DETERMINANTS OF SMALLHOLDER MAIZE FARMERS' INNOVATIVE MARKET CHANNEL CHOICES: CHIEF ALBERT LUTHULI LOCAL MUNICIPALITY

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DECLARATION

I, the undersigned with student number 201734672, hereby declare that this dissertation for the submission of Master of Agriculture in Agricultural Extension and Rural Resource Management is my original work and has not been submitted previously to the University of Mpumalanga and any tertiary institution of learning for the awarding of any qualification. Where I have used information from published sources, the work has been in-text cited, and references are attached at the end of the dissertation. A Turnitin report is attached in the appendix section. The entire report was edited using Grammarly AI (v1.2.219.1798).

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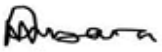
Co- Supervisor/Promoter's Signature:  **Date: 10 March 2025**

CONFERENCE PRESENTATIONS AND PAPERS

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Researchers 'role: *Presenter*

DEDICATION

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LIST OF ACRONYMS

AES- Agricultural Extension Services

ATE- Average Treatment Effect

ATT- Average Treatment Effect on the Treated

DAFF- Department of Agriculture, Forestry and Fisheries

DALRRD- Department of Agriculture, Land Reform and Rural Development

DARDLEA- Department of Agriculture, Rural Development, Land and Environmental Affairs

DOA- Department of Agriculture

FAO- Food and Agriculture Organisation

GDP- Gross Domestic Product

GRAINSA- Grain Producers Association of South Africa

ICT- Information and Communication Technology

IDP- Integrated Development Plan

KECA- Kenya Agricultural Commodity Exchange

MACE- Malawi Agricultural Commodity Exchange

MEGA- Mpumalanga Economic Growth Agency

MNL- Multinomial Logistic Regression

NAMC- National Agricultural Marketing Council

NGO- Non-Governmental Organisations

NPOs- Non-Profit Organisations

NRF- National Research Foundation

NYDA- National Youth Development Agency

PSM- Propensity Score Matching

RSA- Republic of South Africa

RUM- Random Utility Maximization

SAFEX- South Africa Futures Exchange

SD- Standard Deviation

SEDA- Small Enterprise Development Agency

SETA- Sector Education Training Authority

SGDs- Sustainable Development Goals

SHEP- Smallholder Horticulture Empowerment and Promotion

SHMFs- Smallholder Maize Farmers

SHFs- Smallholder Farmers

SLF- Sustainable Livelihood Framework

SMS- Short Message Service

SSA- Sub-Saharan Africa

STATA- Statistics and Data

UMP- University of Mpumalanga

ZIMACE- Zimbabwe Agricultural Commodity Exchange

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ABSTRACT

In sub-Saharan Africa (SSA), maize is a vital crop that provides essential nutrients, supports smallholder maize farmers (SHMFs) in their efforts to overcome poverty, and contributes to enhanced food security. However, yield remains low due to socio-economic limitations and inadequate Agricultural Extension Services (AES). This restricts SHMFs' access to essential market information, thereby diminishing their ability to engage successfully in innovative markets and achieve sustainable production. Therefore, the aim of the study was to investigate the determinants of innovative market channel choices among 272 registered SHMFs, using a multistage sampling process and structured questionnaires. The study was conducted in Chief Albert Luthuli Local Municipality, Gert Sibande District, Mpumalanga, South Africa. Descriptive statistics, Multinomial Logistic Regression (MNL), and Propensity Score Matching (PSM) were used to analyse demographic factors and constraints, innovative market channels, and the effects of AES, using Statistics and Data (STATA). Furthermore, the study adopted the Random Utility Maximisation (RUM) theory as a fundamental framework for choice-making.

The smallholder maize production in Chief Albert Luthuli Local Municipality is primarily dominated by SHMFs aged 35 to 55 years. The results further show that women are represented at 51.09%, resulting in a slightly balanced gender distribution. The distribution of land ownership indicates that communal land is predominantly used by sampled SHMFs, accounting for 43.01%. The farm size distribution shows that most of the sampled respondents produce maize on areas of 3 to 10 hectares, accounting for 57.72%. The study's key findings on age distribution indicate that 51.09% of sampled SHMFs are women, 18.8% are youth, and 57.7% have 3-10 years of farm experience. This underlines the importance of gender roles in decision-making. Contract market channels are used by 34.9% (n = 95), while 3.7% (n = 10) do not sell. These results are followed by collective market channels at 32.4% (n = 88), the least prevalent among e-commerce market channels at 25.4% (n = 69). Technological advancements are crucial in expanding rural economic development.

Gender, age and educational level were statistically significant across the three innovative market channels. Gender was significant for contract, collective, and e-commerce market channels at p = 0.069, 0.094, and 0.031, respectively; age at p = 0.022, 0.011, and 0.018, respectively; and education at p = 0.033, 0.024, and 0.026, respectively. Receiving AES significantly influences innovative market choices, with farm experience (P = 0.049), land ownership (P = 0.037), and hired farm implements (P = 0.055) showing statistical significance at the 5% level in probit regression analyses. Kernel, nearest neighbour, and radius matching methods were used to estimate the Average Treatment Effect on the Treated (ATT). The treatment group (n = 168) exhibited higher propensity scores (mean = 0.85, Standard Deviation (SD) = 0.20), while the control group (n = 104) had lower, more variable scores (mean = 0.24, SD = 0.29), indicating differing likelihoods of receiving AES based on socioeconomic characteristics. Radius matching revealed a statistically significant ATT of 4.65 (SE = 1.79, T = 2.61), indicating that AES influence the choice of innovative market channels.

The majority of the participants reported facing obstacles in implementing innovative marketing channels, as revealed through the Sustainable Livelihood Framework (SLF) five assets: human, social, financial, natural and physical. The highest minimum percentage of respondents affected by constraints within the sustainable livelihood framework was for both financial and natural assets, both of which exceeded 80%. Subsequently, physical and human assets accounted for 60%, whilst social assets exhibited the least influence at 50%. To overcome these constraints, extension practitioners should play a pivotal role in disseminating information and providing training on ICT-driven e-commerce to enhance SHMFs' digital literacy and market access. The study highlights the significant effect of socio-economic factors, including access to AES, gender roles, and financial constraints, on SHMFs' market channel choices, with implications for enhancing their productivity and informed market channel choices. Therefore, it is recommended that SHMFs’ access to innovative marketing channels be enhanced, and that the issues identified by the SLF, AES, market information systems, and market structures be addressed.

Extension practitioners are among the key actors in spreading information and providing training on ICT-based e-commerce platforms. Enhancing digital infrastructure, equipping extension practitioners with necessary digital skills and encouraging collaborative e-commerce platforms to help lower costs, save time and boost SHMFs' choice of innovative market channels. Furthermore, the DOA should strengthen the AES by digitalising their operations to deliver real-time market information, including current prices, weather forecasts and demand fluctuations. Leveraging public-private partnerships, the DOA and industry stakeholders can co-develop an interactive advisory tool that recommends the most suitable marketing channels based on market trends and farmers' production capacity. Integrating the Smallholder Horticulture Empowerment and Promotion (SHEP) approach into this system would further enhance SHMFs' ability to make innovative choices about market channels. Thus, empowering them to become market-oriented, understand consumer needs and strategically align their production with market opportunities.

Keywords: *Smallholder farmers, Innovative market channels, Maize farming, Chief Albert Luthuli, Random Utility Maximisation and Multinomial Logistic Regression.*

CHAPTER ONE: INTRODUCTION

1.1 Chapter introduction

This chapter provides an overview and background of the study, including its objectives. The study commences with an exposition of the background and the problem statement. It subsequently delineates the aim, objectives, hypotheses, and research questions the study seeks to address among smallholder maize farmers in the Chief Albert Luthuli Local Municipality. Additionally, the chapter elaborates on the study's scientific contributions and the influence of farmers' choices on the selection of innovative market channels. This chapter concludes with an outline of the dissertation.

1.2 Background of the study

Over the past decade, the agricultural sector has undergone significant transformations, driven by technological advancements and shifts in producers' behaviour (Dlamini-Mazibuko,Ferrer and Ortmann, 2019). Despite these changes, Smallholder Maize Farmers (SHMFs) often find themselves at a crossroads, needing to balance adopting new, innovative market channels with continuing to use traditional market channels (Musso, 2010; Yiming, 2023). This scenario highlights the importance of understanding the key determinants that shape Smallholder Farmers' (SHFs) choices regarding innovative market channels. These choices are crucial, as they directly influence the agricultural practices and economic outcomes of SHFs (Adugna, Ketema, Goshu, and Debebe, 2019; Schwering, Sonntag and Kühl, 2022). Therefore, a nuanced examination of these factors is crucial to enable SHMFs to navigate the evolving market landscape effectively and capitalise on emerging opportunities. Technological innovations have emerged as pivotal drivers in reshaping how SHFs engage with market channels (Cebiso and Mudhara, 2022).

Access to and utilisation of output markets are two crucial elements influencing the progress of this group of SHFs. The transformative journey of the agricultural market has proven that these factors influence the choices made by SHFs when it comes to market channel selection (Cebiso and Mudhara, 2022). Ultimately, understanding and addressing the key determinants and effects of innovative market channel choices is essential for empowering SHMFs and fostering their success in an increasingly dynamic agricultural market environment. Globally, SHFs make a significant contribution to the economy, accounting for a substantial share of agricultural production.

According to Mekouar (2023), a report on the Food and Agriculture Organisation (FAO), SHMFs collectively contribute approximately 4% to global Gross Domestic Product (GDP). This underscores their significance as key contributors to the global economy, highlighting the need to understand and support their choices to adopt innovative market channels. Therefore, making the choice of innovative market channels essential for overcoming market channel constraints and achieving better outcomes. Factors such as market infrastructure availability, trading relationships, access to information and technology, education level and financial resources are amongst the few that determine SHFs' choice (Teame and Yacob, 2023).

Agriculture is essential for reducing poverty and generating income in sub-Saharan African (SSA) economies, employing 43% of the labour force and contributing 17% to GDP in 2021 (Statista, 2024). This statistic underscores the economic significance of SHFs within national contexts, underscoring the need to address identified constraints and create opportunities for SHFs to thrive. Specifically, when considering maize production, SHFs emerge as pivotal players in the industry. For instance, during the 2020/2021 season in South Africa, SHMFs contributed substantially to maize production, with the Free State and Mpumalanga provinces emerging as top producers, accounting for 44.3% and 22.34%, respectively (National Agricultural Marketing Council [NAMC], 2024). Recognising this link between SHMFs and maize farming underscores the critical need for innovative market channels to enhance productivity and amplify the economic impact of SHMFs' choices across regional and national markets.

Recently, there has been a growing focus on finding new and innovative ways to help SHMFs increase their income and profitability (Musso, 2010; Liu, 2018; Kalauba, 2021). Aragon (2021) defined traditional market channels as those that involve intermediaries offering low prices, thereby reducing the profitability of SHMFs. In contrast, innovative market channels leverage digital platforms to achieve a substantial global reach, with diverse interaction methods such as online purchases (Purchase and Volery, 2020). Innovative market channels use strategies that incorporate digital tools such as social media, e-commerce, and contractual arrangements. To enhance these efforts, governments, Non-Profit Organisations (NPOs), and the private sector are supporting SHMFs through agricultural extension and advisory services. These services aim to enhance productivity and improve livelihood opportunities.

They provide information management, technical guidance, advisory support and regulatory assistance. Additional resources encompass training programs, capacity-building initiatives, infrastructure development for on-farm and off-farm activities and inputs for production (Louw and Jordaan, 2016). These services support SHFs in adopting modern technologies and promoting sustainable agricultural practices. They also facilitate market access by strengthening the SHFs' positions in the value chain, improving product quality and boosting operational efficiency. Thus, enhancing SHFs' competitiveness, increasing income levels and contributing to poverty reduction.

1.3 Problem statement

Traditionally, SHFs have obtained market information from agricultural extension practitioners, which influences their selection of market channels (Yiming, 2023). SHFs have been selling their produce using traditional markets. This is ineffective because of the increasing disparity between the ratio of extension practitioners and the rising number of registered SHFs in need of extension services (Agholor, 2019). Constraining factors such as the use of middlemen, lack of transparency in pricing, poor infrastructure and inadequate access to market, quality control, lack of integration of modern technologies, as well as the inability to add value and meet quality control standards, limit SHFs' choices in selecting market channels (Dlamini-Mazibuko *et al*., 2019).

Research focused on the advantages and disadvantages of various market channels for SHFs (Ariho, Makindara, Tumwesigye, and Sikira, 2015; Mmbando, Wale, Baiyegunhi, and Darroch, 2016; Louw and Jordaan, 2016). However, there is a lack of information on exploring key determinants of innovative market channels, specifically for maize producers. Additionally, some studies have highlighted that some SHMFs prefer traditional markets to innovative ones (Sethi, Guha, and Agarwal, 2014; Mmbando *et al*., 2016). While others have emphasised the benefits of innovative market channels, they have not explored multiple social media platforms (Yiming, 2023). Liu (2018) discussed digital markets but provided little information on the determinants of innovative market channels. In addition, some researchers have focused on identifying constraints in inputs and technology adoption, but few have examined factors influencing the choice of market channels (Agholor, 2019; Ola and Menapace, 2020). This knowledge gap hinders the Department of Agriculture's (DOA) ability to design interventions that encourage SHMFs to select and participate in innovative and profitable markets, potentially trapping them in low-value chains.

Hence, there is a need to understand the determinants of SHMFs' innovative market channel choices, as it is crucial for improving the livelihoods and sustainable agricultural productivity.

1.4 Significance of the study

Maize is a significant grain crop in South Africa, cultivated across various environmental conditions and serves a crucial role in the diets of both rural and urban impoverished populations. Maize has a nutritional composition of 71.88g carbohydrates, 8.84g protein, 4.57g fat, 2.15g fibre, along with various minerals and vitamins (Statista, 2024). Prior research has identified the difficulties SHMFs face in efficiently accessing markets and implementing innovative strategies (Verhaegen and Huylenbroeck, 1999; Ola and Menapace, 2020). While engaging with innovative market channels may offer potential benefits, the factors that influence smallholder maize farmers' choice in this context are not well understood. Engagement with SHMFs is essential to understand their production and market systems and to offer insights into diverse innovative market channels.

