit of solving market access and participation issues in agriculture, many governments and their entities have made efforts to adopt and create digital technologies as the world is infused with digital technologies across all sectors. Digital solutions, tend to be software-based services provided directly to customers, which can be businesses or farmers/consumers (Shakhovskoy, Saab & Colina 2021). In addition, GSAM (2019) stated that online platforms provide greater transparency and visibility of market However, ICT-enabled marketing and access to markets plays a major role, especially for information on market prices and demand. Technologies that disintermediate transactions, such as blockchain, could lower transaction costs (Kos & Kloppenburg). In addition, ICT-enabled marketing and access to markets plays a major role, especially for information on market prices and demand. (Townsend *et al*. 2019).

The digital environment has also led to the rise of Direct-to-Consumer (DTC) models (Kannan 2021). Mobile phone-enabled 'virtual' markets for agricultural products can help farmers link up to alternative buyers or markets (Baumüller 2018). The spread of digital services has also been noted in Ghana through introduction of SavaNet which improve farmers' market access by providing market prices through SMS. There benefits of online market platforms tend to result in fairer prices compared to those offered by a typical middleman (Townsend *et al*. 2019).

Among other avenues aimed to assist South African smallholder farmers mitigate marketing challenges led to development of HelloChoice. The advancement in market orientation and participation can link smallholder farmers to suitable market for agricultural produce as well as boosting for income generation (Otekunrin *et al.* 2019). Thus, service Agri- fintech online trading platform that connects fruits and vegetables direct from farm to buyer (HelloChoice 2023). This dynamic online agricultural trading platform displays fresh produce market prices in the convenience of a farmer and the customer's personal use. This platform was founded in 2018 with aim of building a thriving trading community of buyers and sellers (HelloChoice 2023). It has yield positive impact on agriculture value chain particularly KwaZulu Natal.

To par with the digital innovations designed to address smallholder farmers challenges, the ministry of Agriculture in Eswatini has also taken the initiative through Agricultural Market Information System of Eswatini (AMIS) using its parastatal, NAMBoard to develop an online marketing platform named *Nolwati* Agribusiness Hub which was launched in 2020 (CCARDESA

2022) farmers who register provide information on plantings and forecast harvest dates and yields and can receive information via SMS on their cell phones and Android App which is designed for farmers, businesses and individuals to upload products, place orders online as well as to get weather updates, and a Facebook page. Moreover, has a website, dashboard, and social media platforms (WhatsApp and Twitter) (CCARDESA 2022). However, the awareness of *Nolwati* app is minimal to most Eswatini smallholder farmers.

2.8 DIGITAL FINANCIAL SERVICES

According to Rodríguez-Castelán *et.al* (2021), expanding digital financial services may boost the affordability and availability of financial services among traditionally un(der)served populations in three ways: (1) fostering interconnectivity among banks, (2) reducing the costs of financial transactions, and (3) adding to the supply of mobile money agents to rural areas. Hailu (2016) stated that without access to finance, rural communities are confined to an endemic cycle of poverty and no means of escape. The poor financial status and the lack of owning assets which can serve as collateral, negatively affects the creditworthiness of small-scale farmers (Mdlalose 2016).

2.8.1 Access to financial credit

Inability to access financial credit widen the inequality in a country's population, consequently disadvantaging the rural poor. Wale, Chipfupa & Hadebe (2021) found that more than 58% of the smallholder farmers in KwaZulu Natal have access to consumption and not production credit, mainly from informal sources and they mainly depend on the financial services of micro-lenders popularly known as *Mashonisas* and *Stokvel* or *Umgalelo* (Wale, Chipfupa & Hadebe 2021; Chipfupa & Wale 2018).

Establishment of affordable and sustainable financial credit institutions can help eradicated the financial inequality in agriculture. Townsend *et al*. (2019) recommended that financial institutions and agribusinesses can use digital transaction records to process and facilitate credit. According to Siaw *et al*. (2020) households with access to credit coupled with internet users tend to increase their income in rural Ghana. Digital payments accelerate the transaction process and avoid the problems associated with cash-on-delivery (GSMA 2019). Kim *et al*. (2020) highlighted that digital services that increase farmers' access to credit (Agri-wallet in Kenya), services that increase farmer financial knowledge through training (Arifu in Kenya). In addition, Mutero, Munapo & Seaketso (2016) alluded that Ensibuuko's mobile, co-banking platform works with Uganda's

saving societies to provide financial access and encourage a culture of trust. However, Smidt & Jokonya (2020) augured that small-scale farmers have historically contended with limited access to capital and other financial services. In addition, Mutero and Munapo & Seaketso (2016) pointed out that the age of a smallholder farmer, as well as educational level of a farmer applying for credit are very important hence credit institutions prefer lending to farmers who fall within the economically active age group.

There are three Micro Finance Institutions in the Kingdom of Eswatini, which are the Inhlanyelo Fund, Imbita Women's Finance Trust and the SWEET Micro Finance that uses the group lending methodology at the Chiefdom Level and apply peer pressure to motivate payment (Myeni 2018). Banks in Swaziland have taken giant steps in ensuring that they include ICT in their operations to improve on efficiency and to harness the benefits of utilizing ICT also issue out credit and debit cards to clients with which to pay for goods and services and the money is then transferred electronically between bank accounts (National Information and Communication Infrastructure). However, with all the attempts made smallholder farmers are still facing challenges regarding access to financial credit. Phiri (2020) stated that is it unfortunate that formal financial services are not well-established in Eswatini; as a result, smallholder farmers prefer informal sources over formal institutions. Hence, Myeni (2018) supported that access to finance remains the biggest challenge in the effort to promote the commercialization and growth of the Swaziland smallholder farmer. This is because many smallholder farmers do not own the land they are farming and don't own other forms of collateral (Chandra & Collis 2021).

Myeni (2018) also pointed out that agriculture forms the major segment Inhlanyelo fund of its loan portfolio and loan in Eswatini and beneficiaries are not required to have collateral. However, many small holder farmers are not well informed about the terms and conditions and their eligibility to access the Inhlanyelo fund loan services. This leads farmers to opt for other credits providers. The Imbita Women Trust fund at some point had to suspend the issuing credit to the members in order to develop their saving pool (Myeni 2018).

2.8.2 Digital technology money transfers

Digital technologies have made financial transactions easier and convenient between the buyer and the seller in the market. Modern technology and telecommunications, financial transactions have been made accessible for the unbanked and the under-served rural farmers in Ghana (Peprah,

Oteng & Sebu 2020) The diffusion of ICT has brought about innovative ways of creating access to finance, including but not limited to cellphone banking, branchless banking and fintech (Dlamini 2020).They are able to send and receive money from their wards and business clients at any time Shaibu & Zakaria (2018). Mobile money represents a significant opportunity to help reduce the reliance on cash-on-delivery payments (GSMA 2019). Mobile money (M-money) reduces the transactions costs of sending and of receiving money, especially with inadequate and expensive transport infrastructure in farming communities (Peprah, Oteng & Sebu 2020). Lohento and Ajilore (2015) also stated that Ensibuuko is an established web and mobile applications platform designed to help Ugandan Savings and Credit Cooperative Societies (SACCOS) of small rural farmers mobilize savings and to receive and disburse loans more easily and quickly using SMS and mobile money. Currently, three main telecommunication companies (MTN Ghana, Vodafone Ghana, and Tigo/Airtel) provide m-money services in Ghana with MTN being the market leader with the widest network coverage (Peprah, Oteng & Sebu 2020).

The availability of simple and affordable financial platforms is essential as they can be accessed and utilized by even the least disadvantage farmer. Eswatini has two main mobile operators, Eswatini Mobile and Eswatini MTN. In a quest to improve access to financial services, Eswatini MTN, the sole mobile network operator (MNO) at the time, introduced mobile money in the country in 2011 (Dlamini 2020). Mobile money is one of the simple and convenient digital financial service that was designed to cater any client regardless of their socio-economic background. This is because it is affordable and does not require to be operated using a complex ICT tool. Dlamini (2020) found that a considerable number of people in the Lomahasha area in Eswatini own mobile phones and they are aware of mobile money moreover and were registered and participated in it. It is because MTN has been only mobile cellular operator for decades in the country and has strong reliable network coverage compared to Eswatini Mobile which is its competitor.

2.8.3 Government initiatives in assisting with financial capital.

The governments have a mandate of incorporating strategies which focuses on providing not only technical assistance but also financial assistance in smallholder agriculture. These strategies require timely evaluation in order to ensure if they are still feasible to the targeted groups. According to Aguera *et al*. (2020) the South African government has developed several state-

owned banks, grants and funding schemes tailored to those excluded from the sector, such as the Land Bank, the Agribusiness Development Agency (ADA), the Isivande Women's Fund or the Land Redistribution for Agricultural Development (LRAD) programme.

The Government of Eswatini has also teamed up with development partners to facilitate access to financial services for the farmers. The Small-holder Agriculture Development Program (SADP) in Eswatini supported the reform of smallholder agriculture to assist growers who intended to engage in value addition activities (Myeni 2018). The government of Eswatini also established the Youth Enterprise Fund (YEF) which aims to curb youth unemployment through achieving the following objectives: empowering the youth (YEF) which aims to curb youth unemployment through empowering the youth to engage in economic and commercial enterprises facilitating the provision of skills development for loan recipients and youth at Tinkhundla centres (Singh, Kibiridge & Makhanya).

2.9 EXTENSION SERVICES

The role of extension services cannot be undermined in agricultural development, particularly in smallholder agriculture. Rangarajan & Chitja (2019) pointed out that building human capacity of farmers first requires building capacity among extension educators. Extension officers play a pivotal role in disseminating adequate information between farmers and potential markets. Rajkhowa & Quaim (2021) stated that using digital approaches and technologies can potentially improve the effectiveness of agricultural extension services by reducing transaction costs and improving the quality of the information provided. Atanga (2020) discovered that extension agents were found to be one that provided most information, followed by farmer associations before electronic media (TV and radio) in Ghana. However, Rajkhowa & Quaim (2021) augured that traditional way of information dissemination has two major drawbacks. First, as personal visits are associated with high transaction costs, only a very limited number of farmers can be reached. Second, the information provided through this channel is often generic and not necessarily well adapted to farmers' specific needs and conditions. Hence, ICT-based agricultural extension can bring better opportunities that may improve livelihoods of farming communities. Kim *et al*. (2020) highlighted that Precision Agriculture for Development focuses on sending short message service (text messages) to smallholders with agricultural advice. The issue for the lack of adoption appears

to be more an issue of extension personnel understanding the social dynamics of the farmers with respect to ICT use (Moonsammy 2020).

The Eswatini government extension officers are not prioritized when it comes to rural agriculture development. They lack basic infrastructure which enable them to perform their duties. Simelane, Terblanche & Masariramb (2019) found that the poorly resourced Regional Development Areas (RDAs), low remunerations, large ratio of Extension Officers (EO) to farmers and lack of training opportunities suggest that government is struggling to support public extension in Eswatini. Reforming the working stations of extension officers is a crucial step towards sustainable digitalization of smallholder farming. Simelane, Terblanche and Masariramb (2019) suggested that RDAs need proper computers with internet for Extension EOs to research current information and international studies. Apart from extension officers, the ministry of agriculture in Eswatini has over the years used radio to disseminate extension information to farmers through the local channel. However, its impact on smallholder agriculture has not been thoroughly researched.

2.9.1 Smallholder Farmer Cooperative

The establishment of agricultural associations enable farmers to merge their resources, this in turn improves their overall productivity. Hence, Simelane, Terblanhce & Masariramb (2019) pointed out that individualism, lack of coordinated produce markets and low levels of education may be barriers to finance access since it increases the risk profile of farmers. Agricultural cooperatives play an important role in food production and distribution, and in supporting long-term food security Elias (2020). Moreover, Langyintuo (2020) stated that to address the perception of high risk and lack of collateral limiting commercial banks' lending to farmers, various development practitioners have rolled out innovative financing approaches, including credit guarantee schemes over the past few years. Aku *et al.* (2018) found that smallholder vegetable farmers in Tanzania with an average farm size of 0.5 acre who had access to the market provided by farmer organization have more income per season (USD 220.11) than vegetable farmers who did not belong to the group membership (USD 177.90). Ugochukwu, Carlu & Abiodun (2020) elaborated that membership of farmer cooperative shows significant association with the use of ICT-based market information sources. Tsan *et al*. (2019) also reported that farmers in East Africa belonging to cooperatives and owning large herd sizes show more awareness of, and are more likely to use, ICT-based market information sources.

Myeni (2018) The Co-operatives Societies Act of 2004 facilitates the mobilization of the farmer groups in Eswatini, with a common bond to pool together resources to enhance the marketing for their commodities and access to finance. However, Dlamini & Huang (2019) pointed out that structurally, the cooperative movement in Eswatini lacks a collective value chain management strategy. Simelane, Terblanche & Masariramb (2019) supported that in Eswatini cooperatives also struggle to access market and finance. Masuku and Mutangira (2016) highlighted that accountability weaknesses in cooperatives in Eswatini, such as failure to account for the work done in the cooperatives resulted in poor participation by the general membership moreover, failure to understand the financial reports as a result of low levels of education amongst the membership could result in poor performance of multipurpose cooperatives. Moreover, Dlamini & Huang (2019) elaborated that lack of participation among members causes underinvestment and cooperative inefficiency, resulting in conflicts, poor management and low incentives for members of the multipurpose cooperatives in the Kingdom of Eswatini. Rural Uganda has about 5,000 SAC25igitali organise almost 20 million rural Ugandans into saving societies that encourage savings and provide loans. SACCOs are an effective mechanism to increase financial inclusion and reduce poverty (Pasara *et al*. 2021). Across the country, community members have developed informal credit and savings schemes to mitigate the effects of financial exclusion commonly known as *stokvels*. Self-help groups like Rotating Savings and Credit Associations (ROSCAs), Accumulating Savings and Credit Associations (ASCAs) and Savings and Credit Cooperatives (SACCOs) have been established, these are operational in several constituencies in the Kingdom of Eswatini (Dlamini 2020). The major drawback observed from theses credit societies is failure of accountability and integrity on loan repayment among the members, this leads to collapsing of most of credit societies.

2.9.2 CHALLENGES OF USING DIGITAL TECHNOLOGIES IN SMALLHOLDER AGRICULTURE

Most studies have recommended the adoption of ICT in agriculture as a way of enhancing the smallholder farmer livelihood through improved market information and market access. However, Kos & Kloppenburg (2019) pointed out that increased technology availability to meet transparency demand does not automatically translate to farmer technology adoption. There are challenges experienced through the implementing of digital technologies particularly in smallholder farming. Rotz *et al.* (2019) augured that through a political-economic analysis of digital agriculture, many

farmers struggle to see the benefits of the digital data that their farm technologies are producing. Hassani *et al*. (2022) found that most of the smallholder farmers of Hai and Moshi districts had a low level of digital literacy due to a lack of training and skills to make good use of ICT. Ireri *et al.* (2021) found that trust and transparency were amongst another challenge that faced the Southern Eastern Kenya smallholder farmers particularly the use of mobile phone technology to access farming information was barely trusted as the information source.