The purpose of the study was to identify and analyse the factors that influence SHMFs' selection of innovative market channels. Understanding these determinants enabled the development of appropriate interventions to address them and enhance SHMFs' selection of innovative market channels. Furthermore, assessing the role of Agricultural Extension Services (AES) in helping SHMFs select innovative market channels is significant. The evaluation ascertains the extent to which these services improve SHMFs' understanding and competencies in market strategies. Abera (2016) emphasised that tackling poverty in South Africa requires a primary focus on SHMF participation in the agricultural market. The study promoted a market-oriented system among SHMFs for developing effective agribusiness value chains that can supply sufficient food. This action entailed enhancing maize production and market processes, as well as increasing income-generating capacities among resource-poor SHMFs. This research project provided significant scientific insights for agricultural policymakers to develop effective policies and interventions that enhance market participation among SHMFs. The research findings will contribute to the broader aims of the Sustainable Development Goals (SDGs), specifically in eradicating poverty (SDG 1) and achieving zero hunger (SDG 2), by providing insights that can enhance SHFs’ market participation and livelihoods.

1.5 Overall aim

- To investigate the determinants of smallholder maize farmers' innovative market channel choices in Chief Albert Luthuli Local Municipality.

1.6 Objectives of the study

- To identify innovative market channels used by smallholder maize farmers using a random utility maximisation model.
- To evaluate the effects of agricultural extension services among smallholder maize farmers' innovative market channel choices.
- To explore constraints faced by smallholder maize farmers when accessing innovative market channels.

1.7 Research questions

- Which innovative market channels do smallholder farmers use to sell maize using the random utility maximisation model?
- What are the effects of agricultural extension services on smallholder maize farmers' innovative market channel choice?
- What are the constraints encountered by smallholder maize farmers when accessing innovative market channels?

1.8 Hypotheses

H0: There is no significant relationship between the socio-economic characteristics of smallholder maize farmers and their choice of innovative market channels using the random utility maximisation model.

H1: There is a significant relationship between the socio-economic characteristics of smallholder maize farmers and their choice of innovative market channels using the random utility maximisation model.

H0: Agricultural extension services have no significant effect on smallholder maize farmers' innovative market channel choices.

H1: Agricultural extension services have a significant effect on smallholder maize farmers' choices of innovative market channels.

1.9 Definitions of keywords

1.9.1. Smallholder farmers

The definition of SHFs varies by region and institution; however, a shared criterion is farm size, income level, and resource access, which are contingent on the specific farming enterprise involved. In developed countries, an SHF is characterised as a producer who consistently markets a surplus yet does not necessarily view agriculture as a full-time occupation or the sole source of income (Kalauba, 2021). On the other hand, developing countries characterise SHFs as individuals or households with limited land holdings (Fadeyi, 2022). Smallholder farmers engage in diverse agricultural enterprises, encompassing crops, livestock, and mixed farming, across both developed and developing nations [Department of Agriculture, Land Reform, and Rural Development (DALRRD), 2023].

Although numerous studies have been conducted across various farming sectors by Kalauba (2021) and Hlatshwayo, Ngidi, Ojo, Modi, Mabhaudhi, and Slotow (2021), there has been limited focus on SHFs engaged in maize production. According to DARLLD (2021), SHFs are agricultural producers who operate on small plots of land and generally earn annual profits ranging from R50,000 to R1 million. They frequently depend on traditional agricultural practices and have limited access to resources, including capital, technology, and markets. Smallholder Farmers are essential for food security, supporting local economies and providing sustenance to their communities (Ngqangweni, Mmbengwa, Myeki, Sotsha, and Khoza, 2016; Munyati, Mudhara, and Sinyolo, 2023). This study adopts an operational definition consistent with South African sectoral classifications, including those used by Grain SA and the DARLLD, in which smallholder farmers are characterised not solely by land size but also by structural production constraints. Accordingly, smallholder maize farmers in this study are defined as producers operating up to 20 hectares, exhibiting limited capital intensity, reliance on household labour, and restricted access to markets and irrigation.

1.9.2. Innovative market channels

Innovative market channels are emerging as alternative avenues that enhance market access and marketing of farm products within the agricultural sector and SHFs (Verhaegen and Huylenbroeck, 1999). Innovative market channels encompass a range of options, including e-commerce platforms, collectives, contracts, and specialised retailers (Sethi *et al*., 2014). Innovative market channels exhibit significant variations globally.

Developed economies frequently use advanced online platforms and target niche markets, whereas developing regions depend more on local markets and community-supported agriculture, primarily due to infrastructural limitations (Verhaegen and Van Huylenbroeck, 2001). Currently, there is insufficient scholarly attention directed towards innovative market channels specifically designed for SHMFs. Innovative market channels involve a range of complex activities spanning multiple organisations and disciplines, influenced by technological progress and globalisation (Musso, 2010). Purchase and Volery (2020) highlighted that innovation results in substantial alterations to product or service pricing. Technology plays a vital role in enhancing interactions between channel members and end consumers, emphasising the importance of planning, joint management and integration (Musso, 2010). The creation of innovative distribution channels, branding strategies, communication methods and pricing mechanisms constitutes a crucial element of marketing innovation (Purchase and Volery, 2020).

The framework for innovative market channels that would benefit SHMFs remains contentious and lacks consensus. The evaluation of the influence of innovative market channels is complicated by varying perspectives, methodologies and the absence of measurement tools (Purchase and Volery, 2020). Improving this situation necessitates research that examines how maize production can enhance the utilisation of innovative market channels through a better operational understanding, while also evaluating the determinants that facilitate success and critically assessing their influences (Musso, 2010; Wyche and Steinfield, 2016). Empirical evidence can help identify barriers to SHMF market participation.

1.9.3. Market participation

Market participation for SHMFs in the agricultural landscape involves two essential components: acquiring inputs from the input market and marketing the produce. The decision to participate indicates a farmer's involvement in sales, irrespective of the volume or location of sale (Ndoro and Hitayezu, 2014). Munyati *et al*. (2023) assert that an individual's level of involvement is determined by the sales made in relation to the total maize produced. This definition aligns with the perspective of Hlatshwayo *et al*. (2021), which asserts that efficient and effective interaction within a marketplace constitutes genuine participation. In the context of this study, participation extends beyond simply engaging in sales; it encompasses active, informed, and sustained involvement in marketing activities that build farmers' capacity, enhance farmers' decision-making power, and enable them to benefit equitably from market opportunities

1.9.4. Market channel choices

Kalauba (2021) describes market channels as different routes through which products move from producers to consumers. Munyati *et al*. (2023) argued that market channels consist of interconnected organisations that work together to make products or services available to consumers. These channels represent the downstream part of the value chain and involve different entities at various stages, ultimately ensuring that final products reach consumers. The innovative market channels utilised by SHFs are shaped by various influencing factors. Mmbando *et al*. (2016) argued that the selection of marketing channels is significantly influenced by transaction costs, household wealth, access to credit, AES, and social capital. Appiah-Twumasi, Donkoh, and Ansah (2020) identified traditional financing methods among SHFs, including personal savings, reinvesting previous profits, and income from other commercial crops. Additionally, socio-economic demographics were found to enhance the likelihood of adopting innovative financing methods. Purchase and Volery (2020) examined an innovative business scheme aimed at improving SHFs' market participation, highlighting the need to account for various economic and social factors. Kipkurgat, Onyiego and Chemwaina, (2016) emphasised the significance of rural institutions, producer marketing groups, in enhancing market access and promoting the utilisation of the resistant cultivars. The studies highlight the need to address transaction costs and enhance the availability of financial credit and support services to improve market participation among SHFs.

1.10 Outline of the dissertation

The study is divided into five chapters. The first chapter provides an overview of the research background, establishing a foundation for a thorough investigation into the selection of innovative market channels by smallholder maize farmers. The problem statement identifies deficiencies in understanding the factors that influence SHMFs' choices and presents hypotheses and research questions. The study outlines its overall aim, specific objectives and scientific contribution, establishing a clear framework for the following chapters. In Chapter 2, a literature review is presented, aligned with the study objectives, while Chapter 3 addresses the methodology and theoretical framework. This chapter outlines the study area, data collection and analysis methods and the research methodologies used. Chapter 4 presents the results and discussion, while Chapter 5 summarises the findings, offers conclusions, and provides recommendations. The final section of the dissertation consists of references and appendices. A literature review, along with a conceptual framework, is presented in the following chapter.

CHAPTER TWO: LITERATURE REVIEW

2.1 Chapter introduction

This chapter provides an in-depth discussion of the literature relevant to the study objectives. It reviewed the existing literature and past studies on factors influencing innovative market channel selection among SHMFs. Furthermore, it reviewed and discussed themes related to AES towards market participation, the determinants of innovative market channel choices, and the constraints encountered by SHMFs when selecting innovative market channels. A conceptual framework was developed by synthesising the reviewed literature, and a summary of the chapter followed.

2.2 Maize production in South Africa

Maize is a crucial agronomic crop for food security in the RSA, particularly because it is among the most important staple foods (Grain SA, 2023). The South African maize industry was deregulated in 1997 and operates in a free-market environment, where producers sell to customers' wishes and prices are determined by supply and demand (DALRRD, 2023). The production of maize and the total area planted (hectares) have increased over the last decade (Diko, 2020). Maize is an internationally traded commodity, subject to international market conditions. According to Grain SA (2023), demand and supply conditions in the international maize market directly influence domestic prices. Another important factor influencing the domestic market is the import tariff, which is used to protect domestic producers from low-priced maize imports (Statista, 2024).

The lowest average maize producer's price was recorded in 2004/05 (R513/ton), and the highest in 2015/16 (R4995/ton). The provinces that produce the most maize in RSA include the Free State (40%), Mpumalanga (22%) and Northwest (16%). The Northwest and Free State plant mostly white maize while Mpumalanga plants mostly yellow maize (Grain SA, 2023). White maize is mostly used for human consumption, while yellow maize is used for animal feed. The South African maize market has matured since the deregulation of the agricultural market (FAO, 2019; FAO, 2023). Producers, traders and other intermediaries interact freely in the maize market. Most of the maize produced in the RSA is consumed locally, so the domestic market is important to the industry (Statista, 2024). As maize is an internationally traded commodity, it is also subject to good climatic conditions.

Favourable climatic conditions in many parts of the RSA enable high-yield maize production, particularly in Mpumalanga and the Free State (Grain SA, 2023). A study conducted by Munyati et al. (2023) found that South Africa has become a major global player in maize production, ranking among the top 10 producers worldwide. This success can be attributed to advancements in farming techniques, improved seed varieties and supportive government policies that have encouraged increased investment in maize cultivation (Cebiso and Mudhara, 2022). Thus, improving market participation among

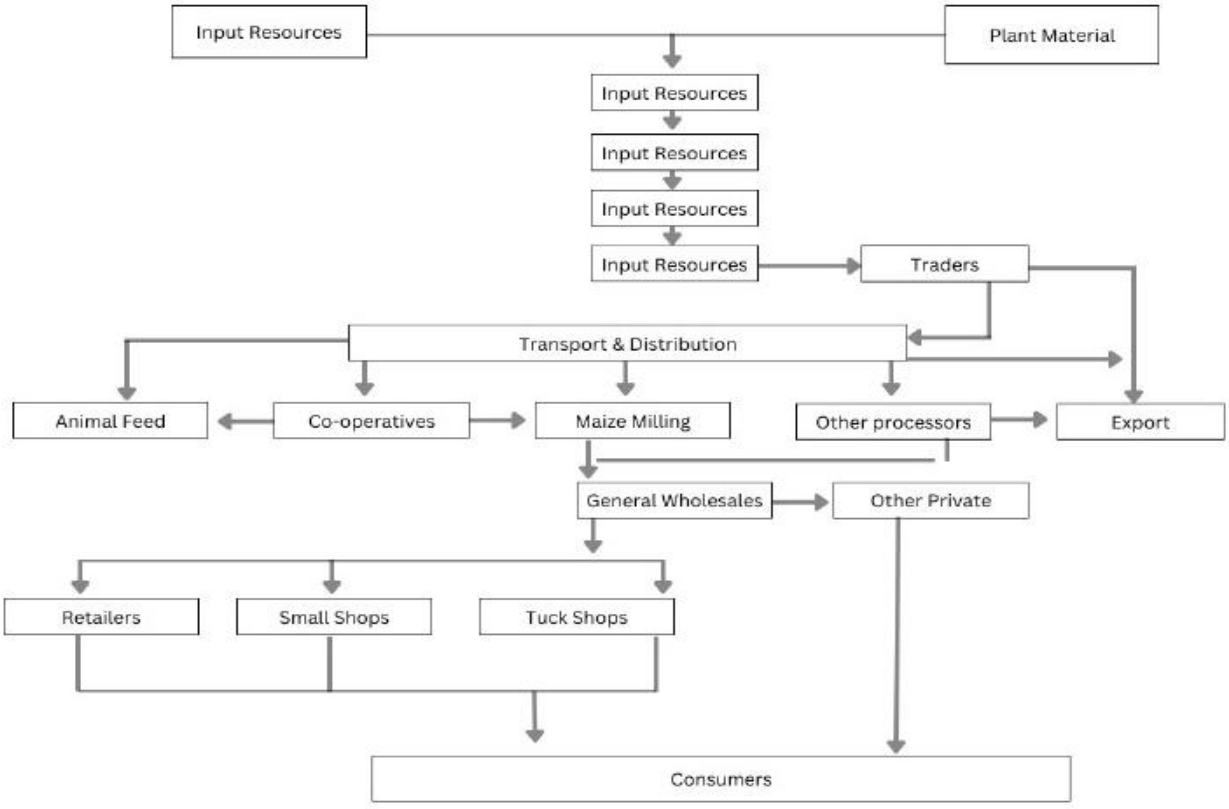

Figure 1: Representing maize value chain

Source: (GrainSA, 2023)

2.3 Concepts of market participation among SHMFs

The first serious discussions and analysis of market participation in South Africa emerged in 1996 with the documentation of the Market of Agricultural Produce Act No. 47 of 1996 (Statista, 2024). This act authorised the establishment of regulatory measures to intervene in the agricultural products market, including levies, the establishment of a NAMC, and other provisions related to the agricultural market (Statista, 2024). In SSA, the agricultural products market plays a vital role in the agrifood supply chain (FAO, 2019).

SHMFs must carefully assess their market channel choice, as it significantly influences their income and overall well-being (Grain SA, 2023). Different market channels offer various prices and services, which directly affect SHMFs' profit margins (Chamberlin and Jayne, 2013). Hence, selecting the right channel is a crucial decision for SHMFs. By opting for a profitable channel, SHMFs can enhance their profitability, invest more in productive assets and improve household welfare. To make an informed channel choice, SHMFs must be knowledgeable about the advantages, requirements, and limitations of each channel. The growth and development of SHMFs depend heavily on their participation in markets. Markets play a crucial role in transforming smallholder agriculture into more commercialized systems that can help rural poor people overcome poverty. However, there is some uncertainty about exactly what constitutes a "market," with different perspectives highlighting its role as a meeting place for buyers and sellers.

2.4 Innovative market channels

2.4.1 Introduction

International competition is increasingly fierce, and market demand is more diversified. SHMFs face opportunities and challenges that coexist in the market world (Xaba and Masuku, 2013; Ouma, Onyango, Ombati, and Mango, 2020; Chiv, Nie, Wu, and Tum, 2020). Smallholder maize farmers typically face a decision about which market channel is most suitable for their agricultural produce (Stastica, 2024). Innovative market channels serve as social structures that help reduce (Mzyece, Shanoyan, Amanor-Boadu, Zereyesus, Ross, and Ng'Ombe, 2023). The costs associated with transactions between different stakeholders in the agricultural value chain (Ouma *et al*., 2020). By providing a collaborative space for interaction, negotiation and choice-making, these channels streamline the exchange of goods, services and information, thereby minimizing the expenses incurred during these transactions (Turyhikayo, Matsiko, Okiror, Obaa, and Hanfet, 2018; Ouma *et al*., 2020; Chen, Hou, Liao, and Wang, 2024). The three innovative market channels discussed in this chapter are contract, collective and e-commerce.

2.4.2 Contract market channel.

The contract market channel in the agricultural sector has gained significant attention in recent years to mitigate price risks and stabilise incomes for SHFs (Derembwe, 2015; Liu, 2018). SHMFs' market participation through contract market arrangements has been receiving much attention in SSA (Abera, 2016; Liu, 2018).

A contract market channel is a pre-harvest agreement between a farmer (seller) and a buyer, typically a processing company or an export agent, in which predetermined quantities of maize are sold at agreed-upon prices (Banda, 2013; Derembwe, 2015). The main benefits of contract markets include reduced risk, guaranteed market access, improved price discovery mechanisms, enhanced productivity through technical assistance, and increased profitability for farmers (Kuzilwa, Fold, Henningsen, and Larsen, 2017). Smallholder maize farmers can enter contracts with agribusinesses or food processing companies that provide inputs, technical assistance and guaranteed offtake of the maize crop at predetermined prices (Derembwe, 2015; Khan, Nakano, Kurosaki, 2019). This ensures a stable market for SHMFs' produce while reducing uncertainties related to pricing and market fluctuations. Models of contract markets play a major role in the welfare of SHMFs by increasing agricultural sector output growth. Khan *et al*. (2019) argued that they deliver better technology, coordinate producers' and consumers' markets, and maintain strong grassroots linkages.

In developing countries, the contract market is mostly promoted by the private sector with little support from public institutions (Khan *et al*., 2019; Ruml and Qaim, 2021). Contract markets improve market access, reduce transaction costs, and provide SHFs with a guaranteed market for their produce (Kuzilwa *et al*., 2019; Ruml and Qaim, 2021). South Africa has witnessed a growing trend of contract market arrangements among SHFs (Kuzilwa *et al*., 2019). The country's experience underscores the importance of establishing clear, enforceable contracts that include dispute-resolution mechanisms. Contract market channels offer several advantages to SHFs. Firstly, contracts provide secure markets by ensuring buyers commit to purchasing a predetermined quantity of produce at an agreed-upon price (Ruml and Qaim, 2021). This stability helps mitigate financial risks for SHFs and encourages investment in quality inputs and improved production practices (Benmehaia, 2019). Additionally, Derembwe (2015) debated that contract market channels often include provisions for technical assistance, such as programs or access to credit facilities that enable SHFs to adopt modern farming techniques.

Contract market channels facilitate access to higher-value markets that are more challenging for smallholders to reach independently (Kuzilwa e*t al*., 2017). On the contrary, this innovative approach connects smallholder producers with agribusinesses, creating mutually beneficial partnerships that offer stability and increased profitability. Various studies have found that institutional, socio-economic, and market factors influence decision-making regarding participation in the maize contract market (Derembwe, 2015; Shewaye, 2016; Khan *et al*., 2019; Maziku and Mashenene, 2024). Smallholder maize farmers are more inclined to participate in contract markets when they perceive greater price stability compared to traditional markets (Khan *et al*., 2019; Kuzilwa *et al*., 2017).

Larger farms tend to be more attractive to buyers because they can consistently meet volume requirements. Strong relationships built on trust between buyers and sellers improve the likelihood of successful contract implementation (Ruml and Qaim, 2020). Additionally, Banda (2013) indicates that engagement in the maize contract market positively affects farmer welfare by providing stable income streams, reducing production risks and facilitating access to necessary inputs such as high-quality seeds and fertilisers. These contracts provide opportunities for technology transfer, knowledge exchange, and skill development among SHMFs through the buyers' extension services (Khan *et al*., 2019). Despite its potential benefits, the contract market in the maize sector faces several challenges. As a result, Buyers often possess more bargaining power than SHMFs, leading to unequal distribution of risks and rewards.

Smallholder farmers often lack critical market information or struggle to understand and negotiate complex contractual terms (Khan *et al*., 2019). Moreover, this lack of critical market information makes it difficult to understand and negotiate complex contractual terms. Weak legal frameworks and inadequate enforcement mechanisms can hinder the effective implementation of contracts, leading to breaches or disputes (Khan *et al.*, 2019). Contract markets in agronomic crops have been found to improve SHMFs' incomes, enhance food security, and enable better access to export markets (Banda, 2013). Studies on the contract market of rice have revealed that it promotes efficiency gains through technology transfer, input provision, improved price discovery and reduced transaction costs (Banda, 2013; Khan *et al*., 2019).

Research on contract market channels for tea production demonstrates that contracts contribute to higher yields, increased income stability and improved farmer training opportunities (Ruml and Qaim, 2021). Contract markets increased productivity through better access to inputs (e.g., improved seeds and fertilisers) and technical advice from contracting companies (Khan *et al*., 2019; Kuzilwa *et al*., 2019). For instance, Banda (2013) found that rice yields were significantly higher among contract SHMFs compared to non-contract SHMFs (Ouma *et al*., 2020). The contract market allows SHMFs to enter modern supply chains that they may not have otherwise accessed. This can lead to improved income stability and reduced-price volatility for producers. Studies from countries like India and Kenya have shown that contract SHMFs receive higher prices than non-contract SHMFs due to direct linkages with agribusiness firms (Ouma *et al*., 2020). Contracts often specify quality standards, which incentivise SHMFs to adopt better practices during production, harvesting and post-harvest handling. Consequently, the contract market has been associated with higher product quality than open markets or traditional supply chains.

2.4.2. Type of contract market channels

2.4.2.1. Short-term contract markets

In the agricultural sector, short-term contract marketing often involves agreements that last only for a single growing season or an even shorter period (Ruml and Qaim, 2021). These contracts offer SHMFs flexibility and immediate cash flow while enabling buyers to source produce quickly to meet market demands (Ruml and Qaim, 2021). Typically involved are items such as vegetables, fruits, and flowers due to their rapid turnaround from farm to table. SHMFs benefit from guaranteed prices under these arrangements, which protect them against price fluctuations between planting and harvest. Buyers can obtain fresh produce at set prices in advance, improving their inventory management capabilities. According to the FAO (2019), such contracts are particularly beneficial during periods of market instability, as they provide security for both producers and consumers.

2.4.1.2. Medium-term contract markets

Medium-term contract markets, typically lasting up to 3 years, offer SHMFs a balance of market stability and operational flexibility (Mashaphu, 2022). These contracts often provide greater access to essential resources, such as loans, improved seeds, and guaranteed market access, which can significantly enhance production and income (Alomia-Hinojosa, Speelman, Thapa, Wei, McDonald, Tittonell, and Groot, 2018).

A study in Pakistan found that medium-term contracts led to higher per-hectare yields and increased profits, driven by improved access to resources (Alomia-Hinojosa *et al*., 2018). In South Africa, these partnerships have demonstrated efficacy for historically excluded SHFs by enhancing access to commercial markets (Auret and Sayed, 2020). Research from SSA demonstrates that contract marketing alleviates risks for SHMFs by providing steady pricing and diminishing reliance on volatile open markets (Muturi, 2020). However, issues persist, rigorous quality requirements and the need for a reliable supply are considerable barriers identified in Nigerian studies, which advocate robust institutional support (Mashapu, 2022; Ouma *et al*., 2020). Medium-term contracts have significant potential, but their effectiveness depends on robust frameworks that address the challenges they pose.

2.4.2.3. Long-term contract markets

Long-term contract marketing involves agreements between farmers and buyers for the sale of agricultural products over extended periods, often exceeding three years (Meemken and Bellemare, 2020; Ruml and Qaim, 2021). This arrangement provides farmers with stable market access and predictable prices, fostering investment in productivity-enhancing practices (Muturi, 2020; Khan et al., 2019). Reducing exposure to market volatility also encourages financial planning and risk reduction. For example, research highlights that long-term marketing contracts in East Africa have improved SHMFs' income stability while promoting the adoption of sustainable farming techniques (Khan *et al*., 2019; Murray-Prior, 2020). In Ghana, such contracts have facilitated access to export markets, enabling smallholders to meet global quality standards (Ragasa, Lambrecht, and Kufoalor, 2018; Muturi, 2020; Ruml and Qaim, 2021). However, challenges such as power imbalances, a lack of transparency, and potential dependency on single buyers remain significant (Ragasa *et al*., 2018). To maximise benefits, long-term contract marketing requires robust institutional frameworks and support systems to address these challenges effectively.

2.4.3 Collective market channel

A collective market channel is a system in which multiple entities collaborate to market and sell products, benefiting from shared resources and expertise (Kiprop, Okinda, Wamuyu, and Geng, 2020). This approach is particularly prevalent in sectors such as agriculture, where producers collaborate to enhance marketing activities while maintaining their independence (Kiprop *et al*., 2019). Research highlights the significance of collective marketing organisations in facilitating cost-sharing, market research and brand promotion, boosting sales and consumer loyalty (Kiprop *et al*., 2019).

The concept of collective market channels is further reinforced as a means not only to drive economic growth but also to foster innovation and resilience in dynamic market environments (Cele and Mudhara, 2020). Existing literature provides valuable insights into the role of agricultural cooperatives in facilitating a collective market for SHFs (Kiprop *et al*., 2019; Cele and Mudhara, 2020; Magakwe and Olorunfemi, 2024). Magakwe and Olorunfemi (2024) indicate that the collective market has emerged as an effective strategy for enhancing access to the marketplace. Collaborating with other smallholder producers enables farmers to enhance their competitiveness both locally and internationally (Cele and Mudhara, 2020). This is done by pooling resources and knowledge while negotiating collectively with buyers, thus securing better prices for farmers' produce (Cele and Mudhara, 2020).

The collective market is a promising solution for overcoming the barriers to accessing agricultural markets and services. It enables farmers to collectively engage in activities such as production, marketing, and processing of agricultural products. This collaborative effort assists SHFs in negotiating better prices, accessing inputs at reduced costs, adopting modern technologies, and gaining direct access to markets (Magakwe and Olorunfemi, 2024). Furthermore, the collective approach enables farmers to share valuable market intelligence, including price, market trends, and consumer preferences (Gyau, Mbugua, and Oduol, 2016). Collective market channels in agriculture have emerged as a viable option for SHFs to improve their market participation, bargaining power and profitability, offering several advantages to producers (Nyawo and Olorunfemi, 2023). In doing so, they enable SHFs to engage in cost-sharing for various activities, such as promotional campaigns, market research, and product branding.

The collective market channel enables producers to harness collective efforts to bolster market presence and enhance competitiveness while maintaining individual autonomy (Orsi, De Noni, Corsi, and Marchisio, 2017). Key benefits of collective marketing initiatives, highlighted by Nyawo and Olorunfemi (2023), include improved market access by pooling resources to effectively reach and serve new markets. This shared effort overcomes individual limitations and opens doors to larger or more innovative markets. According to Arouna (2018), rice production showed that cooperative involvement boosted farmers' incomes by an average of USD 148 per hectare. Similarly, research by Magakwe and Olorunfemi (2024) revealed that when SHFs collaborate, they can negotiate better rates for both inputs and outputs, thereby boosting their farm income.

Furthermore, farmer groups enhance access to market information and extension services, providing farmers with price and buyer information (Nyawo and Olorunfemi, 2023). Thus, increase SHFs' profits through cooperation and potentially increase producers' revenues. Cele and Mudhara (2020) found that collaboration within collective channels enhances coordination and efficiency in supply chains, ensuring more reliable and consistent product delivery. This control improves product quality and customer satisfaction. Moreover, the systemic model by Nyawo and Olorunfemi (2023) illustrates the crucial role of cooperation in dynamic sectors such as the Fresh Fruit and Vegetable market. In such environments, the interdependencies among various factors necessitate collaborative adjustments to remain competitive and responsive to market changes (Arouna, 2018; Nyawo and Olorunfemi, 2023).

The model highlights how integrated efforts optimize outcomes across the supply chain (Cele and Mudhara, 2020). Moreover, collective market channels empower producers to better manage market risks and uncertainties, adapt to shifting consumer preferences and address competitive pressures (Fischer and Qaim, 2012; Magakwe and Olorunfemi, 2024). Thus, enabling producers to stay ahead of consumer trends and preferences, ensuring their products remain relevant and appealing, while facilitating a stronger, more cohesive market presence, which, in turn, makes it easier to build brand recognition and customer loyalty (Arouna, 2018). These advantages enable collective market channels to significantly enhance producers' ability to sustain and grow their market presence in an increasingly competitive and dynamic environment.