Mushi *et al.* (2021) augured that digital services for smallholder farmers usually are established by the stakeholders such as the government, donors, commercial service providers, scientists and public–private partnerships; thus, the modality requires a proper mechanism for sustaining the infrastructure and other resources supporting the services. Kos & Kloppenburg (2019) also highlighted that beyond farm level, governments in countries with high number of smallholders lack the capacity to generate and transform data gathered by digital technologies into useful information that can be used to increase productivity and profits.

2.9.3 STRATEGIES USED TO OVERCOME DIGITAL TECHNOLOGIES CHALLENGES ENCOUTERED BY SMALLHOLDER FARMERS.

It is imperative to understand the underlying socio-economic context of the smallholder vegetable farmers in order to design digital technologies that will favour their context. Glover *et al*. (2019) argued that technology is better understood as a technical practice rather than something embodied within novel artefacts and systems. Rotz *et al*. (2019) suggested that within bottom-up and/or cooperative processes solutions are more likely to be directed by farmers, prioritizing farmers whereby the technology and data are thus typically owned and controlled by a community of farmers, sometimes in conjunction with a public agency or university. Elementary computers literacy is essential for farmers to access internet services for searching helpful information and communicating Akhter *et al.* (2024). When Tanzanian smallholder farmers have digital literacy, it is easy for them to access and disseminate agricultural information to improve their productivity Hassani *et al.* (2022). Therefore, Hassan *et al.* (2022) recommended stakeholders should collaborate and conduct awareness campaigns and training in rural areas to raise the level of digital literacy among smallholder farmers so that they can use ICT to transform their agricultural production.

The financial aspect is essential in consistently producing good quality vegetables. Creating of simple ICT platforms can enable improved financial access. Mushi *et al*. (2022) stated that the government as established the Association for People of Haryana (AFPOH) which is ICT-based agriculture initiative in India that enables most smallholder farmers to access finance for improved agriculture.

2.10 GENDER INEQUALITY

Gender roles have a huge influence in community development. According to Aku *et al*. (2018) gender significantly affected the likelihood of market access, male-headed households had a higher probability of market access than female. Hence, this can be attributed to the social and cultural aspect of the community being studied. This because for most cases it is the man in a family who make the decisions on whether to sell vegetables or not (Chitja & Mkhize 2019). Moreover, Towsend *et al*. (2019) found that the relative uptake among women is low – especially considering the disproportionate burden they bear on the farm. Tsan *et al.* (2019) highlighted that while most of the ICT initiatives are disseminating new information and knowledge useful for rural women, many are not able to make use of it, due to lack of access to complementary sources of support and services (including human networks and financial support). Becker (2020) study found that in India females in the family will be the last ones to own a smartphone and the first ones to give up their smartphone in case of financial difficulties if the family does not earn enough.

Schwidrowski *et al*. (2021) highlighted that gender is a prominent dimension of inequality in Eswatini and reflects different socioeconomic biases facing women. Dlamini (2019) supported that despite their contribution to Eswatini's agricultural economy, women experience dauting constraints on crop production and market access, not to mention a vastly increased workload. Badiane *et al*. (2019) emphasized, access to ICTs alone will not close the gender digital divide hence, proper design and implementation of bottom-up participatory approaches at the community level will be needed to reduce the potential for information inequality.

2.11 GOVERNMENT POLICY

The rate of digital adoption in a particular country is influenced by the government policies and interventions. Digital technologies can create new roles or responsibilities for governments to enable the digital infrastructure (Fan and Rue 2020). Digitalization has the potential of providing

new opportunities in the agriculture sector, the necessary safeguards must be provided in order to allow small-scale farmers to follow their own path to development and not depend on corporations (Atanga 2020). Although smallholder agriculture digitalization recognised as a vital sector for development, it has rarely enjoyed the policy and institutional support necessary to allow smallholders and rural economies to thrive (Fan and Rue 2020). Atanga (2020) argued that the Uganda must put digital agriculture as a national agenda backed by an act, this act should contain all rules and regulatory framework on digital governance where the ministry of food and agriculture would enforce them. Hermanus (2021) emphasized that when developing small-scale farmers, the structure (political, social, and economic factors) that exists could influence the choices of small-scale farmers that can lead to certain development outcome. Thus, characteristics at the country level can also play a role in internet coverage and adoption Rodríguez-Castelán *et.al* (2021).

2.11.1Data protection policies

To avoid high costs of ICTs, data and internet in a country which can hinder their uptake by the citizens, the government should regulate the prices by formulating data protection policies. Ugochukwu, Carlu and Abiodun (2020), recommended that policy interventions are needed to reduce the cost associated with the use of mobile phones. Specifically, data bundles needed for accessing market information may be exempt from charges or provided free of charge through specific networks and platforms designed to provide market information to users. Independent Communications Authority of South Africa's (ICASA's) was able reduce data tariffs on MTN and Vodacom from R149 per GB to R99 in 2020 (Chinembiri 2020).

Eswatini Communications Commission (ESCCOM) is an electronic and postal communications regulatory body and one of its functions is to establish a pricing system to protect end users from excessive price increase and to avoid unfair price competition (ESCCOM 2020). The government of Eswatini has made advancement towards low costs mobile operator by revoking the monopolization Eswatini MTN and introducing its competitor Eswatini Mobile. This has led the citizens to have alternative which enable them to select a more convenient and cost-effective network. However, CCARDES (2023) augured that the provision of low-cost ICT access and low-cost devices and internet data would revolutionize the pace of development.

2.11.2 Policies suitable for smallholder farmers markets

Government should create policies that protect a smallholder farmer when participation in agricultural markets. This would motivate the farmers to commercialise their produce and reduce exploitation they encounter when marketing their produce Okello *et al.* (2020) suggested that access to good-quality data will aid in the development of innovative service delivery and products tools which can be utilized by smallholder farmers. Ensuring that every farmer regardless of their background is aware and has access to digital technology tools should be of great importance when designing policies. Okello *et al*. (2020) highlighted that it essential that Ugandan policymakers, extension officers, dairy agripreneurs and ICT providers collaborate to ensure that all agricultural information available on ICT tools displays complementarity, relevance, accessibility, and feedback to an acceptable degree; and can easily be used by less educated youth dairy agripreneurs. Aguera *et al*. (2020) augured that agricultural policy in South Africa has mostly overlooked the digitalisation of the agriculture sector, failing to provide the appropriate incentives and safeguards for its development, which in turn has been primarily driven by the private sector. This statement has similarities to Eswatini, whereby digitalization on smallholder agriculture has just been introduced and its impact has not been reviewed.

2.11.3 Gender neutral policies

Over the past few decades, a rise of activist, policy advisors advocating on the socio- economic equality on both genders to be prioritized in policy development has been on the rise. According to Chitja & Mkhize (2019) empowering women for greater access to resources, knowledge and support is important they added that this process requires capacitated personnel functioning as a gender machinery alongside legislation, policies and practices to bring forth the desired change. Dlamini (2019) suggested that revision of land policies to enable women in Eswatini to *kukhonta* on their own and have land ownership rights, thereby securing tenure, leading to land investment and increased agricultural productivity. Eswatini government have been seen making adjustments on land settlement policies whereby most chiefdoms are now able to grant land to females in the communal land tenure system. Moreover, there is also gradual shift towards recognizing and promoting women farmers in the country. Specific policy approaches may include the provision of digital literacy training and targeted and sustainable initiatives to promote the acquisition of

mobile devices and service financing schemes particularly among women Rodríguez-Castelán *et.al* (2021).

2.12 ACCESS TO MARKET ON HOUSEHOLD FOOD SECURITY

Several research studies have recommended that commercialization of agriculture in smallholder farming can be a factor that contribute to improve the household food security. Fan & Rue (2020) also agreed that the role of smallholder farms in advancing global food security and nutrition, as well as overall development, is increasingly seen in a broader context. Household food security may rise because commercialization is assumed to lead to increased household income which allows the household to purchase a diversified mix of goods and services, including food, health care, and better housing, among others, or increase the current market basket Kirimi, Gitau & Olunga (2013).

The market surplus increases income for farmers which consequently increase their ability to buy more diverse foods from the market (Sibhatu *et al*.2015). Even though smallholder production is quite low, it is important for household food security (Mdlalose 2016). Greater market access can also increase the opportunities for livelihood diversification (Jacoby and Minten 2009) and income generation, which can, in turn, empower the household to purchase a variety of foods from local markets (Sibhatu *et al*. 2015) ;Usman & Callo-Concha 2021): Manda *et al*. (2020) found that that the contribution of cowpea market participation to household income led to higher food expenditures and a more diversified diet. Townsend *et al*. (2019) stated thar in one recent study, the use of mobile phones was associated with increases in household income, gender equality, and food and nutrition security. People's diets can be enriched by promoting growth of certain crops and income be spent on purchasing nutritious food that smallholder farmers cannot produce (Mdlalose 2016). Reduced income from sugar cane means less income to be shared among members which translates to reduce capacity to purchase food and increased food insecurity (Peter 2011).

2.13. ANALYTICAL FRAMEWORK

2.13.1 1Probit regression model

The probit model is fit to anaylse factors that influence the use of digital technology. The decision on owning digital technology tools used to access market information is a choice rather than an imposition, hence the probit model fits this study. Ownership of more average digital tools varies

on the characteristics of the household including gender, age, level of education, monthly income, internet connection, electricity and data costs The logit and probit models are appropriate whenever modeling which of two alternatives occurs (Hoetker 2007). When an individual's choice is discreet and there are only two choices involved, it is binary choice, and a Logit or Probit model is applicable Sithole *et al.* (2014).

The equation of probit model is:

$$\phi{-}1\ (pi) = \sum_{k=o}^{k=n} \beta k\ xjk$$

The general probit function is:

$$Y\ (0,1) = \beta_0 + \beta_1 X_{1,} + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \ldots\ldots\ldots\ldots \beta_n X_n + \varepsilon_{ij})$$

Where β_0 is the constant term or intercept and β_1, β_2 …. β_n represent the parameters to be estimated and **ε** is the error term.

Whereby:

Y= is probability of ownership of digital tools used in accessing markets which the adopted dummy variable (0, when then farmer owns the digital tool, 1 is otherwise).

The βs are the unknown coefficients to be estimated X is a vector of independent variable comprising of (X_1) gender, (X_2) age, (X_3) level of education, (X_4) monthly income, (X_5) internet connection, (X_6) electricity, (X_7) data costs.

2.13.2 Food security indicators

Household Food insecurity should reveal whether the digital solutions design or market access have brought positive or negative impact in the livelihood of smallholder farmers. The Household Food Insecurity Access Scale (HFIAS) developed by the Food and Nutrition Technical Assistance Project (FANTA) and its partners has been used to measure food access dimension of food insecurity Kalabo *et al*. (2019). To obtain accurate food insecurity information targeting the smallholder farmers, HFIAS is an ideal tool as it can focus on individual at household level. Moreover, this indicator captures the members of the household's perception of their diet, regardless of its nutritional composition (Mango 2014). The HFIAS is an instrument that measures the occurrence of food insecurity and its occurrence in a household in the past four weeks or 30

days period. It comprises nine occurrence questions associated to household food security access. The participant either responds with a yes or no which are coded as 1=yes and 0= no (USAID 2007). Each of the nine questions has a maximum score of 3 and when summed have and a maximum of 27 and a minimum score of 0 (Ndlovu, Thamaga-Chitja & Ojo 2023). Depending on the scores obtained by the household, it can be classified as food secure, and mildly, moderately, or severely food insecure.

2.14 CONCEPTUAL FRAMEWORK

Figure 2.1 below demonstrates the linkage on how enhancing the social and human capital livelihoods of by the introducing of digital technologies smallholder vegetable farmers with the relevant polices can improve market access and resulting in improved outcomes including household food insecurity.

Eswatini has a conducive climatic and physical environment that enables vegetable production however, Magwe *et al*. (2020) highlighted that vegetable production on SNL is practiced by subsistence farmers who are located in the rural areas of the country and are often the vulnerable group with usually low income and high poverty incidents. This has caused shortage of locally produced vegetables in the kingdom because the scale of production enables the farmers to sell the surplus Rugube *et al.* (2019). A study done in the Shiselweni region revealed that most of the vegetable farmers reported lacked skills and training in producing vegetables commercially. This can affect their decision making and competency with regards to accessing stable markets.

The government of Eswatini and its entities has overtime developed strategies and programmes that provide technical and financial support for smallholder farmers from producing to marketing of vegetables. However, there is still a gap regarding understanding of the smallholder farmers' ecosystem. Adoption can be influenced by factors across individuals, such as by income, educational attainment, and sex; as well as at the country-level, such as by the accessibility and affordability of these technologies and the availability of complementary infrastructure (for instance, access to electricity) (Rodríguez-Castelán *et al*. 2021). When analysing of the vegetable farmers' livelihoods, the value of human and social capital should not be ignored especially when designing policies that will benefit the farmer. Creating relevant digital technologies especially ICT's marketing platforms will provide updated market information. Older Swazi farmers may

encounter challenges relating the adoption of digital technologies. Hence, introducing of adult digital literacy classes to the smallholder farmers can improve education levels (Sinyolo 2020). Moreover, instituting education and training programs to all actors across the value chain and to empower farmers on digital tools should be prioritized (Atanga 2020). It is important to understand the right skill sets, processes, and tools that should be put in place for digital adoption to make the agriculture value chains of small-scale farmers to be stronger, more agile, efficient, and effective (Smidt & Jokonya 2021)

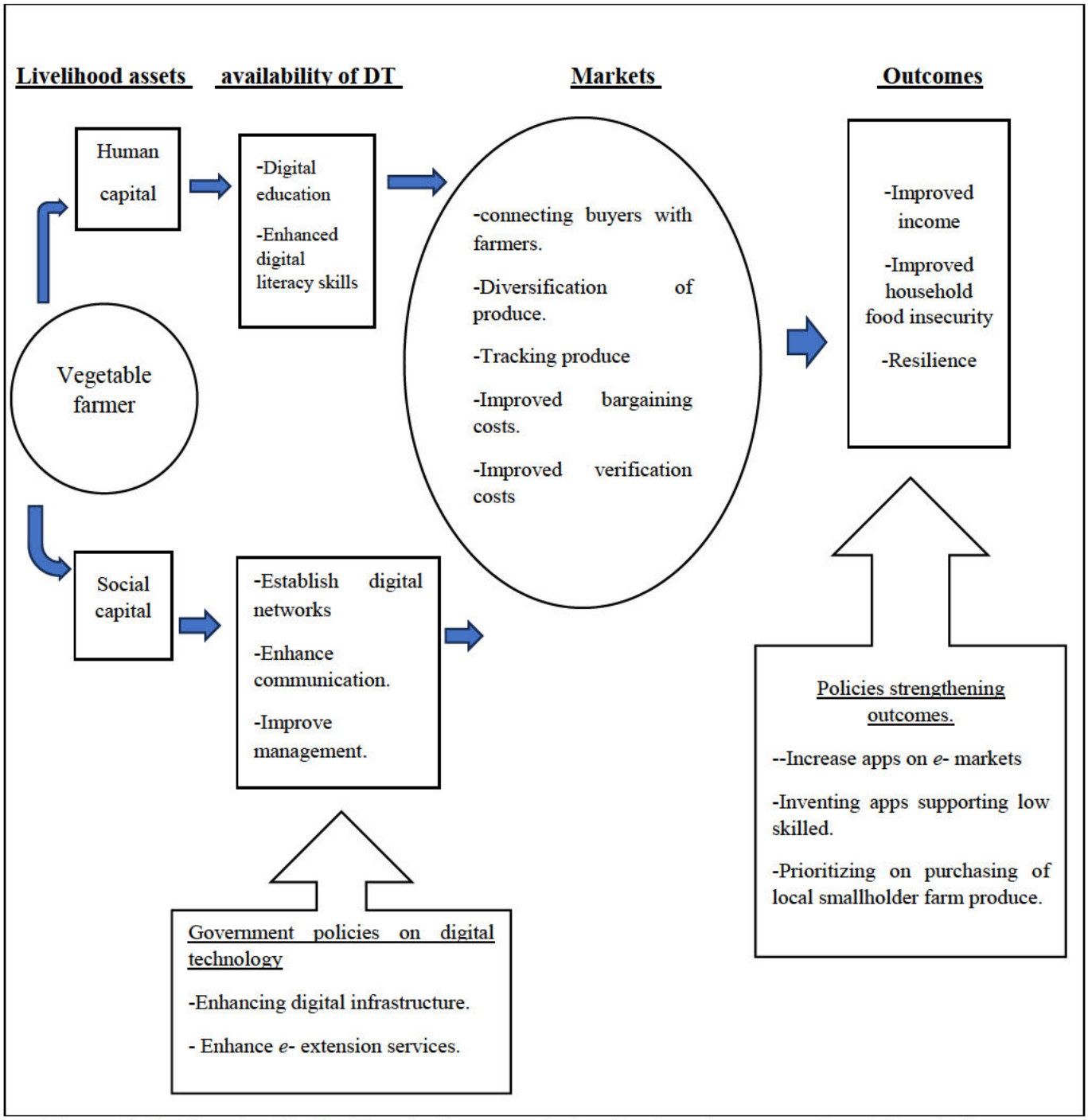

Figure 2. 1: Sustainable livelihoods Framework showing how human and social capital can be used to improve household food security.

2.13 SUMMARY

Accessibility of ICT devices in rural areas depends on the availability of electricity and network (This adversely affects ICT investment in agricultural education, in agricultural institutions, and in the sector as a whole because agriprieners do not understand the additional benefit that ICTs can bring to their activities (Lohento & Ajilore 2015).

At present most researchers are now focusing on transforming agriculture using digital technology and innovation on smallholder farmers. This is due to the awareness of the potential digital technology ability to elevate agriculture development while improving the livelihoods of smallholder farmers. However, it should be noted that adaptation of farmers to digital technology requires intervention from the government through designing and implementing relevant policies, infrastructures and dissemination of digital technology information that suits local context.

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 INTRODUCTION

This chapter entails the overall methods of data collection and analysis used in the study. The chapter describes the geographical location and demographic of the Ntfonjeni and Sidvokodvo communities. This section further describes the research design, and provides a summary on the relevant sampling methods, data collection tools and data analysis.

3.2 THE STUDY AREA AND DESCRIPTION OF SAMPLED FARMERS

The study was conducted in the Ntfonjeni and Sidvokodvo communities. Ntfonjeni community is located in the Northen rural area of Hhoho region. The area is in the top north of Eswatini next to Republic of South Africa border to Mpumalanga province. Agriculture is mainly rainfed and the major crop is maize, although some famers practice livestock farming (Sithole *et al.* 2014). The area is Swazi National Land SNL and is governed by a chief who regulates it using swazi customary laws. This community is part of the Rural development Area RDA programme which was established to provide technical support and extension services in smallholder farming. Smallholder farmers in the region are generally female, elderly, less educated, small land holders who lack access to coordinated markets, individually operating and generally full-time farmers (Simelane, Terblanche & Masirarambi 2019).

Ntfonjeni area is in the Moist Middle veld (MMV) livelihood zone of Swaziland, latitude 25.82 S and longitude 31.42 ^{0} E and altitude 835M. Average annual rainfall is 1099.4mm/year which comes from August to February and maximum temperatures of 34^{0}c. This makes the Hhohho region to be less prone to drought hence most rural communities still practice rain-fed subsistence agriculture alongside semi-commercial to purely commercial agriculture (Simelane, Terblanche & Masirarambi 2019).

Sidvokodvo community is a peri -urban area found in the South of Manzini region. It is situated along the borderline of Shiselweni region. It is characterized as a middle veld.’ Latitude 2” ° 37' 41" S and longitude 3” ° 25' 12" E. The area typically receives about 43.9mm/ per year. The area also have good soils that supports crop, vegetable and fruits. Small-scale farmers in Sidvokodvo dominate the production of the food crops and women generally handle food production, transport to markets, and sale (Sassou *et al*. 2011; SADC 2013; Dlamini 2014).

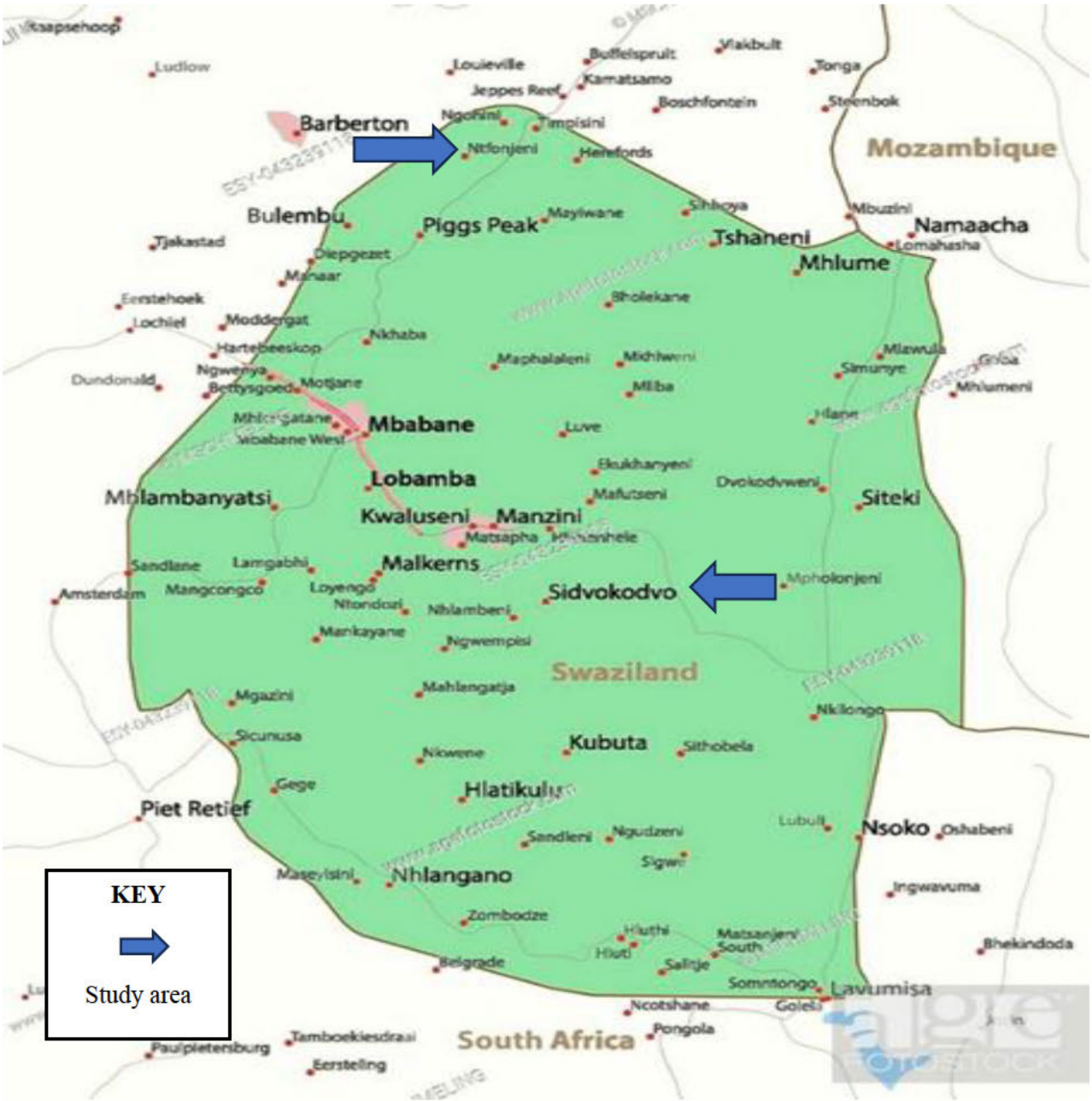

Figure 3.1: Eswatini map showing Ntfonjeni and Sidvokodvo communities. (Source: google)

3.3 RESEARCH DESIGN

The researcher used mixed method approach which combines both the qualitative and quantitative methods. For the quantitative data collection, this study's design was a cross sectional survey design. It enabled the researcher to understand the impact of digital technology in agriculture on market access and household food security among smallholder farmers in Eswatini. The study was conducted among smallholder farmers as primary participants as the source of data. Smallholder farmers are usually provided with extension services aimed to enhance their production. Therefore, key informants can assist in providing detailed information on Ntfonjeni and Sidvokodvo smallholder vegetable farmers perception, attitudes and adoption of digital technologies used access markets. Two key informants who are extension officers that work hand in hand with the farmers were also interviewed. Moreover, a comprehensive information was obtained from NAMBoard reports, online journals and online books which provided literature on supporting smallholder vegetable farmers market access.

Quantitative data was collected through a structured questionnaires whereby face to face interviews with individual farmers and key informants (extension officers) was applied. The structured questionnaire facilitated on capturing data on demographics, food production, digital technology, digital infrastructure, markets, food security. The structed questionnaire was pre - tested on three Sidvokodvo and three Ntfonjeni smallholder farmers which were not sampled. After pre-testing the questionnaire was modified and a final questionnaire was used for the study. Qualitative data was also through interviewing the key informants using open ended questions. Observations of farming areas and farmers were also recorded. This added an in-depth information on how farmers access markets, challenges encountered by farmers in accessing markets, and assistance provided by extension officers which affiliate with the farmers.

3.4 SAMPLING METHOD AND SAMPLE SIZE

Sampling is a very important process in a study as this is when a researcher chooses the participants for their study (Williams, 2007). Purposive sampling was used to collect data in the study. Purposive sampling may be used where simple random sampling may not yield a desired sampling, for example where a researcher is targeting a group of people in a community (Burton 2000; Mkhize 2016). Eswatini has about 70% population found in rural areas (Swazi Nation Land) where most households practice subsistence farming (Rugube *et al*. 2019). The characteristic which was

important in this study was whether the farmers sold their vegetables. In Eswatini most vegetables produced by small-scale farmers are sold informally through open-air markets in rural areas, town markets and farm-gate sales to informal vendors or roadside farm stalls (FAO, European Union and CIRAD 2022). Two key informants who are extension officers, one working under the ministry of agriculture and the other working under Eswatini NAMboard were selected to participate in the study. The National Agricultural Marketing Board is a government of Eswatini business enterprise under the Ministry of Agriculture mandated with responsibilities including, offering farmers support and development through linking the markets with farmers (NAMboard annual report 2019).

Purposive sampling technique was used to select the farming communities. The data of registered smallholder was retrieved from Ministry of Agriculture through the extension officers. Ntfonjeni and Sidvokodvo communities were selected due of their long-range active participation in vegetable farming. Moreover, the presence of digital technologies was observed as farmers sold their vegetables and this would enable the researcher to measure the food insecurity status of the farmers. Moreover, both communities have similar agro- climatic conditions that suit vegetable production. The population was145 of registered vegetable farmers in both communities. A total of 100 smallholder vegetable farmers who actively market their vegetables were sampled in Ntfonjeni and Sidvokodvo communities. This was to determine the different ways used by farmers to access markets. Other reasons were to identify whether the ways used by farmers in accessing markets enhanced their food security.

3.5 DATA COLLECTION TOOLS

Primary data was collected to achieve the objectives of the study. Primary data was collected directly from the farmers and key informant by using structured questionnaires. The data was collected using face to face interviews. The enumerators would pose a question and record the response. The questions were translated to *Siswati*, the local language to overcome literacy challenges that would be encountered by farmers. Secondary data was gathered by reviewing literature on providing support to farmers accessing markets.

3.5.1 Structured questionnaires

A survey questionnaire was administered in the study to gather information on their knowledge and use of digital technology in accessing markets and how it impacts their household food security

status. The structured questionnaire contained open ended and close ended questions. The open-ended questions enabled the participants to state their awareness on digital technology, digital technology devices and their experiences and perception on using digital technology in accessing markets and its impact on food security. The questionnaire was partitioned into five sections, Biographical information; farming practice, and household digital technology; market information, market access and extension services; access to finance and household food security.

The first section of the questionnaire was structured to attain the bibliography data of the participants, encompassed of age, marital status, household head, level of education, employment status, sources of income, size of the land, farming experience. The second section explored the farming practices and membership in an association and digital technology devices owned and used by the farmer. The third section explored different modes used by farmers to obtain market information, market access and extension services. The fourth section explored on services used by the farmer to access finance for farming. The last section measured household food security status of the farmer.

Figure: 3.2 Researcher conducting an interview with a farmer.

3.5.2 Key informants

Two extension officers were interviewed face to face by the researcher using open ended questions. Key informants' interviews aimed to obtain the over-all idea regarding the extent of the use and adoption of digital technology among the farmers when accessing market information, markets, and farm credit. Moreover, it explored the types of extension services brought by the ministry and the non-governmental organizations to support the smallholder vegetable famers.

Figure 3.2 NAMBoard extension officer conducting a production training to smallholder vegetable farmers.

3.6 DATA ANALYSIS

In the study the Statistical Package for Social Sciences (SPSS version 28) was used to analyze the data collected. Descriptive statistics, chi -square were used to analyze the data which is presented in the results section using graphs and tables. Descriptive statistics was used to summaries the characteristics of the demographics of smallholder farmers. Probit regression model was used to determine factors that influence the use of digital technology in marketing. Household Food Insecurity Access Scale score (HHFIAS) and linear regression model was used to determine household food insecurity of the vegetable farmers.

3.7 SUMMARY

This chapter discussed the methodology of the study regarding the methods used to collect and analyze data. The data was collected from a total of 100 farmers of Sidvokodvo and Ntfonjeni communities. Purposive sampling was used to select the participants. Farmers and key informants' interviews which were conducted face to face using structured questionnaires.