The use of collective market channels by SHFs offers several potential benefits, such as shared resources and improved access to larger markets (Agole, Baggett, Ewing, Yoder, and Mangheni, 2022; Nyawo and Olorunfemi, 2023; Konja and Abdulai, 2025). However, there are significant disadvantages and constraints associated with selecting collective market channels (Kiprop *et al*., 2020; Ibikoule, Lee, and Godonou, 2024). This is why it is essential to recognise the disadvantages associated with collective market channels. Factors such as member commitment and coordination costs pose significant challenges that warrant consideration during the implementation phase of collective market endeavours (Arouna, 2018; Agole *et al*., 2022). Although proposed as a potential solution to market access, SHFs' use of collective market channels faces constraints that hinder their effectiveness and growth.

Trust is fundamental for the success of any collective effort. In many cases, farmers may be sceptical about the benefits of pooling their resources and might doubt the fairness and transparency of the cooperative's operations (Agole *et al*., 2022; Munyati *et al*., 2023). In addition, collective market channels often entail stringent requirements regarding product quality, quantity, and delivery schedules (Kiprop *et al*., 2020; Agole *et al*., 2022; Ibikoule *et al*., 2024). Meeting these requirements can be challenging for SHFs due to resource and capacity limitations. Furthermore, delayed payments are a significant issue. Smallholder farmers, who often operate with slim margins and tight cash flows, may struggle financially if payments for their produce are not made in a timely manner, which affects their ability to reinvest in their farming operations (Arouna, 2018; Ibikoule *et al*., 2024).

2.4.3.1. Categories of farmer organisations that facilitate collective market channels.

2.4.3.1.1. Agricultural co-operatives

Agricultural cooperatives have long been recognised as important forces behind rural development, especially in areas where SHFs face significant constraints in obtaining vital resources, such as market information (Ma, Marini, Rahut, 2023; Qu, Zhang, Wang, Ma, Wei, and Kong, 2023). Farmers in many rural areas often work alone because they lack the resources, expertise, and official support needed to compete in increasingly unstable and international agricultural markets (Qu *et al*., 2023). These constraints often result in low agricultural productivity, low income, and increased susceptibility to economic and environmental shocks (Mabunda, 2017; Nyawo and Olorunfemi, 2023). To overcome these obstacles, agricultural cooperatives have emerged as a potent model that enables farmers to pool resources, exchange knowledge, and utilise collective bargaining power to secure better financial terms, capitalise on market opportunities, and adopt environmentally sustainable practices (Mbokazi and Maharaj, 2025).

Agricultural cooperatives are intended to help SHFs improve their standard of living by reducing production and market restrictions (Thaba, 2016; Dlamini and Huang, 2019; Nyawo and Olorunfemi, 2023; Mzuyanda, Ajuruchukwu, Siphe, Mdoda, and Jiba, 2024). Due to its substantial impact on the nation's entire economy since its freedom, agricultural cooperative development was initially embraced in SSA (Mhembwe and Dube, 2017; Dhakal, O'Brien, Mueser, 2021).

Three years after the South Africa Co-operatives Act was established in 1908, the first agricultural cooperatives were established in South Africa. South Africa was established in the Orange Free State in the 1910s (Mzuyanda, 2014). These co-operatives have the potential not only to grow themselves but also to benefit the communities in which they are located (Mbokazi and Maharaj, 2025). The establishment of agricultural co-operatives has been strongly encouraged as an agricultural development policy intervention to help SHMFs manage multiple production and marketing challenges (Olagunju, Ogunniyi, Oyetunde-Usman, Omotayo, Awotide, 2021). In rural communities, agricultural cooperatives play a vital role in providing employment opportunities, ensuring food security, and promoting self-sufficiency (Duguma, 2016). Agricultural cooperatives were established in South Africa in the early 1920s with the goal of empowering and supporting farmers and promoting more equitable access to and distribution of resources (Gwiriri and Bennett, 2020). Wortmann-Kolundzija (2019) discovered that rural farmers' livelihoods are enhanced by increased market access and supply chain distribution.

The primary purpose of agricultural co-operatives in South Africa is to promote socio-economic development by generating income, creating employment opportunities, and empowering black people (Wortmann-Kolundzija, 2019). Agricultural cooperatives are expected to help farmers collectively bargain for better prices and improve access to finance (Nyawo and Olorunfemi, 2023). Resulting in the potential role of agricultural co-operatives complementing government efforts by facilitating sustainable agricultural development, especially among SHFs. Agricultural cooperatives are crucial to supply chains, helping SHFs improve their farming practices and move towards sustainable agriculture (Thaba, 2016; Nyawo and Olorunfemi, 2023). Serving as a catalyst for economic growth because members associate to coordinate size savings and improve bargaining influence (Mzuyanda *et al*., 2024; Nyawo and Olorunfemi, 2023). Nowadays, agricultural co-operatives are increasingly viewed as catalysts for better agricultural knowledge and for eradicating food insecurity and poverty. Cooperative associations tend to enhance crop yields, household earnings, and household resources, and to lower transaction costs for accessing input and output markets (Cele and Mudhara, 2020; Magakwe and Olorunfemi, 2024).

Despite the clear benefits of agricultural cooperatives, South Africa still faces challenges that hinder their effectiveness in helping farmers access collective market channels. One major issue is the lack of knowledge among cooperative members regarding production techniques, soil nutrition, and disease control (Mzuyanda 2014; Turyahikayo, Matsiko, Okiror, Obaa, and Hanf, 2018; Takyiakwaa, Tetteh, and Asante, 2025). Additionally, these cooperatives often fail to involve their members in policy-making processes and struggle to compete with other businesses in the market. Cele and Mudhara (2020) further elaborated that inadequate communication services, market skills, land access and transportation can further impede the success of agricultural co-operatives supporting SHFs.

The literature also records instances in which cooperatives have disappointed farmers (Magakwe and Olorunfemi, 2024; Mbokazi and Maharaj, 2025). In South Africa, agricultural co-operatives fail due to a lack of knowledge and information in production, soil nutrition, and disease control (Mzuyanda, 2014; Cele and Mudhara, 2020; Magakwe and Olorunfemi, 2024; Mzuyanda *et al*., 2024). In most cases, cooperatives fail to involve members in policymaking and to compete effectively with other businesses (Dhakal *et al*., 2021). Ultimately, leading to poor communication, irrelevant market skills, insufficient land and inadequate transport (Orsi *et al*., 2017; Magakwe and Olorunfemi, 2024; Mbokazi and Maharaj, 2025). Agricultural cooperatives play a crucial role in facilitating collective markets and enhancing farmers' market access in South Africa. While cooperative-led initiatives offer potential benefits such as increased bargaining power and shared resources, they also face various challenges and constraints that require careful consideration.

2.4.3.1.2. Farmer associations

One effective way for SHFs to gain access to collective market channels is through the formation of farmer associations. According to Wortmann-Kolundzija (2019), farmer associations are created when several farmer groups unite to form a more prominent organisation, thereby increasing their collective bargaining power and giving them a stronger voice in the market. In the maize industry specifically, the collective market plays a crucial role in helping farmers access broader metropolitan, regional and international markets. This is particularly important for SHMFs who may struggle to compete effectively on their own (Ibikoule *et al.*, 2024).

Many countries in SSA have responded to this challenge by fostering dynamic growth in the number of registered producers' associations and other types of cooperatives (Wortmann-Kolundzija 2019; Mbokazi and Maharaj, 2025). These policy objectives have propelled significant organisational changes in the membership, range and scale of activities of farmer associations. For this reason, many new or reorganised maize grower associations should emerge and employ diverse marketing strategies. Farmer associations provide market information, link SHFs to markets, and enable collective action in market channels. Farmer associations function as intermediaries between SHFs and modern market outlets. Additionally, farmer associations help to resolve transactional issues between farmers and input or financial service firms (Ibikoule *et al*., 2024).

Consequently, utilising a cooperative's service channel for inputs is likely to enhance a member's access to these inputs. Furthermore, the formation of associations contributes to the development of social capital. Belonging to a farmer association supports its members in various ways, enabling them to perform their agrarian activities more effectively and thereby improving their livelihoods. In developing countries, SHFs face numerous challenges when trying to increase their incomes by selling agricultural produce independently (Ochieng, Knerr, Owuor, and Ouma, 2018). This situation highlights the reasons for their collaboration with others. The advantages of joining a farmer's association include participating in collective action, which can improve farmers' agricultural productivity through access to farmland, training opportunities, and logistical support (Nikam, Singh, Ashok, and Kumar, 2019).

The South African government's goal of supporting the development of farmer associations is crucial for addressing the market gaps. Magakwe and Olorunfemi (2024) emphasise the importance of creating smallholder market associations to overcome challenges related to market access for SHFs. By doing so, these associations aim to enhance the delivery, supply and distribution of inputs through AES. In South Africa, farmer associations have been established as a structured approach to improving social well-being by boosting food security and household incomes when SHFs participate in collective activities. Participating in collective markets also enhances SHFs' ability to succeed in high-value marketplaces. Olagunju *et al*. (2021) highlight how collective marketing strategies enable targeting broader metropolitan, regional, and international markets beyond local ones and facilitate long market chains, where their advantages surpass those offered by individual efforts. Additionally, hidden government subsidies, such as free auditing and cooperative training, provide further benefits for farmer associations that utilise collective marketing channels (Dhakal *et al*., 2021).

2.4.3.1. Farmer groups

Farmer groups represent the smallest divisions within farmer associations. The concept of farmer groups dates back centuries, having evolved significantly over time to cater to the dynamic needs of agricultural communities (Arouna, 2018). Farmer groups play a crucial role in the development of rural areas and are pivotal in transforming subsistence-based agricultural practices into more commercialised and profitable ventures (Cele and Mudhara, 2020). Farmer groups are currently the primary strategy for transforming South Africa's agricultural sector. They are considered essential ingredients for accessing market information, increasing bargaining power, sharing resources, and securing credit information for their members, as well as encouraging the adoption of technology (Mzuyanda, 2014; Mzuyanda *et al*., 2024; Mbokazi and Maharaj, 2025). Farmer groups play a crucial role in enhancing both individual and collective well-being. According to Cele and Mudhara (2020), these organisations are instrumental in boosting the income of farming families.

The economic benefits of farmer groups are manifold, offering opportunities to pool resources and achieve economies of scale that would otherwise be unattainable (Mzuyanda *et al*., 2024). Consequently, members can reduce production costs and access better prices for bulk purchasing of inputs, such as seeds, fertilisers, and machinery. Furthermore, collective bargaining powered by farmer groups enhances the ability to negotiate better prices with buyers and reduces the exploitation often experienced by individuals in the market (Mbokazi and Maharaj, 2025). This collective market approach leads to improved income and sustainability for members. Furthermore, this group develops standards for shared value, aiming to achieve common progress by enabling farmers to gain mutual benefits.

Apart from economic gains, farmer groups serve as platforms for knowledge sharing and skill development. These organisations serve as channels for exchanging information on best practices in cultivation, pest management, and new technologies (Chimombo, Matita, Mgalamadzi, Chinsinga, Chirwa, Kaiyatsa, and Mazalale, 2022). This peer learning is invaluable, particularly in regions with limited access to AES (Chimombo *et al*., 2022). Additionally, training programs hosted by farmer groups often involve external experts and development organizations. In most cases, this equips farmers with modern agricultural skills and knowledge. This shared learning promotes innovation and greatly boosts productivity, which is crucial for developing resilience to market constraints.

Tackling these issues is further strengthened by social capital and community empowerment essential components ingrained in the framework of farmer groups (Chimombo *et al*., 2024). These organisations foster a sense of solidarity and mutual support among members. Magakwe and Olorunfemi (2024) illustrated that by working together, members can advocate for policy changes, access government subsidies and grants and push for infrastructural improvements that benefit their entire community. Moreover, farmer groups often promote gender inclusion and empower marginalised members of society, thereby fostering more equitable and inclusive rural development (Konja and Abdulai, 2025).

In areas with weak market infrastructure and ongoing market imperfections, farmer associations play a significant role in enhancing the food security of farm households. Groups offer institutional tools to support the exploration of yield-enhancing technologies, market-oriented tactics, and connections to markets for more effective commercialisation. To strengthen their members' market positions, farmer groups engage in cooperative activities such as product transformation, cooperative food marketing, participatory market research, and business planning. Farmer groups offer their members a wide range of services beyond marketing, including financial and technical guidance, policy lobbying, product transformation, input procurement, and support for production activities.

2.4.4 E-commerce market channel

In many developing countries, SHFs face challenges accessing markets due to small-scale farming systems and market imperfections (Li, Guo, Jin, Ma, and Zeng, 2021). These restrictions make it difficult for SHFs to benefit from market transactions. The emergence and rapid development of rural e-commerce in the developing world have provided a new approach to help SHFs overcome barriers to market access by entering national and global markets through internet trading (Li *et al*., 2021; Schweing *et al*., 2022). This has led to the rise of the internet and technological advancements, which have paved the way for the growth of e-commerce in the agricultural sector.

E-commerce, as an innovative business model and sales avenue, develops a multi-channel platform for trading agricultural products, effectively consolidating online and offline resources (Li *et al*., 2021; Schwering *et al*., 2022). Morepje, Sithole, Msweli, and Agholor (2024) added that e-commerce platforms ensure precise sales tracking, comprehensive traceability, channel selection options, and technological backing, all of which are crucial for revitalising country-level rural economies while boosting SHFs' incomes.

Agricultural e-commerce is characterised by low levels of standardisation, transparent transaction processes, virtual exchanges, and numerous similar offerings (Schwering *et al*., 2022). The ongoing development of rural infrastructure and digital technologies is enabling this form of e-commerce to address challenges in selling agricultural goods. Furthermore, it empowers SHFs who were once passive price recipients with improved negotiation leverage. Additionally, this brings ease, such as access to market data that enables at-home order placements and variety through fresh produce choices, to growers like never before (Zhu *et al.*, 2022). Additionally, e-commerce platforms have revolutionized the way consumers purchase goods, including fresh produce (Zeng, Jia, Wan, Guo, 2017). These digital marketplaces serve as a vital channel for SHFs and producers to market their goods directly to consumers, bypassing traditional retail intermediaries. The rise of online shopping has significantly broadened the reach of agricultural products, allowing consumers to enjoy farm-fresh produce with unprecedented convenience (Zeng *et al*., 2017).