CHAPTER 4

FACTORS THAT INFLUENCE THE USE OF DIGITAL TECHNOLOGY IN MARKET ACCESS AMONG NTFONJENI AND SIDVOKODVO SMALLHOLDER VEGETABLE FARMERS

Abstract

Agricultural digital technology advancements in developing countries largely still lags behind. Even though efforts are made by governments to improve agricultural production through digital innovation and adoption, smallholder farmers are still left behind on understanding, adopting, and incorporating digital technology in their farming. This study therefore investigated household factors that influence the use of digital technology for market access in smallholder farmers of Eswatini The study was conducted in Ntfonjeni and Sidvokodvo communities. Primary data was collected through face-face interviews with 100 active smallholder farmers through purposive sampling using questionnaires. The data was analyzed using descriptive statistics and probit regression model. Descriptive statistics was used to analyze the socio- economic and demographic characteristics of the respondents. The results from the probit regression model indicated that gender, age, level of education, monthly income, electricity, internet connectivity and data significantly influenced the ownership of digital tools used to access market. The results further disclosed that age, level of education and monthly income significantly influenced number of ICT tools owned (basic phone, TV, smartphone, radio, computer, Wi-Fi router and fixed phone) used to access markets. Moreover, chi-square results revealed that there is a relationship between lack of digital exposure and challenges on the use of digital tools in accessing markets. Policies targeting human development must be developed for smallholder farmers. The study recommends that designing of localized digital marketing platforms is essential. Moreover, after training the vegetable farmers, those who market using digital technologies must be given incentives such as gadgets smartphones, tablets programmed with the marketing platform as this will encourage the farmers to adopt the technologies

Key words: Smallholder farmers, digital tools.

4.1 INTRODUCTION AND CONTEXTUALIZATION

Most countries have recently shown interest towards adoption of programmes targeting digitalization of smallholder agriculture. Digital technology is expected to help solve this shortfall in food sufficiency (Atanga 2020). Silvestri *et al.* (2021) found out that the use of ICTs adds a new dimension in delivering advanced and real-time information to the farmers in Tanzania. Moreover, digital approaches, such as radio and SMS are in rapid growth globally, thanks also to their scalability. This shows that digitalization holds the potential of transforming small scale agriculture positively; the use of mobile phones has provided information to farmers in Uganda (Aker 2016: Atanga 2020).

In Eswatini, smallholder farmers are found mainly in the communal land tenure, Swazi Nation Land (SNL) where they practice mixed farming which involves growing crops and rearing livestock (Rugube *et al*. 2019). Most of the Eswatini smallholder farmers live under the poverty datum line, lack formal education and access to improved farm inputs and modernized farming technologies, resulting in reduced production and yields which dwindles the profits of farmers (Thompson, 2011: Rugube *et al*. 2019). The main vegetables grown include cabbages, spinach, lettuce, green peppers, beetroot, and butternuts (Dlamini- Mazibuko 2020). The lack of resources and support results to most smallholders in SNL areas growing vegetables for traditional markets (World Bank 2011: Dlamini- Mazibuko 2020). Hence the ability of vegetable farmers to reach markets and actively engage in the markets is a key challenge affecting vegetable production in Swaziland (Xaba & Masuku 2012). Even though efforts have been made by the government and its entities over time to resolve the challenges, research has shown that Eswatini smallholder farmers continue to face numerous challenges in vegetable value chains Dlamini *et al.* (2022).

Digital tools can empower small-scale farmers to better understand their costs, improve decision-making and facilitate the flow of agricultural knowledge across Agriculture Value Chains (AVCs)for better financial access (Campion 2018). The lack of access to information puts smallholder farmers at a marketing disadvantage in that they may not know what commodities to produce, the relative quantities to produce and the most economical way to produce them with the resources available (Mdlalose 2016). By digitally enabling direct connections between farmers, service providers, and other value chain actors, Platforms can help markets overcome some of

these barriers Shakhovskoy *et al*. (2021). Moreover, digital technology provides a vital source of information to farmers which enhances both their production, in terms of access to inputs, extension and marketing of agricultural products (Atanga 2020). Digital technologies can produce potentially significant gains in developing countries, notably in Sub-Saharan Africa (Rodríguez-Castelán *et al*. 2021). The digital agricultural service platform integrates funds, technology, brand information, and other elements to improve resource allocation efficiency Xie, Lou and Zhong (2021).

Numerous studies have recommended the benefits of digitalization of smallholder agriculture. Despite these efforts, most farmers have not widely adopted improved technologies. As much as most research reveal ICTs as a gate way of improving markets of smallholder farmers, the diffusion process of innovations through information is hindered by farmers' specific characteristics, together with institutional factors and environmental factors (Silvestri *et al* 2021). The potential of technologies may remain unexpressed depending on the social, economic, political, and infrastructural factors that affect the performance of specific technologies and the potential interest of farming communities in new technologies (Vanlauwe *et al*. 2019; Sidibe *et al.* 2021). This study will add on to the existing literature on the factors that influence the use of digital technologies by smallholder vegetable farmers.

The objective of the study is to assess the role of digital technology in agriculture among smallholder farmers in market access and how it influences household food security in Eswatini. Assessing the role of digital technology in agriculture can help recommend interventions aimed at improving smallholder farmers' access to markets. The findings of the study will be of interest to the stakeholders of agriculture in improving and creating new policies on digital development in agriculture that suit the characteristic of the vegetable farmers. The results of the study can be essential in agriculture market development. Moreover, the study will contribute to existing literature by identifying household factors that influence the use of digital technology by smallholder farmers on accessing markets.

4.3 MATERIALS AND METHODS

4.3.1 Study area and description of sampled farmers

This study was conducted in Eswatini at Ntfonjeni and Sidvokodvo communities. The Climate of Eswatini favors the production of different types of vegetables, while soils are also generally good and water for crop production is adequate (Sithole & Grenoble, 2010: Masuku 2012). Ntfonjeni area is located in the Moist Middle veld (MMV) livelihood zone of Swaziland, latitude 25.82 S and longitude 31.42 0 E, and altitude 835M (Sithole, Lagat & Masuku, 2015). Crops that are grown here include maize (*Zea mays*), sweet potatoes (*Impomoea batatas*) and vegetables and rice which are irrigated (Sithole 2014). It falls under the Rural Development Area Programme (RDAP). The main objective for RDAP is to improve the income and general standard of living of Swazi farmers, especially the peasant farmers and at the same time to protect land resources (Sithole, Lagat & Masuku 2015).

Sidvokodvo community is a peri -urban area found in the South of Manzini region. It is situated along the borderline of Shiselweni region. It is characterized as a middle veld.' Latitude 2" ° 37' 41" S and longitude 3" ° 25' 12" E. The area typically receives about 43.9mm/ per year. The area also has good soils that supports crop, vegetable and fruits. Small-scale farmers in Sidvokodvo dominate the production of the food crops and women generally handle food production, transport to markets, and sale (Sassou *et al*. 2011; SADC 2013; Dlamini 2014).

Purposive sampling technique was used to select the farming communities. The data of registered smallholder was retrieved from Ministry of Agriculture through the extension officers. Ntfonjeni and Sidvokodvo communities were selected due of their long-range active participation in vegetable farming. Moreover, the presence of digital technologies was observed as farmers sold their vegetables and this would enable the researcher to measure the food insecurity status of the farmers. Moreover, both communities have similar agro- climatic conditions that suit vegetable production. The population was145 of registered vegetable farmers in both communities. This study sampled 100 smallholder vegetable actively participate in marketing their vegetables.

4.3.2 Research design

A mixed method approach was used to collect data from the participants. Both quantitative and qualitative approaches adopted assisted on gathering detailed information under the research

question. Purposive sampling was used to select 100 active smallholder vegetable farmers who market vegetables. 50 farmers were selected in each community. The data was collected using a survey questionnaire, where face to face interviews were used to elicit responses from the sampled farmers pertaining household digital technology, accessing of markets using digital tools and household food security status. Supplementary information was obtained through key informants, two extension officers who work hand in hand with the farmers.

4.3.3 Data analysis

4.3.1The data was collected the data was collected through a survey questionnaire. It was collected over two-week period in December 2022. The data was then captured and coded in SPSS version 28. Descriptive statistical analysis was used to assess the demographics and socio-economic characteristics of the smallholder farmers. Binary choice models are the most feasible when analyzing choice decisions for example Probit, Logit models (Tambi *et al.* 1999; Chunrong and Norton, 2003; Sekabira *et al*. 2012). Binary responses were encountered thus, choice models were necessary to address the data (Bogdan and Bilken, 2009: Sekabira *et al*. (2012). The model is appropriate since it can resolve the problem of heteroscedasticity and satisfies the assumption of cumulative normal probability distribution (Gujarati, 2004; Kimbi *et al*. 2021). Probit model was fit to estimate the decisions on using digital technologies for accessing markets among the smallholder vegetable farmers since the response dependent variable is a binary one. The dependent variable of the model consists of a dummy variable that represents digital technologies used to access markets in the study. These digital technologies include feature phones, television, radio, smart phones, computer, WIFI-router and fixed phone. The independent variables include gender, age, level of education, monthly income, internet connection, electricity and data costs. Independent probit regression models can be used to assess adoption of more than one improved technology (Kehinde & Adeyemo, 2017: Kimbi *et al.* 2021).

The general equation of probit model is:

$Y_i = F(X_i ß) + \varepsilon_i$

$$Y_i = \begin{cases} 1, if\ use\ the\ digital\ technology \\ 0, otherwise \end{cases}$$

$\varepsilon \sim N(0,1)$; $ß$ = maximum likelihood; ε = error term; X = set of independent variables included in the model.

Since estimates of the probit model provide only direction of effects, the marginal effects are usually calculated to interpret the actual change in probability of independent variables.

Marginal effects = $ß_i \phi(z)$

Whereby:

$$Y(0,1) = \beta_0 + \beta_1 X_{1,} + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 \ldots\ldots\ldots\ldots \beta_n X_n + \varepsilon_{ij})$$

Where β_0 is the constant term or intercept and β_1, β_2 …. β_n represent the parameters to be estimated and **ε** is the error term.

Whereby:

Y= is probability digital technology tools used in accessing markets which the adopted dummy variable (1, when then farmer owns the digital tool, 0 is otherwise).

The β_s are the unknown coefficients to be estimated X is a vector of independent variable comprising of (X_1) gender, (X_2) age, (X_3) level of education, (X_4) monthly income, (X_5) internet connection, (X_6) electricity, (X_7) data costs.

Table 4.1. Independent variables to be used in the probit regression model.

Variable	**Type**	**Definition and measurement**	**Expected sign**
Gender	Dummy	0= male, 1= female	+/-
Age	Continuous	Age of the farmer in years	-
Level of education	Categorical	1= no formal education, 2=primary,3= secondary, 4= tertiary, 5= vocational	+
Monthly income (Emalangeni (E))	Categorical	1≤ E1000, 2= E1001-E1500, 3=E15001- E2500, 4= E 2501-E3500, 5≥ E3500	+
Internet connection	Dummy	0= if access to internet, 1= otherwise	+/-
Electricity	Dummy	0 = if household has electricity, 1= otherwise	+
Data costs	Dummy	0 = if access data, 1= otherwise	+/-

4.4 RESULTS AND DISCUSSIONS

4.4.1 Demographics of smallholder farmers

The demographic characteristics of the sampled smallholder farmers were measured using frequencies and percentages. The results in Table 4.1 shows that a majority of the smallholder farmers were male with 56% compared to 44% female farmers. These results implies that male dominate in marketing of vegetables. Male dominance can be attributed to loss of jobs, retirement, and the high unemployment in Eswatini Masuku, Raufu & Malinga (2014)These results were in line with the study of Rugube *et al*. (2018) who found that the majority (56.7%) of the farmers were males in study of vegetable farmers in Shiselweni region in Eswatini. On the contrary many other results show that female farmers dominate smallholder farming in other African countries Ntuli (2022) found that there were more female (66.7 % compared to male (33.3 %) smallholder farmers in Pietermaritzburg, KwaZulu Natal.

The results of the study show that most farmers are aged between 36- 45years with 26%. These findings indicates that smallholder vegetable farmers who market their vegetables are in their mid-lives. This can be attributed to the fact that smallholder farming requires physical strength and in order to produce marketable vegetables the farmers should actively participate in the production activities. In addition, Dlamini-Mazibuko (2020), found that smallholder vegetable farmers of Hhohho and Manzini region who uses formal and informal marketing channel categories were dominated by male farmers of similar age group with an average of 45 years for formal and 47 years for informal markets suppliers. The findings were similar to the study done by Rugube *et al.* (2018) also found that vegetable farming was dominated by farmers in their productive years in Eswatini.

The results in the Table 4.1 also shows that majority (64%) of the respondent were married. These results indicate that smallholder farmers who market their vegetables are likely to be married. This can be attributed to the fact that married people have a responsibility of supporting the members of their household with necessities of life. Thes results correspond with Jikelela and Sanga (2015) in Kilosa District where most smallholder farmers were married. Married people also have a responsibility of feeding their families (Shabangu 2016).

The results also showed 58 % of the respondents were household heads. These results can be linked previous findings in this study that revealed males dominating female farmers and most respondents being married. This can be attributed to the fact that Swazi culture consider a male being a household head in a marriage.

The results also show that 38% of the respondents have more than 10 years farm experience. This indicates that smallholder vegetable who access markets have a satisfactory vegetable experience, this enable them to be knowledgeable about market participation. This can be attribute to the fact that production and marketing skills can be improved overtime with practice. Phiri (2020) elaborated that when farmers have enough knowledge about agricultural practices and the challenges involved in agriculture, they are likely to be successful in producing good quality crops.

The results also show that 61% of the farmers had attained secondary education. These results indicates that vegetable farmers are literate, but their literacy levels are low. This can be attributed to the fact that smallholder farming is usually considered as practice for less educated as an alternative form of livelihood. The finding was in line with Shabangu (2016) who augured that low education levels amongst small scale farmers can impact negatively on production activities, however that can be answered by good extension support.

The majority of the respondents with (65%) unemployed. This finding indicates that smallholder vegetable farming who access markets is dominated by unemployed farmers. This finding can be linked to the previous results that revealed low education levels amongst smallholder vegetable farmers. Whereby less educated farmers are less likely to acquire permanent and good renumerating jobs to sustain their lifestyle. The finding was in line to Dlamini *et al*. (2022) who also revealed that a majority of smallholder vegetable farmers in the Hhohho and Manzini region were 76% full-time growers. This indicates that farming remains the major alternative livelihood for rural population Eswatini. Kibirige (2019) also indicated that most cabbage smallholder farmers (92%) in the Easten Cape province in South Africa considered farming as their major occupation and further linked it to the endemic unemployment situation among the Qamata and Tyefu population.

The results shows that majority monthly income of smallholder farmers (32%) was between E1000 but less than E 2500.00. This implies that smallholder vegetable farmers who access markets have low monthly income levels. This can be attributed to the fact that vegetable production can be

seasonal and is greatly affected by the climatic conditions. Even though agriculture was not the only source of income since some was from salary, casual income, remittances, grants and pension.

The results also show that 36% of the farmers own land between 1ha and 2.5ha. This indicates that most farmers own small land. This can be attributed to the traditional land tenure system where smallholder farmers are usually distributed. This finding collaborated with Masuku, Raufu & Malinga 2014 study in Eswatini where it was found that l and size used for vegetable production averaged 2.4 ha per farmer. The size of the land was associated with the communal land tenure system whereby a majority of smallholder farmers are distributed.

Table 4.1 Profile of the smallholder farmers in the study areas (N= 100)

Socio- economic demographic Variables	Category	Percentage %
Gender		
Male	0	56.0
Female	1	44.0
Total		100.0
Age of respondent	18- 25 yrs	7.0
	26- 35yrs	15.0
	36- 45yrs	26.0
	46- 55 yrs	16.0
	56- 65 yrs	20.0
	66rys>	16.0
Total		100.0
Marital status		
	Single	21.0
	Married	64.0
	Divorced	2.0
	Widowed	13.0
Total		100.0
Household head		
Yes	0	58.0
No	1	42.0
Total		100.0
Farm experience		
	≤1 yr	9.0
	2-5yrs	32.0
	6-9yrs	21.0
	≥10yrs	38.0
Total		100
Level of education		
	No formal education	10.0
	Primary	19.0

	Secondary	61.0
	Tertiary	7.0
	Vocational	3.0
Total		100.0
Employment status		
	Full time	9.0
	Part- time	12.0
	Unemployed	65.0
	Pensioner	14.0
Total		100.0
Hectares of land		
	≤1ha	33.0
	>1ha less than 2.5ha	36.0
	> 2.5ha	31.0
Total		100.0
Monthly income		
	≤ E 1000	17.0
	E1001- E1500	32.0
	E1501- E2500	23.0
	E2501- E3500	9.0
	≥ E3500	19.0
Total		100.0

4.5 Digital tools used to access markets

The bar graph (Figure 4.2) shows digital tools owned by the smallholder farmers to access market. The results depict that most farmers owned a feature phone (23. 6%). Feature phones are simple phones that limits the user to send and receive short text messages and making and receiving phones calls. Dlamini (2020) alluded that most rural adults in Eswatini have access to mobile phones. David-benz *et al*. (2016), although most producers are equipped with mobile phones, their use remains very marginal for these business contacts. It was also found that 23% own television their household. 22.8% owned radio in their households. Access to a radio enhances a farmer's access to information about expected weather conditions, the advantages of using improved technologies, where to buy the inputs or sell output and at how much (Sinyolo 2020). For a long time, radio has remained the most widely used source of information in rural areas Jikelela & Sanga (2015). The results show that 18.2% owned smartphones. Chandra and Collins (2021) highlighted that smartphone costs are rapidly decreasing. This could be attributed to the influx of cellphone companies which causes an oversupply of cellphones in the market. The results showed that 7.3 % owned a computer ownership in the household. The least owned digital tools were a fixed phone 2.2%. Asenso-Okyere &Mekonnen (2012) suggested that the low penetration rate for

fixed telephone may be due to the expanding mobile subscription. Another least digital tool owned was a Wi-Fi- router 3.0 % This could be attributed to the high cost of owning and subscription to a WIFI-router.

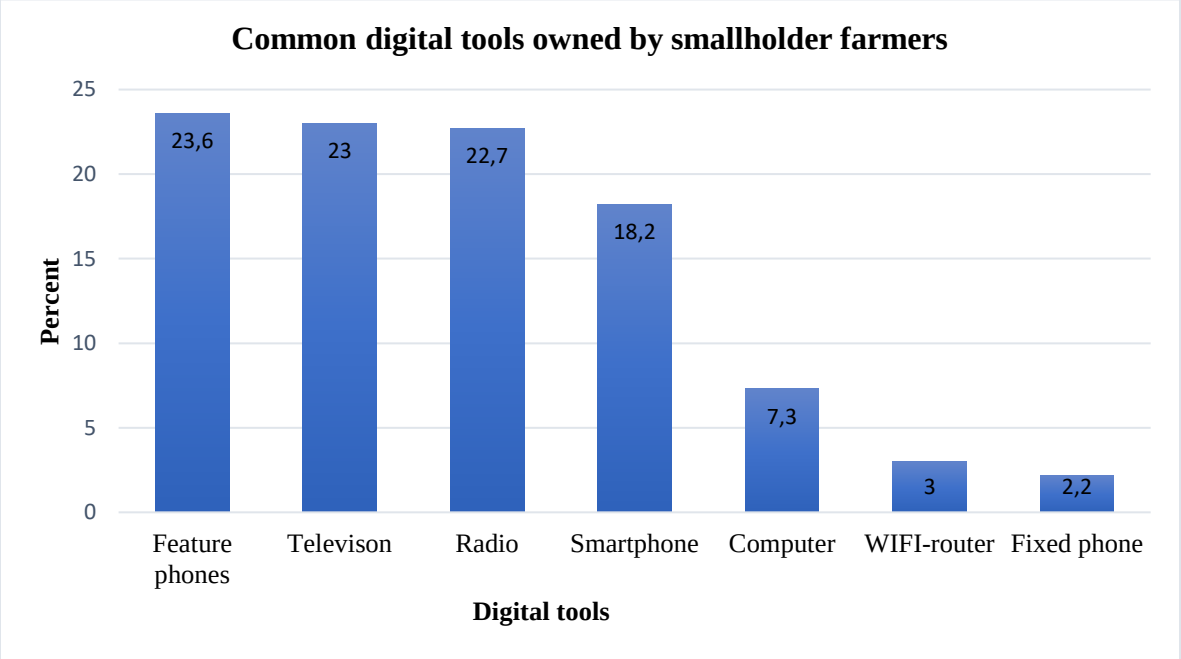

Figure 4.2 Digital tools used to access markets by smallholder famers.

4.6 Household factors that affect the use of digital technology in market access.

The results in Table 4.2 depicts that overall, the probit model provided good fit to estimate the outcome. The results shows that some socio- demographic, economic and digital infrastructure are significant at ($p< 0.001$) on ownership of digital tools used to access market.

Age has a coefficient of -0.152. The result of the study shows that age is negative and statistically significant in influencing the access to digital technology for market access. This implies that an increase in age of the household head decreases the probability of having access to digital technology. The implication could be traceable to the fact that aged farmers are technology averse as compared to their younger counterparts that technology loving. This is in line with the study of Okello *et al*. (2012) who also revealed that the use of ICT tools for agricultural transactions is greater among the younger farmers.

Education has a coefficient of -0.587. There result of the study shows that education is negative and statistically significant in influencing the access of digital technology for market access. Therefore, this suggests that an increase level of education of the farmer decreases the probability of having access to digital technology for market access. This implication could be traceable to the fact that most smallholder farmers are usually less educated and agriculture is usually their primary source of income compared to educated farmers who are usually permanently employed are likely to practice farming for subsistence purposes. These findings are contrary with (Paudel *et al*.2020; Smidt & Jokonya 2022) revealed that educated and experienced farmers were the most likely to adopt technologies for profit reasons.

Income coefficient 0.31. There results of the study shows that income is positive and statistically significant in influencing the access of digital technology for market access. This indicates that an increase of household income increases the probability of having to access to digital technologies for market access. This implication could be traceable to the fact that increased income increases the affordability of owning the digital technology tool compared to household with low-income level households. This is in line with the findings of Smidt & Jokonya (2019) study in South Africa revealed that given the low incomes of most small-scale farmers, it is difficult, if not impossible, to buy digital technology of their own accord.

Table 4.2 Probit model; Household factors that influence the use of digital tools.

Variable	Coef.	Std. Err.	Chi square	P-value
Constant	2.957	0.7718	14.681	<0.001
Gender	-0.357	0.2404	2.205	0.138
Age	-0.152	0.0852	3.164	0.075*
Level of education	-0.587	0.1514	15.041	<0.001***
Monthly income	-0.086	0.0860	1.010	0.031**
Internet connection	-0.374	-0.2460	2.313	0.128
Electricity	0.113	0.3228	0.122	0.727
Data costs	0.317	0.2113	2.255	0.133
(Scale)	0.978	0.1537		
Likelihood ratio=27.329				
Prob $ch^2 = 0.001$				

***significant at 1%; **significant at 5%; significant at 10%

4.7 Challenges that hinder the usage of the digital tools when marketing.

Table 4.3 shows the common challenges that hinder farmers in using digital tools when marketing their agriculture produce. The majority of the smallholder farmers 30.8% lack digital marketing education This indicates that most farmers are not aware of digital technology in marketing. Moreover, 26% farmers lack digital exposure. This indicates that farmers most farmers exposure is limited to simple digital technology tools. The results show that 20% farmers are affected by expensive data costs. There results indicate that mobile broadband networks have high charges on the services. Furthermore, the results also show that 19.2% famers experience poor network coverage. This indicates that the strength of the internet network varies in the different communities. The results depict that few households 4.0% have no electricity in the household. This imply that most of the rural household in the country has benefited from the rural electrification programme.

Table 4.3 Challenges that hinder the usage of digital tools when marketing vegetables.

Challenge	**Percent (%)**
Poor network coverage	19.2
Lack of digital exposure	26.0
No electricity in household	4.0
Expensive data costs	20.0
Lack of digital market education	30.8
Total	**100.0**

4.8 Relationship between the challenges of using digital tools and age of the farmers.

The Table 4.4 shows the relationship between the challenges encountered by the smallholder farmers when using digital tools when marketing their farm products. The chi-square results show that there is no significant relationship between network coverage and age of the farmers. This imply that network coverage has no effect on the usage of digital tools. There results from the table below depicts that is a significant relationship at 5% ($p<0.001$) between the lack of digital exposure

and age. This implies that older farmers are not exposed to digital technology compared to young farmers. Moreover, expensive data costs have no significant relationship with age of the farmers. Furthermore, the results depicts that there is a significant relationship at 5% ($p<0.001$) between lack of digital marketing education and age of the farmers. This imply that older farmers are not yet well educated on the operation digital tools compared to younger farmers. There results show that there is no significant relationship between lack of electricity in household and age of the farmer.

Table 4. 4 Relationship between the challenges of using digital tools when marketing and the age of the famers.

Challenges	Df	X^2	p-value
Poor network coverage	5	2.428	0.787
Lack of digital exposure	5	19.87	<0.001*
Expensive data costs	5	3.523	0.620
Lack of digital marketing education	5	21.372	<0.001*
No electricity in household	5	0.806	0.977

N= 100, *= 5% significance

4.9 CONCLUSIONS AND RECOMMENDATIONS

The objective of the study was to investigate household factors that influence the use of digital technology in market access among smallholder farmers of Eswatini. The findings of the study revealed that most digital tools used to access the market owned by farmers included a feature phone, TV, radio, and smartphone respectively. The demographic, socio-economic, and digital infrastructure were important factors used in explaining adoption of digital technology in a household which can be measured by ownership of ICTs. The parameters: gender, age, level of education, monthly income, internet connection, electricity, and data costs were used to predict the likelihood of ownership of digital technology tools used to access markets in a household in the probit regression model. The results revealed that age had a negative influence on the ownership of digital tools. Moreover, education was found to have a significant relationship on ownership of digital tools. There less educated farmers were found to have more ICT tools than farmers with high education levels. Furthermore, the monthly income was found have a significant relationship with ownership of the digital tools. Famers with low monthly income levels were found to own fewer digital tools used to access markets. In addition, the findings revealed that smallholder

vegetable farmers encountered challenges on using digital marketing tools when marketing including lack of digital exposure and lack of digital marketing education. The chi- square results further showed an association between the age of the farmer and lack of digital exposure and lack of digital education.

The study recommends that programmes should be created aimed on developing and enriching the farmer's human capital assets including the youth regarding the of digital technology in farming. The designed programmes should entice the youth to participate in agriculture. Awareness programmes on the use of digital technology son market access such as campaigns should be created this would encourage the farmers to adopt the digital technologies by using their smartphones. Moreover, progrrammes that provide digital skills technology among farmers should be designed farmers should be educated from their communities on the benefits of marketing their vegetables using digital technologies. Rural Development Areas RDA centers development with digital technologies such as WIFI-connection and computers, tablets that are already will enable all vegetable farmers from different socioeconomic background to access marketing platforms at no cost.

CHAPTER 5

THE ROLE OF USING DIGITAL TECHNOLOGY IN MARKET ACCESS AND IMPACT OF MARKET ACCESS ON FOOD SECURITY

Abstract

Over the years Eswatini government through the ministry of agriculture has made efforts to improve food insecurity in the nation through empowering smallholder farmers and designing programmes aimed at improving their livelihoods. However, the efforts still remain vain since about 63% of the population including smallholder vegetable farmers live below the poverty line and they experience low food insecurity. Digital technology in market access can help improve household food security of smallholder vegetable farmers. This has resulted in a need to explore the impact of digital technology in agriculture on market access and food security among smallholder farmers in Eswatini. A purposive sampling technique was used to sample a total of 100 smallholder vegetable farmers from HHohho and Manzini region who participated vegetable markets. Their responses were analyzed using SPSS version 28. Key informants (extension officers) were also interviewed to get in depth information regarding market participation of farmers and digital technology in smallholder agriculture. Descriptive statistic was utilized in analyzing the demographics. Among the common vegetables produced, cabbage and spinach were the most common vegetables produced by smallholder farmers. Phone calls were the common digital tool used by farmers when advertising. The vegetable farmers received most of market information from other farmers in the cooperative and extension officers. Mobile money was the most used digital platform for money transaction among smallholder farmers. Furthermore, food insecurity was measured using Household Food Insecurity Access Scale (HHFIAS) Score. The HHFIAS findings revealed that 24% farmers were food secure, 39% farmers were moderately food insecure, 31% farmers were mildly food insecure and 6% were severely food insecure.

Key words: Smallholder farmers, Markets, Extension Officers, Food Insecurity

5.1 INTRODUCTION AND CONTEXTUALIZATION

Globally the issue of limited access to market and market information among smallholder farmers has remained a constraint to most of the governments because access to market information is considered a key institutional factor that affects the participation of smallholders in markets Nwafor *et al.* (2020). Smallholder farmers in the rural areas of developing countries are still especially disadvantaged regarding capacities involving modern sustainable farming practices (Landmann, Lagerkvist & Otter 2020). Among other reasons Okello (2012) mentioned that smallholder farmers are especially disadvantaged because they trade in small volumes, usually in local markets, hence are not able to take advantage of economies of scale to reduce the fixed transaction costs of exchange with buyers. (Jikelela & Sanga 2015) pointed out that farmers need different types of information from farm preparation to post-harvest and marketing to make informed decisions, timely information is essential to famer to increase production (Jikelela & Sanga 2015). Mdlalose (2016) highlighted that the opportunity for smallholders to raise their incomes depends not only on their ability to sell their produce at local level but also at regional and even export markets. However, (Mitku 2014: Megerssa *et al*. 2020) argued that market participation of smallholder farmers is very limited and agricultural markets are also fragmented which increases the transaction costs and reduces farmer's interest to produce products for the market.

Xaba & Masuku (2012) stated that in order for marketing efficient and maximized, using strategies that reduce marketing costs: such as the use of co-operatives; increasing the size of activities; improving the business volume; creating awareness of markets among farmers; recruiting experienced market personnel; and introducing novel methods of marketing using managerial control (Xaba & Masuku 2013).Hence inking smallholder farmers to markets is an important policy in Sub-Saharan Africa (USAID, 2022).