This transformation is reshaping the agricultural supply chain, optimizing it for the digital age and catering to the growing demand for transparent and sustainable food sourcing. A key driver of this transformation is the increased usage of Information and Communication Technology (ICT) and internet connectivity, which have given rise to digital platforms that offer new market channels for SHFs (Cebiso and Mudhara, 2022). These platforms establish direct connections between SHFs and buyers, providing up-to-date market data, facilitating price discovery, and offering access to financial services (Zhu, Shen, Tian, Wu, and Mu, 2022). E-commerce platforms are simplifying the process by offering a convenient way for sellers and buyers to connect. This innovation is generating increased efficiency in agribusiness transactions. As a result, the digital evolution spurred by e-commerce platforms not only enhances consumer experience but also empowers SHFs by integrating them more seamlessly into the global marketplace.

Additionally, the e-commerce market channel is gaining importance in agribusiness, driven by the expansion of internet infrastructure in rural areas (Sethi *et al*., 2014). Agriculture is undergoing a digital transformation, opening new possibilities for documentation, precision production, and market information procurement. E-commerce has become a strategic tool for agricultural businesses, enhancing success in a digital economy by providing more information and market access to buyers (Alomia-Hinojosa *et al.*, 2018). Globally, the number of online marketplaces and online stores selling agricultural produce has increased rapidly. In recent years, a number of Agri e-commerce platforms have been launched across developing countries (Alomia-Hinojosa *et al.*, 2018).

These platforms provide farmers with new opportunities to sell their produce and connect with potential buyers. The increasing share of e-commerce in agricultural trade, along with producers' so far hesitant behaviour, has sparked significant interest in understanding what influences a farmer's decision to participate in or refrain from innovative market channels (Sethi *et al*., 2014). The adoption of e-commerce marketing channels for agricultural products has the potential to enhance the livelihoods of SHFs by facilitating their access to innovative markets (Alomia-Hinojosa *et al.*, 2018); Zhu *et al*., 2022). The proposed e-commerce channels serve as a useful tool for connecting SHFs with potential buyers and enhancing the efficiency of the agricultural value chain (Musso, 2010).

While some research emphasises how SHFs can benefit from increased market reach and reduced reliance on intermediaries through e-commerce platforms (Bellemare, 2012; Ariho *et al*., 2015). Research highlights the potential of e-commerce to revolutionise SHFs' productivity and independence by improving market access and reducing reliance on intermediaries (Bellemare, 2012; Ariho *et al*., 2015; Yiming, 2023). The use of e-commerce by SHFs goes beyond simply gaining access to markets. According to Long (2021), it provides helpful information for making informed choices about crop selection, pricing techniques, and market patterns. Moreover, it promotes price transparency and fair transactions, thereby enhancing trust between buyers and SHFs (Yiming, 2023). E-commerce used by farmers in SSA, such as social media and phone calls, is discussed below.

2.4.4.1. E-commerce platforms used in SSA.

For many years, both public and private sector participants have been seeking effective strategies to tackle the short- and long-term challenges in agriculture markets. This includes fulfilling the needs of SHFs (World Bank, 2020). As new farming methods, technologies, and inputs make agriculture more knowledge-intensive, it becomes increasingly important for all agricultural stakeholders to facilitate the smooth flow and exchange of information across market channels (Musso, 2010; Bratha, Rony, and Winarso, 2022). According to Cebiso and Mudhara (2022), information platforms facilitated by ICTs provide new opportunities to gain experience, secure the best prices, and access sources of financial support. Consequently, the development of e-commerce platforms is increasingly significant in SSA, with platforms tailored to address local needs and conditions.

Platforms like Kenya Agricultural Commodity Exchange (KACE) in Kenya, Esoko in Uganda, Ghana, Mozambique, as well as Tanzania, Malawi Agricultural Commodity Exchange (MACE) in Malawi, Zimbabwe Agricultural Commodity Exchange (ZIMACE) in Zimbabwe are amongst the few used for improving market participation (Agri market app, 2020). Additionally, (Cebiso and Mudhara, 2022) discussed that the South African Futures Exchange (SAFEX) in South Africa and Nokia Life Tools in Nigeria are making notable strides in connecting SHMFs to broader markets and resources.

South Africa has also seen the emergence of several web-based agricultural e-commerce platforms, particularly in Gauteng province, which offer various channels for marketing fresh produce (Sithole, 2024). Through online marketplaces, farmers can list and sell fruits, vegetables, dairy products, and other agricultural products thanks to platforms like Evergreens, De'Farmer, Ferreira Fresh, Farm Fresh Online, and Market Chef (Farm Fresh online, 2015; Evergreens, 2021; Fresh stores online, 2021; Ferreira fresh, 2022; De'farmer, 2023; Market chef, 2023; Sithole, 2024). These platforms serve as a bridge between urban consumers and farmers, providing delivery services, safe online payment methods, and 24-hour access to fresh produce (Sithole, 2024). By connecting producers and consumers, these systems have modernised the traditional value chain. They also provide farmers with convenience and increased market reach if they have access to internet-enabled devices and dependable logistics.

A significant move away from traditional marketing strategies and towards digitally driven trade is indicated by the expanding use of e-commerce in the agricultural industry (Cloete and Doens, 2008). Producers, processors, and consumers are all value chain participants that can coordinate, communicate, and work more efficiently thanks to e-commerce. It changes how products and services are marketed and distributed, creating new business partnerships and innovative market structures, as noted by Cloete and Doens (2008). Smallholder farmers can further increase their market participation with the right digital training and infrastructure support, as evidenced by the growing dominance of social commerce, particularly through platforms like Facebook Marketplace and WhatsApp groups (Sithole, 2024). Thus, in South Africa's evolving agri-food system, promoting digital literacy, affordable internet access, and inclusive e-commerce policies could enhance SHFs' resilience, income, and competitiveness.

2.4.4.1.2. Social media

Globally, social media applications are considered a major force in communication and serve as the primary medium for mass marketing and broadcasting, given their widespread use (Cebiso and Mudhara, 2022). Social media offers major opportunities that enable millions of SHFs to access the same information without being constrained by geographical barriers and other localised constraints (Cebiso and Mudhara, 2022). Social media platforms are increasingly used to exchange agricultural knowledge and information. SHFs have turned to these platforms due to their ease of use, quick feedback mechanisms and ability to connect with other farmers, extension workers, agriculture specialists, agribusinesses and consumers across various regions (Cebiso and Mudhara, 2022). As a result, social media has opened new possibilities for SHFs and extension organisations, while also benefiting policymakers and administrators. With its potential to provide equal access to information and agricultural technologies worldwide, it is gaining widespread acceptance within farming communities globally (Verhaegen and Van Huylenbroeck, 2001).

2.4.4.1.2. Phone calls

Mobile phones have increasingly become important communication tools in both developed and developing countries. The adoption and use of mobile phones among SHFs have been triggered by improved accessibility, network connectivity, user-friendliness and affordability (Nyagango, Sife, and Kazungu, 2023). The use of mobile phones for phone calls holds promise for SHFs by providing, among other things, new approaches to accessing agricultural marketing information. Phone calls serve as a crucial platform for selling produce, particularly for SHFs in the Ayaou-Sran region (Oura and Kouassi, 2015; Nyagango *et al*., 2023). By utilising mobile phones, SHFs can communicate directly with buyers and traders, discussing product availability, selling conditions and timing (Ray, 2017). This strategic use of mobile communication enhances decision-making and facilitates quicker sales, allowing SHFs to sell their products more efficiently than through traditional individual purchasers (Lelethu Mdoda and Mdiya, 2022). Consequently, this integration of mobile technology significantly boosts SHFs' incomes and streamlines the food trade process (Chhachhar and Memon, 2019).

In South Africa, several agricultural institutions, including the DALRRD, ARC, and the Agricultural Sector Education and Training Authority (SETA), have incorporated social media as information systems. Instagram, LinkedIn, Facebook and WhatsApp are part of the information system (Cebiso and Mudhara, 2022). These platforms are used to share links, news updates and farmer/consumer inquiries and feedback (Chhachhar and Memon, 2019). Emerging and innovative information and communication technologies hold the potential to enhance market participation. Furthermore, the use of social media and phone calls among SHFs in Kenya and Zimbabwe has received considerable attention (Baumuller, 2015; Wyche and Steinfield, 2016; Yiming, 2023). Few studies have explored drivers of mobile phone calls adoption for marketing by SHFs in South Africa (Sethi *et al*., 2014; Baumüller, 2015).

2.5 Effects of AESs among SHFs' innovative market channel choices

2.5.1 Introduction

Agricultural extension and advisory services are systems that play an indispensable role at the frontline of market channel choices by disseminating timely and accurate agricultural market information to SHFs through training and advisory services (Loki and Mdoda, 2023). Moreover, AES make critical contributions to minimising the lack of knowledge by serving as intermediaries for transferring research to SHFs (Loki and Mdoda, 2023). Public extension services remain the repository and main source of agricultural information for SHFs in developing countries (Mzuyanda *et al.*, 2024). The role of public extension agents includes linking SHFs to relevant institutions and disseminating research-based knowledge and technologies to rural communities to improve their livelihoods (Loki and Mdoda, 2023).

Extension practitioners disseminate information on new, innovative techniques for crop and livestock SHFs and related production and management practices, thereby improving the socio-economic status of rural communities.

Despite this, SHFs that have access to AES are struggling to meet the innovative market demands for their products (Antwi-Agyei and Stringer, 2021). Research emphasises the vital role of AES in improving SHFs' access to information, boosting productivity and supporting sustainable agricultural practices (Antwi-Agyei and Stringer, 2021; Loki and Mdoda, 2023).

It further indicates that AES positively affects the technical efficiency and production levels of SHFs, thereby increasing crop yields and economic development in rural areas (Veesam et *al*., 2025). A meta-analysis indicates that AES have a positive influence on agricultural producers' market participation decisions (Loki and Mdoda, 2023). This influence is particularly significant for those growing crops and horticultural crops.

The findings underscore the crucial role of market-oriented extension services in enhancing SHFs' welfare and bolstering food security (Antwi-Agyei and Stringer, 2021). The Agricultural Extension Service not only facilitates knowledge transfer and skill development but also influences SHFs' choices toward more innovative, market-oriented agricultural practices.

2.5.2 Agricultural extension services

One of the most effective ways to combat rural poverty and food insecurity has been through programs that increase agricultural productivity (Kalogiannidis and Syndoukas, 2024). This is because it may assist SHFs in addressing issues, enhance adult learning in rural regions, transfer technology, and directly involve SHFs in the creation of the agricultural information and understanding system (Loki and Mdoda, 2023). Extension is defined as systems that should facilitate SHFs' access to information, knowledge, and technologies (Mzuyanda *et al*., 2024). Facilitate their interaction with partners in research, education, agricultural enterprises, and other relevant institutions, and assist them in developing their own technical, organisational, and management skills and practices (Manyakanyaka, Modirwa, Tshwene, and Maoba, 2022).

This concept views extension as a crucial tool for enhancing the productivity and effectiveness of agriculture, related activities, and other economic activities to meet the needs of the people. As a result, it is regarded as a tool for promoting laws that would increase the security and calibre of agricultural products (Msuya, Annor-Frempong, Magheni, Agunga, Igodan, Ladele, Huhela, Tselaesele, Msatilomo, and Chowa, 2017). Since the primary goal of agricultural extension is to improve SHFs' knowledge of rural development, it has developed a reputation as a crucial component of technology transfer. A crucial component of enabling development is agricultural extension, given its significant role in enhancing agriculture and rural regions (Raidimi and Kabiti, 2019; Yusuf, Popoola, and Yusuf, 2022).

Agricultural extension services play a pivotal role in facilitating market access for SHFs, particularly in developing countries (Manyakanyaka *et al*., 2022; Maesela, Senyolo, and Belete, 2023). AES are defined as tools that promote agricultural development through the application of scientific research, the acquisition of new knowledge for practical agriculture, and the adoption of innovative technologies through farmer education, training, demonstration, and advisory services (Manyakanyaka *et al*., 2022). The significant role of AES in providing SHFs with the knowledge, skills, and resources to enhance their agricultural practices, increase productivity, and effectively connect with buyers (Maesela *et al*., 2023).

According to Lukhalo and Zwane (2022), AES is a series of communication interventions designed to improve and resolve challenging situations in agriculture, often involving multiple stakeholders. The National DALRRD (2023) expands on this by explaining that AES is a systematic approach to collaborating with SHFs or communities, imparting essential expertise and competencies to improve agricultural production. This includes educating SHFs on sustainable farming methods, irrigation techniques, pest management strategies and post-harvest handling practices (FAO, 2023). With improved agricultural information, SHFs can produce high-quality maize that meets market standards. AES involves trained professionals providing SHFs with information, guidance and farm assistance (Lukhalo and Zwane, 2022).

The primary objective of these services is to facilitate the adoption of innovative technologies and practices that can enhance productivity and profitability in the agricultural sector. Thus, equipping SHFs with valuable market information, such as prices, demand patterns, and various market channels (Lukhalo and Zwane, 2022; DALRRD, 2023). Agricultural extension practitioners facilitate the dissemination of information about available resources and guide SHMFs on how to access them efficiently (Yusuf *et al*., 2022). Furthermore, AES assists SHFs in overcoming barriers to market access. These barriers include limited credit, inadequate infrastructure, insufficient knowledge of market requirements and standards, and inefficient value chain linkages (FAO, 2023).

AES contribute to poverty reduction, rural development, sustainable market engagement, and food security in developing countries (Raidimi and Kabiti, 2019). Msuya *et al*. (2017) and Manyakanyaka *et al*. (2022) emphasised that AES is a valuable tool for encouraging agricultural development through scientific research, knowledge and technologies. Agricultural extension services are instrumental in facilitating market access for SHMFs. Additionally, AES offer expertise, competencies and resources to enhance agricultural practices and boost productivity.

2.5.2.1. Agricultural advisory services offered to smallholder maize farmers in South Africa.

SHFs rely heavily on advisory services to acquire vital information and knowledge that enables them to participate effectively in profitable market channels, as highlighted by Manyakanyaka *et al*. (2022). These invaluable services equip SHFs with the insights, technical guidance, and assistance they need when making decisions on production practices and market strategies to achieve better market access (Mdiya, Aliber, Ngarava, Bontsa, and Zhou, 2023). The importance of AES in boosting SHFs' long-term agricultural capabilities is not examined (Loki and Mdoda, 2023). The current literature does not provide a thorough evaluation of how these services change market engagement patterns for SHFs (Loki and Mdoda, 2023; Alam, Sarma, Begum, Crase, Tama, and Kader, 2024).