ICT solutions can increase efficiencies and improve competitive dynamics in agriculture, which can raise agricultural productivity and incomes, and increases food security (USAID 2013). Atanga (2020) emphasized that the use of ICT can be a tool that will provide access to credit, inputs and create trust between farmers and stake holders across the value chain (Panel M.M., 2019:10). In addition, Asenso-Okyere & Mekonnen (2012) pointed out that there is evidence that rural incomes have been increasing with the use of ICTs to access knowledge and information.

(Lokanathan and Kapugama, 2012: Jikelela & Sanga 2015) augured that even though ICTs do exist in rural areas to what extent do they have helped the smallholder farmer to access market information is questionable.

Agricultural development is an important strategy for growth of developing countries like Eswatini (Dlamini- Mazibuko 2020). Agriculture dominates the economy of Eswatini, and it has a great impact and significance on output and income (Rugube *et al.* 2019). Xaba & Masuku (2013) stated that vegetable production on SNL is practiced by subsistence farmers. However, (Phungwayo, Kushitor & Koornhof (2021) stated that these farmers contribute only 11% of total agricultural output with cereal yields at a low average rate of 1.1 tonnes per hectare, even though these farms serve as the livelihood base for the rural population. Moreover, Masuku, Raufu & Malinga (2014) augured that production of vegetables by smallholder farmers in Swaziland is inconsistent and lower than the national demand, hence the gap is filled by imports from South Africa. Vegetable production in Swaziland is a seasonal activity and farmers, especially on Swazi Nation Land (SNL) produce maize in summer and vegetables in winter with the most commonly produced vegetables in the country being tomato, cabbage, carrot and onion Masuku, Raufu & Malinga (2014). There has also been an increase in the production of baby vegetables such as baby marrow and pattypan (NAMBoard 2016). Smallholder agriculture can moderate the rural exodus, create growth linkages and enlarge the market for industrial goods (Dlamini & Masuku 2012). However not much work has been carried out on profitability of producing vegetables in Eswatini (Rugube *et al*. 2019).

For farmers to respond positively to new ideas, they must be properly educated on how best to apply the new ideas to their farming activities (Dlamini & Worth 2016). Farmer associations are source of information that has much influence on farmers activities (Atanga 2020). Sufficient literacy is required to use and unlock the potentials of digital marketing platforms (USAID 2022). Moreover, (USAID 2022) emphasized that good extension service providers are one of the foundations of a successful agricultural intervention, as they teach farmers how to improve their business skills and farming to increase the total yield and quality of their crops.

Poor adoption of new technologies by smallholder farmers is another weakness mainly due to lack of accurate, reliable and timely information dissemination for effective decision making (Dlamini & Worth 2016). Thus, improved market access results in commercialization of agriculture, which has short, medium, and long-term benefits to farmers (Okello 2012). Improving the ICTs of

smallholder farmers can be considered as empowering them in agricultural activities. Empowered smallholder may engage in the modern agricultural practice for more production (Magesa *et.al* 2020). Eswatini government has intervened in improving incomes of smallholder farmers through establishing the National Marketing Board (NAMBoard). This is a government parastatal which was established through the Act of 1985 of Eswatini to provide technical support to farmers to enhance local production and marketing of agricultural produce (Dlamini- Mazibuko 2020).

Vegetable production is dynamic and plays an important economic and dietary role in the lives of many people in Eswatini. However, Phungwayo, Kushitor & Koornhof (2021) stated that dietary patterns show a high reliance on maize and other starches, but low consumption of fruits, vegetables, milk, and meat. The problem of food insecurity has several dimensions, which range from the global, regional, country, local and household levels to the individual level (Mango *et* al. 2014). To this date, there is limited information of food security status of the smallholder vegetable farmers. Most studies tend to focus on exploring of the implications of support provided for smallholder farmers with less information on the overall impact on food security. Adopting digital technology for accessing markets have positive benefits to smallholder farmers. Generally, the use of ICT in the agricultural sector can help in the reduction of rural poverty and incidences of food insecurity among smallholder farmers of Kilimanjaro in Tanzania where agriculture is the main source of income (Kremer and Houngbo, 2021: Hassani *et al.*2022). Existing digital technologies provide small-scale farmers with the opportunity of promoting agricultural productivity and household income, particularly in rural areas of developing countries Tanzania included (Livondo *et al* 2015). This study is aimed at exploring and assessing the impact of digital technology on market access and the influence of accessing markets on household food insecurity among smallholder farmers in Eswatini. This study will be of interest in food and security policy makers and the findings will be essential in developing interventions aimed at combating food insecurity among rural farming households (Ndlovu 2020).

5.2 MATERIALS AND METHODS

This study was conducted in Eswatini at Ntfonjeni and Sidvokodvo communities. The Climate of Eswatini favors the production of different types of vegetables, while soils are also generally good and water for crop production is adequate (Sithole & Grenoble, 2010: Masuku 2012). Ntfonjeni area is located in the Moist Middle veld (MMV) livelihood zone of Swaziland,

latitude 25.82 S and longitude 31.42 0 E, and altitude 835M (Sithole, Lagat & Masuku, 2015). Crops that are grown here include maize (Zea mays), sweet potatoes (Impomoea batatas) and vegetables and rice which are irrigated (Sithole 2014). It falls under the Rural Development Area Programme (RDAP). The main objective for RDAP is to improve the income and general standard of living of Swazi farmers, especially the peasant farmers and at the same time to protect land resources (Sithole, Lagat & Masuku 2015).

Sidvokodvo community is a peri -urban area found in the South of Manzini region. It is situated along the borderline of Shiselweni region. It is characterized as a middle veld.' Latitude 2" ° 37' 41" S and longitude 3" ° 25' 12" E. The area typically receives about 43.9mm/ per year. The area also has good soils that supports crop, vegetable and fruits. Small-scale farmers in Sidvokodvo dominate the production of the food crops and women generally handle food production, transport to markets, and sale (Sassou et al. 2011; SADC 2013; Dlamini 2014)..

5.2.2 Research design

A mixed method approach was used to collect data from the participants. Both quantitative and qualitative approaches adopted assisted on gathering detailed information under the research question. Purposive sampling technique was used to select the farming communities. The data of registered smallholder was retrieved from Ministry of Agriculture through the extension officers. Ntfonjeni and Sidvokodvo communities were selected due of their long-range active participation in vegetable farming. Moreover, the presence of digital technologies was observed as farmers sold their vegetables and this would enable the researcher to measure the food insecurity status of the farmers. Moreover, both communities have similar agro- climatic conditions that suit vegetable production. The total population of registered farmers was 145 in both communities. Purposive sampling was used to select 100 active smallholder vegetable farmers who market vegetables. 50 farmers were selected in each community. The data was collected using a survey questionnaire, where face to face interviews were used to elicit responses from the sampled farmers pertaining household digital technology, accessing of markets using digital tools and household food security status. Supplementary information was obtained through key informants, two extension officers who work hand in hand with the farmers.

5.2.3 Analytical frameworks

5.3.1 HOUSEHOLD FOOD INSECURITY ACCESS SCORE(HFIAS)

Food security indicators are used to measure the household food insecurity status of the vegetable farmers who access markets using digital technologies. Severe food insecurity can negatively affect the health and subsequently the overall productivity of the vegetable farmers. HFIAS was used to measure the food insecurity of the smallholder vegetable farmers who market their vegetables. This indicator captures the members of the household's perception of their diet, regardless of its nutritional composition (Coates *et al.*2007: Mango *et al* 2014.) According to Mango *et al.* (2014) the HFIAS reflects the three universal domains of household food insecurity: anxiety about household food insecurity, insufficient quality of food supplies, and insufficient quantity of such supplies. HFIAS has standard questions which enables the respondent to recall about their food insecurity for the past 30 days (Mango *et al.* 2014).

The captured responses will first be analyzed using percentages to reveal the degree of food insecurity of a household. (1=secure, 2= mildly food insecure, 3= moderately food insecure and 4= severely food insecure). To obtain a detailed information on the food insecurity status of smallholder farmers, demographics and socio -economic parameters that influence food insecurity will be employed. This model fit the study as this will provide information as to whether market access coupled with the demographic and socio-economic characters has an influence access their household food security.

Following the guidelines by Coates *et al.* (2007), the HFIAS is computed as the sum of the frequency of occurrence during the past 30 days for the nine-food insecurity-related conditions as follows:

HFIAS (0 to 27) = Q1axF1 + Q2axF2 + Q3axF3 + Q4axF4+ Q5axF5 + Q6axF6 + Q7axF7 + Q8axF8 + Q9axF9

The collected insecurity score in a household can range between (1-27), 27 being highest and 1 being the least on the HFIAS.

In this study a linear regression model was used to determine household food insecurity of the smallholder vegetable farmers on the interrelated demographic and socio-economic determinants of food insecurity including age, gender, level of education, land, income, access to extension

services, access to markets using digital tools. The variables were hypothesized to affect household food insecurity as shown in Table 5.1.

Table 5.1 Independent variables

Variable	Description	Expected sign
Age	Age of the farmer in years	+
Gender of household head	0= male, 1= female	+/-
Level of education	Education level of household head	+
Income (E)	Income from E1000 to E3500	+
Size of land	Size of land (ha)	+
Member of a cooperative	0= yes, 1=no	+/-
Access to extension services	0=yes, 1= no	+/-
Access to markets using digital tools	0=yes, 1=no	+
Access to credit	0=yes, 1=no	+

5.3 RESULTS AND DISCUSSION

5.3.1 Vegetables produced by the smallholder farmers.

The result from the Table 5.2 depicts that cabbage is a popularly grown vegetable (18.21%). In Eswatini green cabbages are the most common and are mostly produced for consumption and marketed through the National Agricultural Marketing Board (Singh, Kibirige & Makhanya). followed by spinach with (14.87 %). Chili pepper (5.64%) and green beans (3.33%) being the least produced vegetable respectively. The results were almost similar to Rugube *et al.* (2019) study conducted in the Shiselweni region of Eswatini where commonly grown vegetables within the study area onions, cabbages, spinach and green pepper were produced. About (8.46%) of the farmers grew baby vegetables which included baby marrows, petty pans, and baby corn. Most of the baby vegetable farmers were contracted with the NAMBoard.

Table 5.2. Common vegetables produced by smallholder farmers.

Vegetables produced	Percent (%)
Cabbage	18.2
Beetroot	7.4
Onions	10.0
Spinach	14.9
Lettuce	8.7
Tomatoes	11.3
Baby vegetable	8.5
Green pepper	12.1
Chili pepper	5.6
Green beans	3.3
Total	**100.0**

5.4 MARKET INFORMATION

Table 5.3 shows results of common sources of market information used by smallholder farmers. The results revealed that most of the vegetable farmers (37.39%) obtain market information from other farmers who are members in the agricultural cooperative. This collaborated with Majokweni (2018) findings which revealed that about 84% of the sampled farmers at Umsinga, KwaZulu Natal stated that the information they received from other farmers contributed to increases in their production specifically, cooperatives provide production, marketing and economic services such as digitalisation of financial capital, collective production and value addition to realize economies of scale (Dlami and Huang 2019). The finding also indicated that famers obtained their market information from extension officers. It was noted that farmers contracted with NAMBoard received most of the market information form NAMBoard extension officers. Lastly (27.03%) obtain market information from their neighbours. This could be due to the fact that farming is prevalent in the rural areas where most households engage in it.

Table 5.3. Sources of market information used by smallholder farmers. (N=100)

Sources of market information	Percent (%)
Neighbours	27
Extension officers	37.4
Other famers in an agriculture vegetable cooperative	35.6
Total	**100.0**

5.5 FARMERS MARKETS

The figure 5.4 shows the different vegetable markets of smallholder farmers. The results depict that a majority of farmers 40.25% sell their produce directly to the local community members through farm gate sales. The results collaborated with Rugube *et al.* (2019), study in Eswatini smallholder farmers found that greater portion of the farmers 82% had no formal market to sell their produce (vegetables). They mainly 53% sold their vegetables at the local village market (vending), while some 25% used the door-to-door method of selling vegetables. This could be due to no entry requirements regarding food safety standards and commission fees required when selling to the community. The results also show that 25.31% of farmers sold their vegetables to NAMBoard. This indicates that some smallholder farmers are may not be fully aware about the benefits of contracting with the marketing board or farmers may be failing to uphold the standards and consistency of supplying vegetables leading in termination of contracts by the marketing board. Moreover, the results depict that (19.50 %) vegetables are sold to vendors. Least farmers (14.93%) sell vegetables to large retailers. This could imply that farmers are not aware on the requirements of selling their produce to large retailers, especially subsistence vegetable farmers. This finding was in line with Rugube *et al*. (2019) who also found that a minority of the farmers (22) supplied vegetables to local supermarkets.

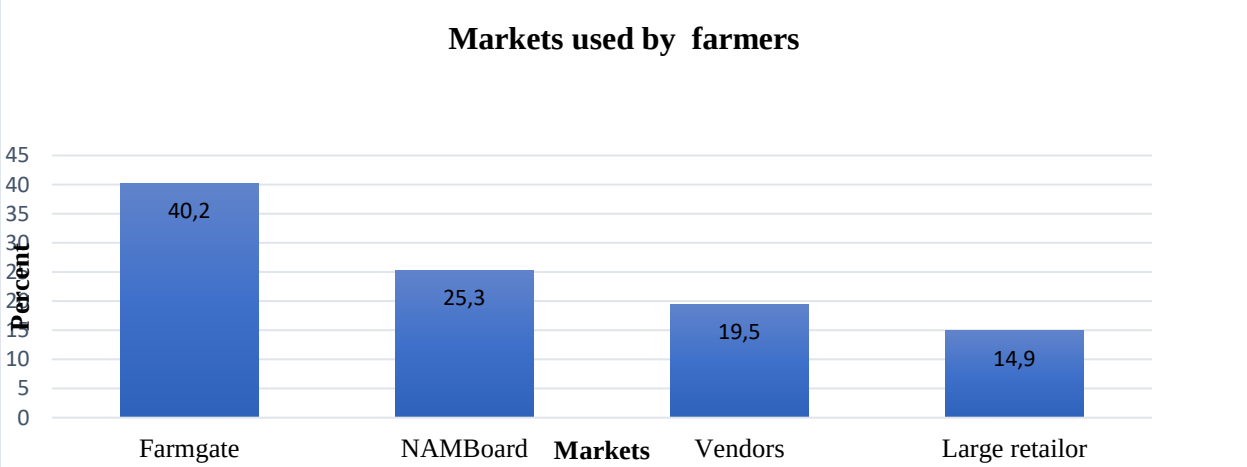

Figure 5.4 Markets used by smallholder farmers.

5.6 EXTENSION OFFICERS' VIEWS ON DIGITAL MARKETING IN SMALLHOLDER FARMING

The government of Eswatini through the ministry of agriculture and its parastatals established the agricultural extension aim at developing the rural areas by hiring qualified extension officers. Simelane, Teblanche & Masarirambi (2019) also found that the extension officers (EOs) in Eswatini were experts in different agricultural fields like horticulture, soil science, land and water management, and agribusiness management. One of the two extension officers interviewed was servicing under the ministry of agriculture and had less than 5 years of experience in the field and hold a degree in horticulture. The other extension officer was servicing under the government parastal, NAMBoard and had more than 10 years of experience in the field and hold a degree in agronomy. Their primary role is providing extension services related to vegetable and crop production. There results in table 5.6.1 below indicate that even though some smallholder farmers are aware of the *Nolwati a*gribusiness hub, which is an online app, vegetable farmers have not actively participated on marketing their produce in the app. Thre is no vegetable farmer who responded in the study that they used a website to advertise and sell their produce. CCARDESA (2022) reported that the most significant challenges experienced in the two Eswatini innovations include for Agricultural Information System (AMIS), the affordability of using the Nolwati agribusiness hub App, Platform and USSD services.

Table 5.5 Extension officers' views on digital marketing in smallholder farming.

Question	Quoted responses
Are smallholder farmers aware of digital technology in agriculture?	*They are partially aware. Digital technology has just been introduced to the farmers, in 2020 NAMBoard the developed Nolwati agribusiness hub which is an online marketing platform. However, some farmers are aware, some are not.*
Are there any digital platforms created for smallholder farmers you are aware of?	*Yes, the Nolwati app It is designed for farmers to upload information of their produce from planting and agro-dealers to upload their produce and buyers to buy farmers' products in the*

	*platform**.** However, the attitude and perception towards online marketing is still a challenge.*
What are the common digital marketing tools used by smallholder farmers to market their produce?	*Farmers use cellphones to communicate with the buyers. Some use smartphones to post their produce in social media platforms including WhatsApp and Facebook.*
Are smallholder farmers trained on marketing their vegetables?	*Yes. Farmers are trained from production up to marketing of vegetables by us (extension officers), NGO's. Sometimes trainings take place in the RDAs in organized classrooms: or the extension officers conducts field visits on the field.*
Are smallholder farmers trained on marketing their farm products using digital technology?	*Yes, but less often, NAMBoard extension officers are the ones who usually provide market information directly to the farmers.*
Do smallholder farmers prefer traditional ways of marketing their farm products?	*Absolutely, they prefer traditional methods. The less digital literate farmers encounter challenges on using Nolwati app since it is complicated, and I think it is because it is programmed in English. In addition, those who understand it do not share the information to the less literate. The contracted and active smallholder farmer were trained to use the app that has been introduced by the government which was developed by agricultural Marketing Information System (AIMS).*
Are there any agencies that offer educational and technical support to farmers on improving their digital literacy?	*Yes, Ministry of Agriculture, NAMBoard and Financial Inclusion and Cluster Development Project (FINCLUDE).*
Many factors contribute to the use of digital technology. Given your	*Age, unless they are pensioners, older farmers tend not to lean on using digital technology tools.*

experiences does gender and age of the farmer contribute?	
Do you think accessing market improve the famers' livelihoods?	*Yes, when the farmers have commercialized their farming.*

5.8 HOUSEHOLD FOOD INSECURITY AMONG SMALLHOLDER FARMERS OF HHOHHO AND MANZINI REGIONS

The Household Food Insecurity Access Scale score in figure 5.8 revealed that 39% of the smallholder farmers who market their vegetables using digital technologies were moderately food insecure. This was also indicated on table 5.6 where by 22.3% of the smallholder vegetable farmers were not able to eat preferred foods in their households in the past 30 days followed by 21. 2% farmers who were also not able to eat even less preferred foods in their households. FANTA (2007) HFIAS indicator explained that a moderately food secure household sacrifices the quality more frequently by eating a monotonous diet or undesirable foods sometimes, often, and /or started to cut back on the quantity by reducing the size of the meal, numbers of the meals, rarely or sometimes. But it does not it does not experience the three severe conditions (FANTA 2007).

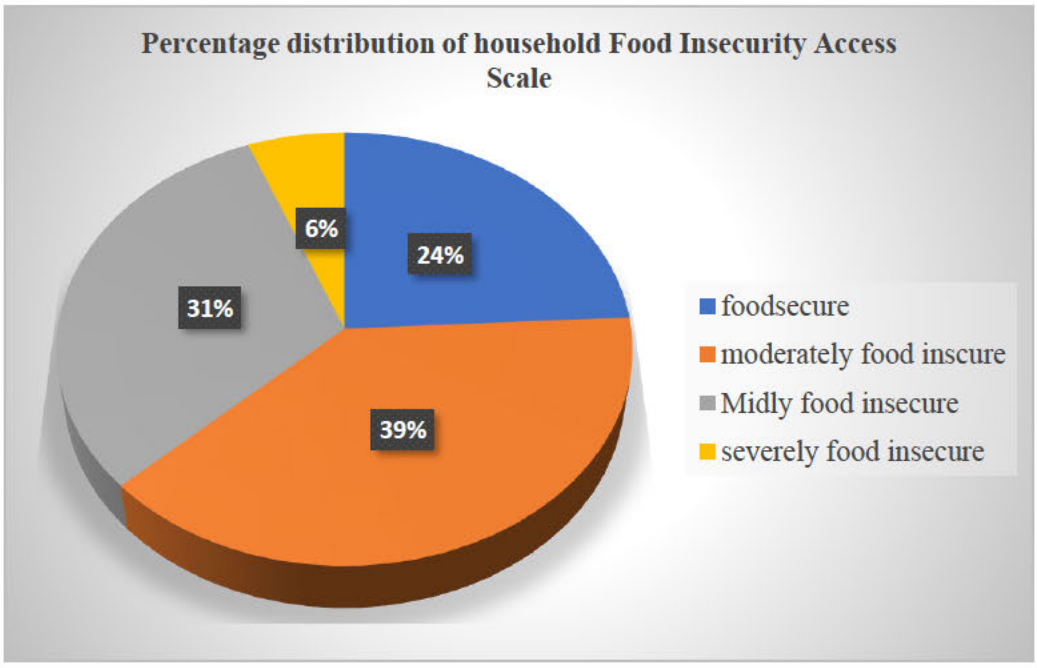

Figure 5.8: Percentage distributions Household Food Insecurity Access Scale (HHFIAS) Score.

Table: 5.6 Percentage distribution of Household Food Insecurity Access Scale in the past 4 weeks

Indicator	**Percentage %**
Anxiety about food insecurity	12.8
Inability to eat preferred foods	22.3
Availability of only a limited variety due to lack of resources	18.6
Inability to eat even less- preferred food	21.2
Availability of only smaller amounts of food	10.9
Reduced number of meals	8.0
Having no food in the house	5.1
Going to bed without having eaten any food	0.7
Spending the day and night without any food	0.4
Total	**100**

5.8.1The model estimates for determinants of HFIAS

The results on Table 5.6 Show that household food security of smallholder vegetable farmers that use digital technologies to market their vegetables is significantly influenced by age, gender, monthly income, member in a vegetable cooperative, market using digital tools and access to credit.

Age has a coefficient of 0. 011.There results shows that age is positive and statistically significant influencing the household food insecurity. Therefore, this indicates that an increase in age of the farmer increases the probability of the household on being more food insecure. This implication can be traceable to the fact that older farmers are less likely to use digital technologies when marketing their vegetables compared to younger farmers.

Gender of household head has a coefficient of 0.102. The results reveal that gender has a positive and statistically significant in influencing household food insecurity. Therefore, this indicates that being female increase the likelihood of the household on being more food insecure. This

implication can be attribute to the fact that female headed households are often poorer and usually do not afford digital technology tools used to access markets.

Monthly income has a coefficient of -0.038. These results depict that monthly income is negative and statistically significant in influencing household food insecurity. Moreover, this indicates that a decrease in the monthly income increases the probability of the household on being food insecure. This implication can be attributed to the fact that most smallholder vegetable farmers usually obtain low monthly income because they practice subsistence farming.

Member of a farmers' vegetable cooperative has a coefficient of -0.173. These results reveal that being a member of a vegetable cooperative is negative and statistically significant in influencing household food insecurity. Hence, this indicated that not being a member of a vegetable cooperative increases the probability of the household on being food insecure. This can be attributed to the fact that smallholder farmers who are members of a vegetable cooperative are usually provided with training on using digital technologies when marketing compared to those smallholder famers who are not members of a vegetable cooperative.

Marketing using digital tools has a coefficient of -0.365. This result depicts that marketing vegetable using digital tools is negative and statistically significant in influencing household food insecurity. Therefore, this implication indicated that a decrease in using digital tools to access markets increase the probability of the household on being food insecure. The probable explanation is that farmers that do not use digital technologies tend to produce less demanded vegetables due to lack updated market information.

Access to farm credit has a coefficient of -0.156. This result indicates that access to farm credit is negative and statistically significant influencing household food insecurity. Therefore, this implication depicts that a decreases in access to farm credit increases the probability of a household on being food insecure. This can be attributed to the fact that smallholder farmers who do not have access to farm credit tend to produce few quantities and often lack update market information which is usually disseminated through digital technologies.

Table 5.7: linear regression results of determinants of Household Food Insecurity Access Scale score

Explanatory variable	Coefficient	Standard error	p-value
Age	0.011	0.142	0.007**
Gender of household head	0.102	0.055	0.065*
Level of education	0.031	0.033	0.339
Monthly income	-0.038	0.21	0.071*
Employment status	-0.013	0.35	0.704
Member in a vegetable cooperative	-0.173	0.053	0.002**
Market using digital tools	-0.365	0.132	0.007**
Access to farm credit	-0.156	0.065	0.018*
Extension services	0.104	0.113	0.361

N=100, F (3.640), R^2 = 5.353. Significant levels ***1%, **5%, *10%

5.9 CONCLUSIONS AND RECOMMENDATIONS

The objective of the study was to determine the impact of digital technology on market access and how market access influence household food security among smallholder vegetable farmers of Eswatini. The study found that the common vegetables grown by farmers included cabbage, spinach, green pepper, lettuce, tomatoes, onion, beetroot, baby vegetables green, chili pepper and green beans. The study found that the major mode of digital marketing used by most smallholder farmers was phone calls. None of farmers were aware of any website used as digital marketing platform for vegetables. Most vegetable farmers market their vegetables at farm gate. It is therefore concluded that digital technology, in its current form had less impact on marketing among smallholder vegetable farmers of Eswatini. HFIAS score was used to measure household food insecurity, thus 39% moderately food insecure, 31% mildly food insecure food insecure. Moreover, the linear regression depicted that age, gender of household head, monthly income, member of a vegetable cooperative, market using digital technology tools and access to farm credit had a significant influence on household food insecurity.

Therefore, the study recommends policy makers and rural development agents to explore digital technologies and digital innovation in agriculture that focus on empowering smallholder farmers. Understanding the social structure of the farmers and how they interact amongst each other and with members in their households. This can enable the policy makers to develop a systemic approach starting from empowering and training of the extension officers on the value digital technology in agriculture. This could include creating digital marketing platforms that are less complicated, understandable to smallholder farmers regardless of their socio -economic background. Training of smallholder farmers on digital adoption should be a long- term strategy so that farmers gradually adopt and value of digital technology in accessing markets. Moreover, smallholder farmers should be educated and encouraged on the importance of consuming a balanced diet in their household. This could be done thorough consistently providing an updated market information to smallholder farmers on growing vegetables that are in high demand as it may increase their income and subsequently enable them to purchase diverse foods. Also, vegetable farmers should be sensitized on the benefits of improved food insecurity through growing and consuming diverse vegetables in their household.

CHAPTER 6: CONCLUSIONS AND RECOMMENDATIONS

6.1 Overview

Numerous interventions have been done by the Eswatini government through the ministry of agriculture and other supporting agencies on rural development. Smallholder farming has also been supported with aims of reducing food insecurity through establishing NAMBoard which facilitates markets for farmers. However, smallholder farmers continue to encounter challenges on accessing markets. Sometimes this is associated with lack of timely market information, lack of advertising and lack of bargaining power being inconsistent in production.

This study will enable the stakeholders involved in smallholder farming to explore the potential of integrating digital technology in smallholder farming in market access. The study assessed the role of digital technology in agriculture on market access and household food security among smallholder farmers in Eswatini in the Manzini and Hhhohho regions. The objective of the study was addressed by dividing it into three sub-problems namely:

- What are the household factors that influence digital technology in market access?

- What is the role of the use of digital technology on market access?
- How does market access impacts food security in smallholder farmers?

The study was guided by the sustainable livelihood framework (SLF). SLF describes the necessary assets which are required by a household to improve its wellbeing. The study focused on two of the SLF capitals, capital human and social capital. To implement change of a desired outcome on a specific population, human capital is crucial when empowering the targeted individuals/ groups. In addition, social theories outline the social structure, ties, and relationships between an individual and household (Thamaga-Chitja &Tamako 2017). Understanding the famer's social and human capital in the study areas can be used to understand the extent of digital technology adoption on market access. Improved income from market sales positively improves household food insecurity status.

A mixed method approach including qualitative and quantitative data was used to address the sub objectives. A questionnaire was used to gather primary information from 100 smallholder farmers. The questionnaire was translated to the native language *(Siswati*) during the interviews. Purposive sampling was used to select the participants who are vegetable farmers who also market their vegetables. The data was analyzed using a Statistical Package for Social Sciences (SPSS) version 28. Moreover, the data was analyzed using descriptives statistics, chi-square, t-test, and a regression probit model and ordinal logit regression model. A structured interview schedule was used to gather detailed information from two key informants who are the extension officers that work hand in hand with the farmers. Secondary information was obtained from parastatal reports and online journals and online books.

6.2 Conclusions

The conclusions of the study were drawn from the objective and sub-problems which are discussed below:

Objective of sub- problem 1: What are the household factors that influence digital technology in market access?

The objective under the sub problem1 was to explore the household factors that influence digital technology in market access. Firstly, the common digital technology tools used to access markets were feature phone, TV, smartphone, computer, WIFI-router and fixed phone. The results

indicated that feature phone, TV, and radio were the major digital tools owned by smallholder farmers. Moreover, Socio- demographic, economic and digital infrastructure were important factors in explaining adoption of digital technology in a household. A probit regression model was used predict if gender, age, level of education, monthly income, internet connection, electricity, a data costs had a positive significance on the average digital tool used to access the market owned in a household the regression probit model showed that. According to the probit model age, level of education and monthly income had a significant influence on the average digital tools that are to access market owned in a household. These factors directly impact the average digital tools used to access markets owned in a household.

The results also explored the challenges that hinder the farmers in using the digital tools when accessing markets. The challenges were poor network coverage, Lack of digital exposure, expensive data costs, lack of education on digital marketing, no electricity in the household. The chi- square results revealed that there is a relationship between lack of digital exposure and digital marketing among the smallholder farmers. This implies smallholder farmers require to education on digital literacy and its value and positive effects in agriculture.

Objective of sub problem 2: What is the impact of the use of digital technology on market access?

The objective under the sub- problem2 was to determine the common vegetables grown by smallholder farmers and the markets of used by smallholder vegetable farmers.

The findings of the study revealed that the common vegetables grown by farmers include cabbage, spinach, green pepper, lettuce, tomatoes, onion, beetroot, baby vegetables green, chili pepper and green beans. These results showed that the vegetables produced have high demand in the market and they are consumed in a famers' household.