2.5.2.2. Formulation of business plan and management

Generating income is the foundation of market participation; hence, creating a thorough business plan is crucial. It is essential for extension practitioners to support SHFs by helping them develop comprehensive plans that gather important information on production costs, projected yields and market demand while also assessing their financial capabilities and identifying potential sources of funding (Maesela *et al*., 2023). Manyakanyaka *et al*. (2023) debated that agricultural economists play a crucial role in helping SHFs develop tailored business plans for innovative market channels. These professionals assist with financial management, budgeting, cost analysis, pricing strategies and facilitating access to technology or equipment. (Maesela *et al*., 2023). Moreover, they link SHFs with relevant stakeholders throughout the process of developing their business plans (Loki and Mdoda, 2023). Despite these contributions, the literature on the effectiveness of such collaborations in securing sustainable market access for SHFs remains limited.

Additionally, extension services assist in connecting SHFs with key stakeholders, such as the Small Enterprise Development Agency (SEDA), the Mpumalanga Economic Growth Agency (MEGA), and the National Youth Development Agency (NYDA), to provide support for business planning and management (Thapa and Shrestha, 2019). These stakeholders offer a range of valuable services, including business registration, financial management advice, and market research. The significant role of extension practitioners in helping smallholder maize farmers achieve market access by developing business plans cannot be emphasised enough.

2.5.2.3. Company/ farm registration

Farm registration is a crucial step for SHFs and agricultural enterprises looking to legitimise their operations and gain formal recognition. This involves establishing a distinct legal identity, which offers significant benefits such as increased access to financing, protection against liabilities and enhanced market credibility (Thapa and Shrestha, 2019). The guidance and assistance provided by government extension practitioners to SHMFs during the farm registration process are pivotal (Msuya *et al*., 2017). They offer vital information, documentation support, practical advice, and continuous mentoring for successful registration (Antwi-Agyei, Stringer, 2021).

However, there is a need for an in-depth evaluation of the efficiency and effectiveness of such services rendered by extension practitioners. A critical appraisal would identify any challenges or bottlenecks hindering their performance and suggest ways to streamline procedures, enabling SHFs to receive better service from them. Such analysis offers valuable opportunities to enhance this essential system of farmer support. Additionally, the recognition of distinct farming entities significantly impacts SHFs' ability to access diverse market channels (Msuya *et al*., 2017). Such formalised structures not only confer legal legitimacy but also help secure financial resources. This enables enhanced engagement with an expanded network of partners, customers, and distribution channels.

2.5.3 Training and compliance

2.5.3.1 Value- addition for maize

The South African Department of Agriculture, Grain SA and Timbali are providing extension services that offer training programs for maize farmers geared towards value addition (Grain SA, 2023). Msuya *et al*. (2017) observe that these initiatives cover diverse areas, including post-harvest handling techniques, processing methods and strategic market approaches aimed at adding value to maize products. Smallholder farmers receive practical guidance on appropriate drying strategies, coupled with storage solutions designed to reduce losses while preserving product quality (Manandhar, Milindi, and Shah, 2018). Additionally, these programs provide knowledge of a variety of processing methods, such as milling, grinding, and extrusion, enabling SHFs to produce high-value-added commodities, such as flour, meal, snacks, and animal feed, among other related products, from their maize crops.

The training sessions have a two-fold objective: to equip farmers with crucial expertise and awareness, and to facilitate their entry into more profitable markets by broadening income opportunities. To gain a thorough understanding of the effectiveness of specialised training in improving the maize value chain, it is imperative to undertake an in-depth analysis that draws from various scholarly sources. Manyakanyaka *et al*. (2021) highlight how targeted training programs can significantly enhance SHFs' knowledge on innovative processing methods, leading to improved quality and added value of their produce. According to Msuya *et al*. (2017), maize farming can benefit from value addition, thereby increasing profitability through product differentiation and premium pricing. With access to extension services-led instruction, participating SHFs learn about market trends, consumer interests, packaging mandates, and certification requirements necessary to access new sectors of the marketplace.

2.6 Constraints faced by smallholder maize farmers

2.6.1 Introduction

In the global pursuit of empowering SHFs, enhancing market participation is a crucial element for ensuring food security and economic development, particularly in regions such as SSA (DAFF, 2020). Globally, SHFs face shared constraints, including inadequate access to credit, information, and infrastructure, which impact their ability to engage effectively with innovative market channels (DAFF, 2020; Munyati, 2023). While various interventions, including the establishment of rural market institutions and cooperative structures, have been implemented, studies such as those by (Hlatshwayo *et al.*, 2021) and (Maponya *et al.*, 2018) suggest that their actual influence on market participation remains limited.

At the national level, the South African government has demonstrated commitment by supporting rural market institutions such as the fresh produce market, yet the efficacy of these interventions in significantly improving market participation among SHFs remains a challenge, as indicated by numerous studies (Cebiso and Mudhara, 2022; Munyati, 2023). Notably, there is a need for in-depth analyses that explore the socio-economic and contextual constraints specific to SHFs in South Africa. Within this broader context, SHFs encounter constraints that impede their access to innovative markets and limit their ability to capitalise on market opportunities. The constraints are arranged using the sustainable livelihood framework.

2.6.2 Financial constraints encountered by SHMFs

2.6.2.1 Cost of transporting farm produce

Transport plays a crucial role in facilitating the mobility of people and goods. It provides the means for the flow of people, information, raw materials and finished products required for the survival and advancement of society (Olagunju, 2022). Generally, transport has been identified as a vital factor in agricultural development because it provides the means to assemble inputs and to move farm products from farms to various markets and to individual homes. The high cost of transporting agricultural produce to market centres is a significant barrier for SHFs (Olagunju, 2022). Due to the dispersed nature of rural farms and inadequate infrastructure, transport costs often account for a large share of SHFs' marketing costs (Olagunju, 2022; Abdulkadir and Aishat, 2024). Long distances to markets exacerbate these costs, making it challenging for SHMFs to transport their produce efficiently and effectively.

Studies have shown that transport costs can account for up to 60% of total marketing expenses for rural SHFs (World Bank Group, 2020; Abdulkadir and Aishat, 2024). Moreover, SHFs typically lack access to their own means of transport, forcing them to rely on intermediaries or public transport systems. This reliance often results in higher transaction costs and reduced profit margins. A study conducted by Abdulkadir and Aishat (2024) highlighted that SHFs in remote areas are particularly vulnerable to exploitation by middlemen who capitalise on their limited mobility to offer lower farmgate prices. Thus, the transport cost constraint not only hinders access to markets but also undermines the economic viability of smallholder farming operations (Tamene and Megento, 2019). Innovative solutions, such as cooperatives and collective transport arrangements, have been proposed to address this issue.

2.6.2.2 Limited access to credit and financial institutions

The inadequacy of access to capital stands out as a formidable constraint preventing SHMFs from embracing modern farming techniques and technologies (Sebola, 2018). Maize farming, like many other modern agricultural practices, demands substantial investments in various inputs, including high-quality seeds, fertilisers, pesticides, machinery and efficient irrigation systems (Changalima and Ismail, 2022). Unfortunately, a significant number of SHMFs struggle to secure the necessary financial resources for these critical investments (Changalima and Ismail, 2022; Ola and Menapace, 2020). For this reason, the limited availability of financial institutions in rural areas significantly affects SHMFs' ability to access diverse market channels.

A lack of access to credit is a recurring issue, as SHFs often lack the collateral required by traditional banks. This constraint limits their ability to invest in market-related expenses, such as transportation, packaging and storage. According to the International Fund for Agricultural Development, over 70% of SHFs in SSA lack access to formal financial services, which hinders their participation in more lucrative market channels (FAO, 2019). Financial institutions play a critical role in providing credit, savings and insurance services, which are essential for mitigating market risks. However, many rural areas are underserved by formal banking systems, such as the Land Bank, leaving SHMFs with few options to finance their marketing activities. In response, microfinance institutions and informal lending mechanisms have emerged as alternatives.

However, these solutions often come with high interest rates and limited loan sizes, which do not adequately address the financial needs of SHMFs (Ledgerwood, Earne, and Nelson, 2013). Strengthening rural financial infrastructure and introducing tailored financial products for SHMFs are essential for enhancing their market participation. This financial constraint directly influences the productivity and quality of maize produced by SHMFs (Sebola, 2018). Without the means to acquire improved seeds and fertilisers, SHFs are unable to optimise yields and meet the stringent quality standards set by emerging-market channels (Myeni, Moeletsi, Thavhana, Randela, and Mokoena, 2019).

2.6.2.3 Inadequate access to market information using online platforms

Although SHFs play a crucial role in producing various commodities, they often have weak connections to markets, partly due to limited access to market information (Mdoda, Mvelase, and Maziya, 2024). Information, Communication, and Technology have become vital sources of new technological insights that can help bridge the informational gap along value chains for impoverished SHMFs. This connection can link them with lucrative markets that offer opportunities for increased farm income and poverty reduction (Baumuller, 2015). Despite the rapid spread of ICTs, even reaching rural areas where many SHMFs possess such tools, their effectiveness in enhancing innovative market participation remains uncertain. Smallholder farmers in SSA face inadequate access to relevant market information, which hampers their capacity to make well-considered choices about harvest timing, market destinations, and pricing (Morepje, *et al*., 2024). While e-commerce platforms can enhance connectivity and facilitate information flow, challenges such as digital literacy and infrastructure deficits persist.

Consequently, SHMFs often encounter outdated or insufficient market information, which limits their market participation and economic outcomes, despite the potential benefits of ICT in linking them to profitable markets (Morepje *et al*., 2024). Market information is vital for SHFs to make informed choices about harvest timing, market destinations, pricing, and storage options. However, obtaining accurate market information is challenging for SHFs. Even when they manage to access such information, it is often insufficient or outdated (Baumüller, 2015). The lack of comprehensive market information is a common issue due to the high number of SHMFs, inefficient communication systems, low literacy rates, and inadequate information management practices, compared to the ratio of government extension practitioners (Maziku and Mashenene, 2024).

SHFs' lack of information and knowledge about alternative market channels limits their participation in the market. Many of these SHFs reside in remote areas with limited access to information and technology (Maziku and Mashenene, 2024). As highlighted by Louw and Jordaan (2016), this hinders their awareness of emerging market opportunities, such as online platforms or contract farming arrangements. Without proper knowledge dissemination and training programs, they remain unaware of potential avenues for expanding their market reach. Access to timely and relevant market information is crucial for SHFs seeking profitable market opportunities (Louw and Jordaan, 2016). On the contrary, SHFs find it difficult to access such information due to limited literacy rates, language barriers, or inadequate communication infrastructure (Maziku and Mashenene, 2024). This lack of market knowledge deprives SHMFs of the necessary insights to identify advantageous market channels or negotiate fair prices effectively.

2.6.2.4 Cost for buying packaging materials

Over the years, packaging has become an integral part of the agribusiness value chain (Kwaku and Fan, 2020). It has evolved beyond its traditional role of merely protecting products to serving as a key marketing tool that enhances shelf appeal, communicates product information and helps establish brand image and awareness (Pickson and He, 2021). Essentially, this means that the visual design of a product's packaging significantly influences its marketability. However, SHMFs are still constrained by the high cost of buying packaging materials for their produce (Kwaku and Fan, 2020; Pickson and He, 2021; Maziku and Mashenene, 2024).

The high cost of packaging materials, such as sacks and crates, is another significant financial constraint for SHMFs (Ssajakambwe, Elepu, Walekhwa, and Mulebeke, 2019). Proper packaging is essential for preserving maize quality and meeting market standards, particularly in formal and export markets (Kwaku and Fan, 2020). However, the cost of purchasing durable and standardised packaging materials is often prohibitive for resource-constrained SHFs. Inadequate packaging leads to post-harvest losses and lower prices for produce, as poorly packaged goods are less appealing to buyers (Abass, Ndunguru, Mamiro, Alenkhe, Mlingi, and Bekunda, 2014). Additionally, SHFs often lack access to bulk purchasing opportunities, which could reduce the unit cost of packaging materials. This limitation further entrenches their reliance on low-value, informal market channels. Effective packaging not only protects products but also communicates essential information to consumers, thereby influencing their purchasing choices (Abase *et al*., 2014; Kwaku and Fan, 2020). This aspect is critical in a competitive market where differentiation is key. Collaborative efforts, such as farmer cooperatives and public-private partnerships, have been suggested to address this issue. By pooling resources, SHMFs can access packaging materials at reduced costs, thereby improving their market competitiveness (Kwaku and Fan, 2020).

2.6.2.5 Limited access to grants and donations

Limited access to financial support mechanisms, such as grants and donations, constrains SHFs' participation in maize marketing (Lukhalo and Zwane, 2022). Grants and subsidies can play a pivotal role in offsetting production and marketing costs, enabling SHFs to invest in quality inputs and access profitable market channels (Lukhalo and Zwane, 2022). However, many SHFs are excluded from these programs due to bureaucratic inefficiencies, lack of awareness, or restrictive eligibility criteria. Aliber and Hall (2012) found that less than 30% of SHFs in South Africa had accessed government grants, despite their availability. This disconnects between policy intentions and on-the-ground realities limits the effectiveness of financial support initiatives. To address this issue, it is essential to improve the transparency and accessibility of grant programs. Streamlining application processes, raising awareness through AES, and targeting support toward marginalised farmer groups can enhance the impact of financial assistance. Additionally, fostering partnerships among governments, NGOs, and private-sector actors can increase the availability of resources for SHMFs.

2.6.3 Physical constraints encountered by SHMFs

2.6.3.1 Tarmac road with potholes

Physical infrastructure is frequently highlighted as a crucial factor in driving economic growth in both developed and developing nations (Ngubane, Masuku, and Chamane, 2025). In Africa, investing in rural roads is a top priority for governments aiming to reduce poverty. This focus on road investment also aligns with the development community's efforts to alleviate poverty and provide more equitable opportunities for people living in rural areas (Abdulkadir and Aishat, 2024; Ngubane *et al*., 2025). According to Alberts, Rheeder, Gelderblom, Shephard, and Burger (2019), roads are the most predominant mode of transportation in sub-Saharan African countries, accounting for over 75% of passenger travel and freight movement. The region's road network significantly contributes to its socio-economic advancement. However, compared to their counterparts worldwide, especially those in developed regions, the transport infrastructure in many developing countries remains considerably underdeveloped (Kalauba, 2021).