The results showed that most farmers sold their produce to the local community at farm gate. This can be attributed to the fact that smallholder a majority farmer owned less than 2.5ha and the land was also used for growing field crops besides vegetables, hence this affects productivity. Moreover, the results revealed that according to the views from extension officers, some smallholder vegetables farmers were aware about the digital marketing platform named *'Nolwati',* even though smallholder vegetable farmers were more inclined on using the traditional marketing platforms such as selling at farm gate. These implication can be attributed to the fact that

smallholder vegetable farmers are not fully aware of digital technology and its benefits hence they do not a have positive attitude on adopting the digital technologies in marketing.

There is a greater need for the ministry of agriculture and supporting agencies to simplify and localize the digital platforms, this will enable even to the least digital illiterate farmer to understand the digital platform. Campanians should create an awareness and familiarize the '*nolwati app' amongst* smallholder farmers. Moreover, smallholder vegetable farmers should be trained on the use of the digital marketing platform in the communities.

Objective of sub- problem 3: How does market access impacts food security in smallholder farmers?

The objective under subproblem3 was to investigate the impact of market access on household food security. Household Food Insecurity Access Scale score was used to measure household food Insecurity in the preceding four-week period. The scores revealed that most smallholder farmers were moderately food insecure. It means that in the past four weeks more households worried about food some household may have eaten a monotonous diet and may have cut of number of meals and the size of the meals but have not experienced severe level of food insecurity. Educating farmers on the importance of food and nutrition. Even though farmers produce the vegetables it cannot be assumed that they daily consume a balanced diet. Promoting commercialization of vegetable to improved income should be prioritized and consumption of the vegetables should not be overlooked.

6.3 Policy recommendations

The conclusion drawn from the study was that the most owned ICT tool was a feature phone. This is a simple cellphone that has limits access to internet broadband amenities' such as social media and websites which are online markets. The demographic, socio- economic factors of a household such as age, level of education and monthly income affects the ownership of average digital tools (feature phone, television, radio, smartphone, WIFI-router and fixed phone) used to access markets. The results suggest that older farmers, less educated farmers and less income household has an influence on the number of digital technology tools owned. Furthermore, most farmers used phone calls to advertise their produce which is mostly sold at farm gate. It is therefore concluded that digital technology, in its current form had less impact on marketing among the smallholder vegetable farmers Moreover, Smallholder vegetables farmers are moderately food insecure. This

means that most smallholder households sacrifice on the quality of food by eating repetitious diet with limited nutrients and has started rationing meals. This finding suggests that even though Eswatini vegetable smallholder farmers access markets, it does not subsequently lead to a food secure household.

The Ministry of Agriculture (MoA) and other NGOs' that support smallholder farmers should consider incorporating a bottom-up approach human and social assets. Sustainable programmes aimed at gradually developing farmers' human assets should be established. This can be achieved through farmers training and providing the rural development centers with digital infrastructure including computers and WIFI connection to be accessed by the farmers for market information. Monitoring and evaluation of the programmes is crucial when expecting a positive outcome Moreover, policy makers must understand the farmers' social environment and create programmes that fit the farmers' environment. This could be achieved by encouraging smallholder farmers to form and actively participate in farmers cooperatives as this would increase their sales volume and extension officers should consistently communicate and provide extension services in more often to the smallholder farmers. Food security policies and programmes targeting the smallholder should be developed with an understanding that even though smallholder farmers are the food producers they are amongst the vulnerable groups high levels of food insecurity. This can be done through promoting diversification on farming. A diverse diet improves food and nutrition security. Moreover, timely education the farmers on the negative effects of poor food and nutrition

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8. APPENDICIES

Appendix1: Questionnaire

QUESTIONNAIRE

SCHOOL OF AGRICULTURE, EARTH AND ENVIRONMENTAL SCIENCES

UNIVERSITY OF KWAZULU NATAL

Section A: Demographics

1.

2. Male	3. Female

4. Age of respondents

1. 18-25yrs	2. 26-35yrs	3. 36- 45yrs	4. 46-55yrs	5. 56-65 yrs	6. 66yrs ≥

5. Marital status of respondent

0. Single	1. Married	2. Divorced	3. Widowed

6. Are you a household head?

0. yes	1. No

6. Farm experience

1. > 1yr	2. 2yrs- 5yrs	3. 6yrs- 9rys	4. 10yrs ≥

7. Level of education

0. No formal education	1. Primary	2. Secondary	3. Tertiary	4.Vocational	5.Other (Specify)

7. Employment status

0. Full employment	1. Employment Part time	2. Unemployed	3. Pensioner

8. Sources of monthly incomes

0. Salary	1. Pensions	2. Remittances	3. Wages	4. Causal income	5. Government grants	5.Other (specify)

9. Monthly income (E= Emalangeni)

0. ≤ E1000	1.E1001- E1500	2. E15001-E 25000	3.E2501-E3500	4.AboveE3500

10. Hectares of land

0. ≤ 1ha	1. Greater than 1ha less than 2.5ha	2. Greater than 2.5ha

Section B: Farm and household Digital technology

11. Which type of vegetable/ crops do you produce?

0. Vegetables	1. Crops	3.Both

12. Which crops do you grow in your farm?

Types of crops	**Tick below**	**Growing season**		**How much per ha**	**Grown For consumption**	**Grown for sale**
		Summer	**Winter**		✓	✓
Cabbages						
Beetroot						

Onions						
Spinach						
Lettuce						
Tomatoes						
Maize						
Pumpkins						
Sweet potatoes						
Sugarcane						
Other (Mention)						
Other (Mention)						
Other (Mention)						

13. Are you involved in any famers' association?

0. Yes	1. No

14. If yes, how many associations are you involved in?

……

15. Name of co- operative, activities and number of meetings. (Please circle)

Name of co-operative	Main activities	How many times do you attend the meetings
	1. Crops/vegetables 2. Livestock 3. Handcraft 4. Poultry 5. Other (specify)	0=Never 1= Once a week 2= Twice a week 3= Once a month 4 = Quarterly

		5 = once in 6 months
	0. Crops/vegetables 1. Livestock 2. Handcraft 3. Poultry Other (specify)	0=Never 1= Once a week 2= Twice a week 3= Once a month 4 = Quarterly 5 = Once in 6 months
	1. Crops/vegetables 2. Livestock 3. Handcraft 4. Poultry 5. Other (specify)	0=Never 1= Once a week 2= Twice a week 3= Once a month 4 = Quarterly 5 = Once in 6 months

16. Which digital technology tool do you own in your household? (Please tick)

Digital technology tool	0= YES	1= NO
1.Smartphone		
2. Normal cellphone		
3. Fixed phone		
4. Television		
5. Computer		
6. Wi-Fi router		
7. Radio		
8. Other (specify)		

Section C: Market information, Markets access, extension services

17. Which mode of advertising do you use? (Please tick)

0. None	**1. Word of mouth**	**2. Radio**	**3. Poster**	**4. Website**	**5. None**	**6.any other**

18. Which digital technology tool do you use to receiver market information? (Please tick)

1. **TV**	2. **Cellphone**	3. **Newspaper**	4. **Computer**	5. **Radio**	6. **Other**

17. How often do you receive market information from the digital tools? (Please tick)

Digital tools	1. Always	2.Sometimes	3. Less often	4. Rarely	5. Never
1. TV					
2. Cellphone					
3. Newspaper					
4.Computer					
5. Radio					
6. Other					

19. How else do you receive market information? (Please tick)

1.Neighbours	2.Extention officer	3.Other farmers	4 Other(specify)

18. How often do you receive market information? (Please tick)

Source	1. Always	2. Sometimes	3. Less often	4. Rarely	5 Never
1. Neighbours					
2. Extension officer					
3. Other farmers					
4. Other (specify)					

19. How long is the distance to the market? (Please tick)

1. ≥1.5km	2=1.6km-4km	3=4.1km-7km	4=5.1-10km	5= >10km

20. Where do you normally sell your produce? (Please tick)

Location	✓
1. Local community	
2. Large retailers	
4. National Marketing Agricultural Board	
5. Other (Mention)	

21. How many times do you sell your produce (Please tick)

Types of crops	0.Never	1. Every season	2.After six months	3. Once a year
1. Cabbages				
2. Spinach				
3. Lettuce				
4. Onions				
5. Beetroot				
6. Tomatoes				
7. Maize				
8. Pumpkins				
9. Sweet potatoes				
10. Sugarcane				
11. Other (specify)				
12. Other (specify)				
13. Other (specify)				

22. Who determines the price of your produce?

……

23. How is the quality of the infrastructure? (Please tick)

Infrastructure	Excellent	Good	Bad	Worse
1.Internet connectivity				
2. Electricity supply				
3. Roads				
4.Data costs				
5. Water supply				

24. Do you access the market using digital tools? (Please tick)

0 yes	1. No

25. Who assist you on using the digital technology tools when accessing markets? (Please tick)

1. None	
2.Relative	
3.Other farmers	
4.Other	

26. If yes, how often do you use the digital tools to sell your produce to buyers? (Please tick)

Digital tool	**1. Always**	**2. Sometimes**	**3.Less often**	**4. Rarely**
1. Cellphone				
2. Newspaper				
3. Radio				
4.Televison				
5.Computer				
6. Other(specify)				

27. What are the challenges that hinder your usage of digital tools when marketing you produce? (Please tick)

Challenge	**0= Yes**	**1= No**
1. Poor network coverage		
2. Lack of exposure in using digital tool		
3. Expensive data costs		
4. No electricity in the household		
5. Lack of education on digital marketing		
6. Other (specify)		

28. What mode of money transaction is used when receiving sales income? (Please tick)

1. Cash	**2. Mobile money**	**3.Internet Banking**	**4.Other**

29. Do you receive extension services/ trainings? (Please tick)

0= Yes	**1= No**

30. How does the extension agent communicate with you? (Please tick)

1. SMS	**2. Calls**	**3. Live visit**	**4. Email**	**5. Zoom meetings**	**6. Other (specify)**

30. What knowledge does the extension agent provides you with regarding farming and marketing of produce? (Please tick)

Skill provided	**0= Yes**	**1= No**
1. Skills training on producing quality of produce &value addition		
2. Communication (contracting with buyers)		
3.Input provision		
4. Pricing of produce		
5. Record keeping		
7. Budgeting		
7.Other		

Access to finance

32. How do you finance your farming? (Please tick)

Source	**0= YES**	**1= NO**
1. Salary		
2. Credit		
3. Grants		
4. Micro finance institution		
5.Other (specify)		

33. Did you require farm credit in the last five years? (Please tick)

0= Yes	**1=No**

34. Were you able to obtain it?

0= Yes	**1= No**

35. If yes, who provided you with finance? (Please tick)

Source of credit	0= Yes	1= No
1. Self- finance		
2.Cooperative		
3. Bank		
4. Government institution		
5. Money lender		
6. NGO funding programme		
7. Other (specify)		

36. Do you have any collateral? (Please tick)

0= Yes	**1= No**

37. If yes, what form of collateral assets do you have? (Please tick)

Collateral assets	✓
1. Livestock	
2. Transportation (Car, bus, tractor)	
3. Land	
4. Pension fund	
5.Property	
6. Other (specify)	

Section D: Household food security

Please provide information about your household food by recalling four-week period.

Household Food Insecurity Access Scale (HFIAS) measurement tool

NO	**Question**	**Response options**	**CODE**
1.	In the past four weeks, did you worry that your household would not have enough food?	0 = No (skip to Q2) 1=Yes	**…….**
1.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**…….**
2.	In the past four weeks, were you or any household member not able to eat the kinds of foods you preferred because of a lack of resources?	0 = No (skip to Q3) 1=Yes	**……..**
2.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**…….**
3.	In the past four weeks, did you or any household member have to eat a limited variety of foods due to a lack of resources?	0 = No (skip to Q4) 1 = Yes	**……..**
3.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**……**

4.	In the past four weeks, did you or any household member have to eat some foods that you really did not want to eat because of a lack of resources to obtain other types of food?	0 = No (skip to Q5) 1 = Yes	**……..**
4.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	…….
5.	In the past four weeks, did you or any household member have to eat a smaller meal than you felt you needed because there was not enough food?	0 = No (skip to Q6) 1 = Yes	**…….**
5.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**……..**
6.	In the past four weeks, did you or any other household member have to eat fewer meals in a day because there was not enough food?	0 = No (skip to Q7) 1 = Yes	**…….**
6.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**……..**

7.	In the past four weeks, was there ever no food to eat of any kind in your household because of lack of resources to get food?	0 = No (skip to Q8) 1 = Yes	**…….**
7.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks	**……..**
8.	In the past four weeks, did you or any household member go to sleep at night hungry because there was not enough food?	0 = No (skip to Q9) 1 = Yes	**…….**
8.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks	**…….**
9.	In the past four weeks, did you or any household member go a whole day and night without eating anything because there was not enough food?	0 = No 1 = Yes	**…….**
9.a	How often did this happen?	1 = Rarely (once or twice in the past four weeks) 2 = Sometimes (three to ten times in the past four weeks) 3 = Often (more than ten times in the past four weeks)	**……..**

Appendix 2:

Key informant interview questionnaire

SCHOOL OF AGRICULTURE, EARTH AND ENVIRONMENTAL SCIENCES

UNIVERSITY OF KWAZULU NATAL

Section A: Demographics

Name of the respondent

……

Age of respondent

……

Work experience as extension officer (years).

……

Section B: Structured questions

Digital tools

1. Are smallholder farmers aware of digital technology in agriculture?
   ……
   ……
   ……
   ……..
2. Are there any locally digital marketing platforms (e- markets) created for smallholder farmers you are aware of?
   ……
   ……
   ……
   ……
   ……
   ……

3. What are the common digital tools used by smallholder farmers to market their farm produce?
   ……
   ……
   ……..
4. Are smallholder farmers trained on marketing their farm products?
   ……

5. (i). Are farmers trained on marketing their farm products using digital technology?
   ……

   (ii). Howoften?.....

6. Do smallholder farmers prefer traditional or technological ways of marketing their farm products?
   ……
   ……
   ……

7. Are there any other organizations or agencies that offer technical and educational assistance to smallholder farmers to improve their digital literacy?
   ……
   ……
   ……
   ……
   ……

8. Many factors can contribute to the use of digital technology by farmers. Given your experiences. Does gender and the age of the farmer contribute to the use of digital technology in accessing markets?
   ……
   ……
   ……
   ……
   ……

9. Are the any efforts made by the government through the ministry of agriculture on developing smallholder farmers marketing strategies through digital agriculture innovations and adaptation?
   ……
   ……
   ……

……
……

10. Do you think accessing markets improve smallholder farmers' livelihoods?

……
……
……
……

Appendix 3: Ethical clearance

UNIVERSITY OF KWAZULU-NATAL
INYUVESI YAKWAZULU-NATALI

26 October 2022

Busile Glory Lukhele (219087958)
School Of Agri Earth & Env Sc
Pietermaritzburg Campus

Dear BG Lukhele,

Protocol reference number: HSSREC/00004669/2022
Project title: Impact of digital technology in agriculture on market access and household food security among smallholder farmers in Eswatini.
Degree: Masters

Approval Notification – Expedited Application

This letter serves to notify you that your application received on 28 August 2022 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 26 October 2023.
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 to be submitted when study is finished.

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

Yours sincerely,

[redacted]

Professor Dipane Hlalele (Chair)

/dd