The condition of tarmac roads in rural areas is poor, often riddled with potholes, and poses a significant challenge for SHMFs attempting to transport maize to markets. Inadequate road maintenance increases travel time, vehicle wear and tear and transportation costs, which directly influences SHMFs' profitability (Alberts et al., 2019). Furthermore, delays caused by poor road conditions can lead to the spoilage of perishable produce, thereby reducing its market value. Empirical evidence suggests that improved road infrastructure is correlated with better market access for SHMFs. Investments in rural road rehabilitation led to increased agricultural productivity and market participation (Kalauba, 2021).

However, such improvements remain unevenly distributed, leaving many rural areas underserved and disconnected from major markets (Maziku and Mashenene, 2024). Poorly maintained roads, including tarmac roads with potholes, significantly hinder SHMFs' access to markets, increasing costs and spoilage risks (Olagunju, 2022; Abdulkadir and Aishat, 2024). Addressing these challenges requires coordinated efforts from governments and development agencies to invest in road infrastructure. Additionally, policies that integrate road development with broader rural development plans can further enhance market accessibility (Alberts et al., 2019).

2.6.3.2 Gravel roads not accessible during rainy seasons

Gravel roads, a common feature in rural areas, become nearly impassable during the rainy season, significantly hampering SHMFs' ability to transport produce. Waterlogging and mud can immobilise vehicles and farm machinery, causing delays in farming operations and delivery of produce to markets (Tamene and Megento, 2019). These disruptions not only increase costs but also jeopardise SHMFs' market commitments. The influence of inaccessible gravel roads during rainy seasons is particularly pronounced in regions that rely on seasonal crop production. According to Ola and Menapace (2020), road accessibility during critical harvest periods plays a decisive role in determining SHFs' income levels. The lack of reliable infrastructure leads to post-harvest losses and diminished bargaining power for SHMFs. Mitigating these challenges necessitates investments in all-weather roads and the adoption of innovative drainage solutions to improve the resilience of rural road networks. Moreover, equipping SHMFs with appropriate tools and vehicles designed for rugged terrains can minimise delays and operational inefficiencies (Ssajakambwe *et al*., 2019).

2.6.3.3 Inadequate Storage Facilities

Inadequate storage facilities pose a significant physical constraint for SHMFs, resulting in substantial post-harvest losses. Without proper storage, maize is susceptible to pests, mould and spoilage, reducing its quality and marketability (Abass *et al*., 2014). SHFs often resort to makeshift storage methods that fail to protect produce effectively (Affognon, Mutungi, Sanginga, and Borgemeister, 2015). The absence of modern storage facilities not only affects individual farmers but also undermines the entire agricultural value chain. For instance, post-harvest losses in SSA account for up to 30% of total production, significantly affecting food security and the incomes of smallholder farmers (Affognon *et al*., 2015). Additionally, limited storage capacity compels SHFs to sell their crops immediately after harvest when prices are usually low, further reducing their earnings. Solutions to this problem include establishing community-based storage facilities and promoting affordable, farmer-friendly storage technologies. Governments and development partners can support these initiatives through subsidies and technical assistance, ensuring that SHFs have access to reliable storage options (FAO, 2019).

2.6.3.4 Limited Access to Production Resources

Limited access to essential production resources, such as farm machinery, implements, and tools, constrains SHFs' ability to enhance maize productivity. The high cost and scarcity of these resources leave many SHFs reliant on manual labour, which is less efficient and time-consuming (FAO, 2019). This limitation reduces their capacity to meet market demands and participate in competitive market channels. The lack of mechanisation also exacerbates disparities between SHMFs and larger commercial producers.

Tamene and Megento (2019) highlight that SHFs in SSA use significantly less mechanised equipment than their counterparts in other regions, which contributes to lower yields and limited market access. Addressing this gap is critical for improving productivity and profitability in smallholder farming systems. Strategies to improve access to production resources include establishing machinery-sharing cooperatives and subsidised equipment-leasing programs. Maziku and Mashenene (2024) debated that integrating resource provision with AES can enhance SHFs' knowledge and capacity to utilise these tools effectively. Maziku and Mashenene (2024).

2.6.4 Natural Constraints encountered by SHMFs

2.6.4.1 Unreliable Water Supply for Irrigation

Water scarcity poses a significant global challenge, significantly influencing agriculture, especially in regions prone to drought (Moreptje *et al*., 2024). In South Africa, SHFs face substantial difficulties due to restricted water availability and inefficient usage practices (Morepje *et al*., 2024). These SHFs are vital for the nation's food security and rural economy but often struggle with outdated production methods that lack consistent access to reliable water supplies. Approximately 90% of SSA agriculture is rainfed, making SHFs vulnerable to erratic weather (Chipfupa and Wale, 2019; Dirwai, Taguta, Senzanje, Nhamo, Cofie, Lankford, Harsen and Mabhaudhi, 2024). An unreliable water supply significantly hampers SHF productivity, limiting their ability to meet market demand.

Many SHFs depend on rainfall, making their agricultural activities vulnerable to erratic weather patterns (FAO, 2023). Without consistent irrigation systems, crop yields remain low and unpredictable, reducing the availability of surplus produce for marketing. Research by Morepje *et al.*, (2024) underscores the importance of irrigation in increasing agricultural output. SHFs with access to reliable irrigation can grow crops in off-season periods, ensuring a steady supply to markets. However, the high costs of installing and maintaining irrigation infrastructure are prohibitive for many SHFs, leaving them reliant on rainfall that is inconsistent.

2.6.4.2 Insufficient Arable Land

The scarcity of arable land poses a significant challenge to SHFs, restricting their ability to expand maize production (Cousins, 2016). Population growth and land fragmentation have reduced the availability of cultivable land, forcing SHFs to operate on smaller plots (FAO, 2023). This limitation constrains productivity and reduces economies of scale, further influencing market participation (Ezike, Fadiji, Onjewu, Abubakar, and Mohammed, 2024). Farm size is a critical determinant of maize production among SHMFs. However, SHMFs have limited access to arable land, which constrains their productivity. According to Chamberlin and Jayne (2013), SHFs with limited land access are more likely to engage in subsistence farming rather than commercial agriculture. This restricts their ability to invest in innovative market channels and benefit from higher returns.

2.6.4.3 Unfavourable Weather Conditions

Climate variability, including changes in temperature and rainfall, directly affects maize yields (Ezike et al., 2024). For instance, a study in Nigeria found that 33% of maize yield variation was explained by changes in rainfall and temperature (Munga and Kwena, 2024). Extreme weather events, such as droughts and waterlogging, have been shown to severely reduce maize yields, particularly in the Northwest province (Omotoso, Letsoalo, Daud, Tshwene, and Omotayo, 2024). Climate variability has intensified these challenges, with extreme weather events becoming more frequent (Omotoso *et al*., 2024). Such conditions not only reduce crop productivity but also disrupt market supply chains. SHFs lacking access to weather-resistant crop varieties and climate-smart agricultural practices are particularly vulnerable. A study by Poole (2017) highlights the importance of adopting resilient farming systems to mitigate the effects of climate change. However, the high cost of these technologies and limited access to extension services impede their widespread adoption among smallholders. Developing and disseminating affordable climate-smart technologies, coupled with robust weather forecasting systems, can help SHMFs adapt to changing climatic conditions. Public-private partnerships can play a crucial role in making these solutions accessible to SHMFs.

2.6.5 Social constraints encountered by SHMFs

2.6.5.1 Poor Support for Resolving Conflicts Related to Water Rights

Effective water rights management is crucial to agricultural productivity, yet SHMFs often struggle to resolve conflicts over water use due to inadequate support. Disputes frequently arise from competition among SHMFs, especially in regions with scarce or unevenly distributed water resources (Ezike *et al*., 2024; Morepje *et al*., 2024). Poor conflict-resolution mechanisms disrupt access to irrigation, which in turn further affects maize production and market participation. Studies indicate that collective management of water resources, supported by strong institutional frameworks, reduces the prevalence of water-related conflicts (FAO, 2023; Morepje *et al*., 2024). For example, FAO (2023) found that participatory water governance systems in Tanzania effectively mediated disputes and improved water allocation for agricultural purposes. However, such systems are often underdeveloped in many rural areas, leaving SHFs without recourse for resolving disputes. To address these challenges, governments and non-governmental organisations must invest in strengthening water user associations and providing training in conflict resolution (Morepje *et al*., 2024). Developing legal frameworks to formalise water rights and enhance enforcement can further promote equitable access and reduce conflicts (FAO, 2023).

2.6.5.2 Conflicts Within Farmer Groups/Cooperatives

Conflicts within farmer groups or cooperatives undermine collective efforts to access markets effectively. Disputes often stem from issues such as an unequal distribution of benefits, a lack of transparency in leadership, and divergent priorities among members (Bijman and Wijers, 2019). These conflicts weaken the group's bargaining power, making it difficult to secure favourable terms in innovative market channels. Research highlights the importance of trust and cooperation for the success of farmer groups (Bijman and Wijers, 2019; Nyawo and Olorunfemi, 2023). Nyawo and Olorunfemi (2023), reported that well-functioning cooperatives enhance access to markets by pooling resources and reducing transaction costs. However, internal conflicts often lead to group dissolution, leaving individual SHMFs at a disadvantage in competitive markets. Promoting effective governance within farmer groups through capacity-building programs and transparent leadership structures can mitigate conflicts. External support from agricultural extension services and development agencies can further enhance group cohesion and market performance (Bijman and Wijers, 2019).

2.6.5.3 Inadequate Training on Maize Production

The lack of adequate training on maize production limits SHMFs' ability to adopt improved practices and achieve higher yields (Ezike *et al*., 2024). Many SHFs rely on traditional methods that are often inefficient and unsustainable. Without access to modern agricultural knowledge, SHFs struggle to meet the quality standards required by innovative market channels. Empirical evidence suggests that training programs have a substantial impact on enhancing productivity and market participation (Veesam *et al*., 2025). Carelsen, Ncube, and Fanadzo (2023) demonstrated that farmer field schools in the Western Cape enhanced crop yields by introducing SHFs to better crop management practices. However, the coverage and frequency of such programs remain insufficient in many rural areas, leaving a majority of SHFs underserved (Carelsen *et al*., 2023). Expanding the reach of agricultural training programs, particularly in remote areas, is essential to bridging this knowledge gap. Leveraging digital platforms and mobile-based training can also improve accessibility and equip SHFs with the skills needed to thrive in competitive markets (FAO, 2023).

2.6.5.4 Insufficient Training on Maize Marketing

Insufficient training on maize marketing prevents SHMFs from identifying and utilising profitable market channels. Many SHMFs lack knowledge about pricing strategies, buyer preferences and market dynamics, which limits their ability to negotiate favourable terms (Grain SA, 2023). This knowledge gap often leads SHMFs to sell their produce to middlemen at low prices rather than explore innovative marketing avenues. Evidence suggests that training programs focused on marketing skills empower SHMFs to make informed choices and increase their income (Grain SA, 2023). Veesam *et al.* (2025) found that market training initiatives enhanced SHFs' ability to engage with diverse buyers and negotiate more favourable prices. However, such programs are often underfunded and fail to reach marginalised SHMFs. Enhancing marketing training through public-private partnerships and integrating it into broader agricultural extension services can address this challenge. Additionally, tailoring training content to local market conditions can ensure its relevance and effectiveness for SHFs (Carelsen *et al*., 2023).

2.6.5.5 Inadequate Relevant Market Information

The lack of access to relevant market information hinders SHMFs' ability to select profitable market channels. Many SHFs are unaware of current market prices, demand trends and quality requirements, leaving them at a disadvantage in negotiations (Mittal and Mehar, 2016). This information asymmetry contributes to their reliance on traditional markets and intermediaries, limiting their participation in innovative channels. Timely access to market information significantly improves farmers' decision-making and income. Mittal and Mehar (2016) found that mobile phones enabled SHFs to access real-time price information, reducing price dispersion and enhancing market efficiency. However, such technological interventions are not uniformly available, particularly in rural areas with poor network coverage. To overcome this constraint, governments and development partners must invest in robust information dissemination systems, including mobile applications and radio programs, tailored to the needs of SHFs. Strengthening extension services to provide market intelligence can further empower SHMFs to make informed marketing choices (World Bank, 2020).

2.6.6 Human Constraints encountered by SHMFs

2.6.6.1 Insufficient Extension Service Assistance/Support

Extension services play a pivotal role in equipping SHFs with the knowledge and skills needed to access innovative market channels. However, many SHFs report inadequate support from these services, which undermines their ability to adopt new practices and connect with profitable markets (Alam *et al.*, 2024). The limited outreach of extension services in rural areas often results from understaffing, inadequate funding and logistical challenges, leaving many SHFs without critical assistance (Raidimi and Kabiti, 2019). Effective extension services improve productivity and market access by providing training, facilitating market linkages and offering technical advice. In SSA, farmers with access to extension support are more likely to adopt innovative agricultural practices and participate in high-value markets(Msuya *et al.*, 2017). Unfortunately, the lack of consistent, high-quality extension support perpetuates low productivity and limits SHFs' ability to engage with diverse market options. The use of mobile-based advisory services has proven effective in providing timely support to SHFs, particularly in remote areas (Manyakanyaka *et al.*, 2022).

2.6.6.2 Inadequate Technical Assistance for Compliance with Market Entry Regulations

SHMFs face significant challenges in meeting market-entry regulations, including quality standards, certification requirements, and traceability protocols (Grain SA, 2023). The absence of technical assistance exacerbates this issue, making it difficult for SHFs to participate in formal and innovative market channels (Jawoko, Opio, Mwesigye, and Bariyo, 2023). Compliance with these regulations often requires specialised knowledge and resources that many smallholders lack. Technical assistance programs tailored to the needs of SHMFs can improve compliance rates and facilitate access to lucrative markets. Shabangu (2015) found that SHFs who received technical support for SAGAP certification experienced a 30% increase in income from export markets. However, the limited availability of such programs and the high costs of certification deter many smallholders from pursuing compliance. Public-private partnerships can also play a crucial role in helping SHMFs meet regulatory requirements and access competitive markets (Jawoko *et al*., 2023).

2.6.6.3 Lack of formal education influences farmers' decisions for maize marketing

The low levels of formal education among SHFs often impede their ability to make informed marketing choices. Education enhances SHFs' understanding of market dynamics, negotiation strategies and the benefits of engaging with innovative channels (Agholor, 2019). However, many smallholders lack basic literacy and numeracy skills, which limits their ability to interpret market information and evaluate options. Thus, a strong correlation is shown between education and market participation. Ruml and Qaim (2021) found that educated SHMFs in India were more likely to use market information systems and negotiate better prices. In contrast, uneducated SHFs tend to rely on traditional markets and intermediaries, where they face exploitative practices and low returns. Integrating practical marketing education into agricultural extension services can also help bridge the gap for SHFs with limited formal education (Statista, 2024).

2.6.6.4 Insufficient network infrastructure hinders farmers' ability to use online platforms

The growing reliance on digital platforms for marketing agricultural produce poses a significant challenge for SHMFs in regions with poor network infrastructure (Cebiso and Mudhara, 2022). Access to reliable internet and mobile networks is essential for SHFs to utilise online marketplaces, mobile apps and other digital tools for marketing maize (Tumukunde, 2018). However, many rural areas in developing countries lack adequate infrastructure, making it challenging for SHFs to adopt these technologies. Improved network infrastructure positively affects SHFs' ability to access market information and connect with buyers.

Mittal and Mehar (2016) demonstrated that mobile phone adoption in Niger significantly reduced transaction costs and enhanced the bargaining power of SHFs. Despite these benefits, the digital divide continues to exclude many smallholders from participating in online platforms. Investments in rural network infrastructure, combined with affordable internet access, are crucial for enabling smallholders to utilise digital tools for market access. Public-private partnerships and government subsidies can play a crucial role in bridging this digital gap and enhancing SHMFs' market participation (Statista, 2024).

2.6.6.5 Insufficient marketing skills limit farmers' ability to choose innovative market channels

Marketing skills are essential for SHFs to identify and utilise profitable market channels effectively. However, many smallholders lack training in marketing strategies such as pricing, product differentiation and customer targeting (Oluwatayo, Sebetha, and Ojo, 2021). This limitation often leads to poor market choices, resulting in lower income and reduced competitiveness. Studies have shown that marketing skill development programs can significantly enhance SHMFs' decision-making and market outcomes (Mittal and Mehar, 2016; Oluwatayo *et al*., 2021; Ndlovu and Masuku, 2021). A program in Tanzania that trained SHMFs in marketing and negotiation skills increased their income by 25% through better access to high-value markets (Kalogiannidis and Syndoukas, 2024). However, such programs are often limited in scale and fail to reach most smallholders. Maponya *et al*. (2018) suggest expanding marketing training initiatives through extension services and farmer organisations can address this gap. Additionally, incorporating market literacy components into broader agricultural education programs can ensure that SHFs are equipped with the necessary skills to thrive in innovative market environments.

2.7 A conceptual framework of the determinants of smallholder maize farmers' innovative market channel choices

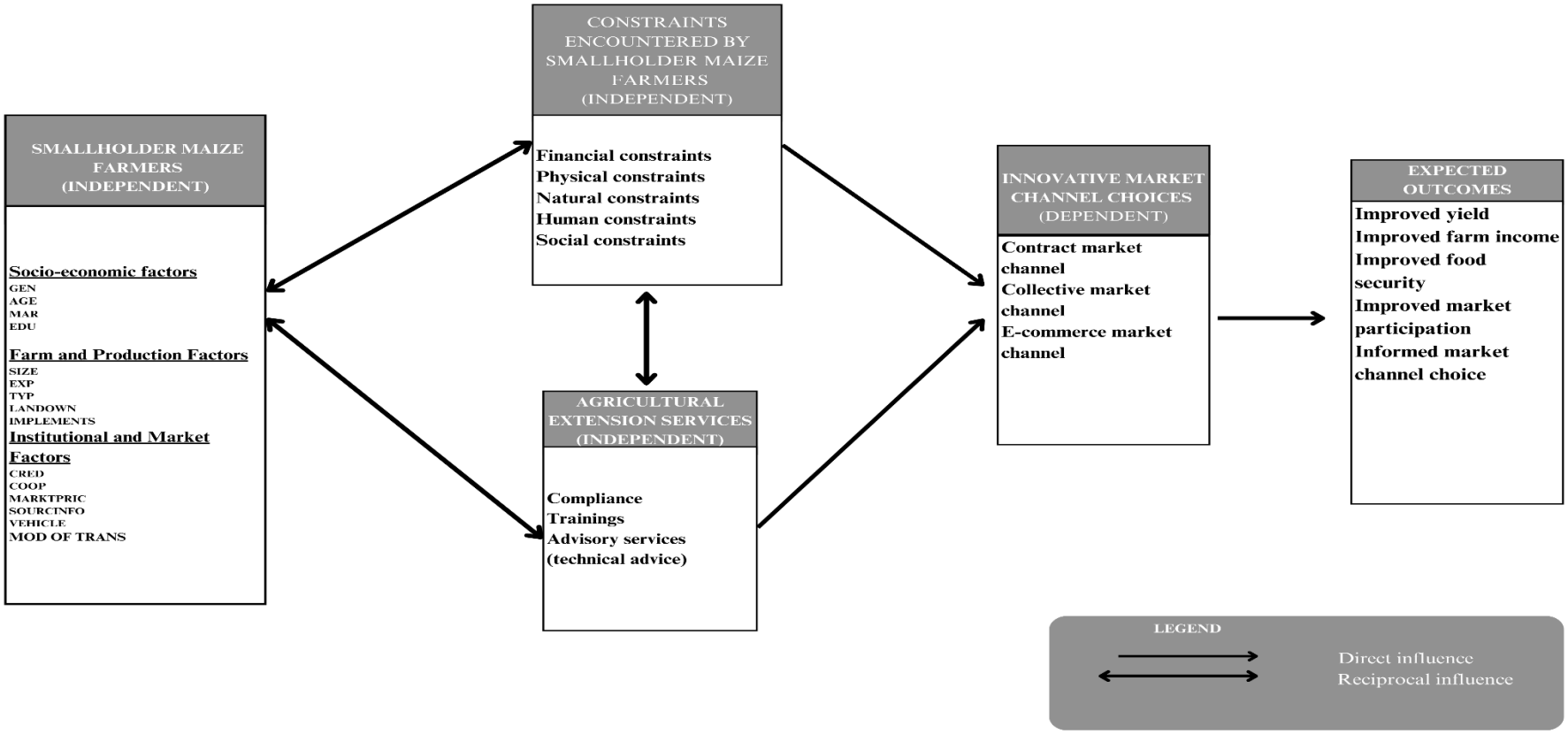

Figure 2: A conceptual framework of the determinants of smallholder maize farmers' innovative market channel choices

Source: (Author, 2024)

The conceptual framework examines the factors influencing SHMFs' choices of innovative market channels in Chief Albert Luthuli Local Municipality, as informed by the literature. The framework focuses on the interplay between AES, constraints and the outcomes associated with innovative market channel choices. This framework highlights the dynamics of SHMFs' choice-making processes and their implications for innovative market participation. Smallholder maize farmers are the main actors in the framework, representing a constant factor. SHMFs' choice regarding innovative market channels is shaped by multiple socio-economic factors and access to AES.

These services include technical advice, training, and guidance on compliance with market and quality standards, all of which enable smallholder maize farmers to overcome barriers and make informed choices in adopting innovative and competitive farming practices. AES empower SHMFs with knowledge of market requirements, improved production practices and access to reliable buyers. There is a bidirectional relationship between constraints and AES. SHMFs face several constraints that influence their ability to participate in innovative market channels. Financial constraints, including limited access to credit and high transportation costs, hinder their competitiveness. Physical constraints, including inadequate infrastructure and storage facilities, further limit the market access of SHMFs. Social factors, such as governance issues within farmer groups, hinder collective bargaining power, while environmental challenges, such as unreliable irrigation systems, exacerbate production risks. The dependent variable in this framework is SHMFs' choice of innovative market channels, which includes contract markets, collective markets and e-commerce markets. Each of these channels provides unique opportunities for SHMFs to make informed market channel choice, improve yield and farm income, thus enhancing food security.

This diagram illustrates the interactions between components, with arrows representing direct influence and reciprocal influence. Smallholder maize farmers indicate their pivotal role. Arrows from AES to Constraints (financial, physical, social, human and natural), show how AES mediates these challenges. Constraints and AES connect to innovative market channel choices (contract, collective, and e-commerce), representing the dependent variable. The expected outcomes of participating in these market channels include improved income, enhanced market participation and sustainability. SHMFs can achieve higher profitability, invest in productive assets and adopt resilient practices to navigate market fluctuations. These outcomes underline the transformative potential of targeted interventions to support SHMFs.

2.8 Chapter summary

This chapter examines the factors that influence smallholder maize farmers' engagement in innovative market channels. This work synthesises essential themes from the literature to establish a conceptual framework that delineates the critical variables, relationships and outcomes related to SHMFs' market choices. This chapter contextualises the significance of maize production in South Africa's agricultural framework, highlighting its contribution to food security and rural livelihoods. The analysis explores market participation dynamics among SHMFs, emphasising the increasing significance of innovative market channels, including contract farming, collective markets and e-commerce, in improving SHMFs' access to profitable opportunities.

The chapter subsequently examines AES as a crucial intermediary in the choice-making process. AES enables the transfer of knowledge, skills and resources, allowing SHMFs to address constraints and make informed market choices. The significance of AES in addressing issues such as insufficient information, restricted credit access, and inadequate infrastructure is emphasised. This chapter analyses the constraints encountered by smallholder maize farmers, encompassing financial, physical, social, human, and natural barriers, and assesses how these factors affect their participation in market channels. This highlights the need for targeted interventions to alleviate these constraints and enhance the market participation of SHMFs.

The conceptual framework synthesises these components, offering a visual and narrative representation of the interconnections among SHMFs, AES, constraints, market channel selections and expected outcomes. The framework provides a basis for examining the factors that influence SHMFs' choices. The chapter concludes by highlighting the anticipated results of engaging in innovative market channels, such as increased income, greater market participation and sustainability, thereby emphasising the potential for significant transformation in smallholder farming systems. This chapter is followed by Chapter 3, which discusses the methods of data collection and analysis.

CHAPTER THREE: MATERIALS AND METHODS

3.1 Introduction

This chapter outlines the specific materials and methods for locating, selecting, processing and analysing information on the subject. The subsequent portion of the section adheres to a defined structure. The document includes a study map that outlines the study area, research design, sampling techniques, and data collection methods. The chapter concludes with a description of the variables used in the data analysis. This section also incorporates ethical considerations, the validity, and the reliability of the structured questionnaire, and concludes with a chapter summary.

3.2 Study area

The research was conducted in 10 villages within the Chief Albert Luthuli Local Municipality, located in the Gert Sibande District of Mpumalanga Province. Mpumalanga is one of the nine provinces in South Africa and is home to three districts, as shown in Appendices 3 and 4. Chief Albert Luthuli is the second-largest municipality in the district, with a population of 187,935, of whom 89.4% are African (Statista, 2024). The predominant language used in Chief Albert Luthuli is siSwati. This is followed by IsiZulu, English, and Afrikaans, which are prevalent in the community and are influenced by its proximity to KwaZulu-Natal and cultural interactions with adjacent areas. SiSwati is the predominant language, spoken by 78.7% of the population

The municipality comprises multiple communities, including Badplaas, Bettysgoed, Carolina, Nhlazantse, Dullstroom, Dundonald, Glenmore, Nhlaba, Mooiplas, Tjakastad, eMpuluzi, Mayflower, Oshoek, and neighbouring villages, all shown in Appendix 5. The communities in question are rural and have limited access to infrastructure and AES. Agriculture is the cornerstone of the municipality, sustaining the livelihoods of its people, with maize farming the most widely grown crop, followed by livestock and vegetable production. Chief Albert Luthuli ranks as the second-largest local municipality in the Gert Sibande district, following Govan Mbeki (Municipalities of South Africa, 2021).

The district constitutes the largest segment of the Mpumalanga Province, which has a total land area of 76,495 km² (Municipalities of South Africa, 2021). A significant portion of the population participates in smallholder agricultural practices, especially for maize production. The Chief Albert Luthuli serves as a gateway to some of Southern Africa's premier agroecological zones, thanks to its temperate climate. The region experiences moderate to high rainfall, with an average annual precipitation of 800-1,200mm (South African Weather Service, 2021). The region experiences clearly defined wet and dry seasons, characterised by average summer temperatures of 30 degrees Celsius and winter temperatures of approximately 15 degrees Celsius (South Africa Weather Service, 2021).

In the first week of October 2023, following the approval of the study topic as outlined in Appendix 1, the research team visited the area to evaluate its suitability for the research. The visits covered Msukaligwa Local Municipality and Chief Albert Luthuli. The aim was to confirm whether maize farming is dominant among SHFs and to assess whether they market their produce. These visits were instrumental in pinpointing the municipality that would serve as the research site. Additionally, the visit helped identify key individuals to approach for permission to survey in various villages, note the languages spoken, and engage with traditional authorities to facilitate access to different areas. The research team also established connections with relevant stakeholders, like Timbali Incubator, Grain SA, and other NGOs, who collaborate with the department in providing AES.

Chief Albert Luthuli stands out as an exemplary agronomic-producing area within Mpumalanga, leveraging its advantageous climate. Despite their potential, SHFs face various constraints that impede their ability to access and benefit from innovative market channels, thereby limiting their profitability (Famo and Machate, 2023). Issues such as insufficient mechanisation, post-harvest losses, insufficient numbers of extension agents, and limited access to high-quality seeds hinder SHFs from expanding their market reach (Famo and Machate, 2023). Despite the constraints, there is a move towards improved innovative market channel choices with the opening of the Mpumalanga International Fresh Produce Market in Nelspruit. This market is poised to boost local food access and create job opportunities, thereby reducing poverty in the province.

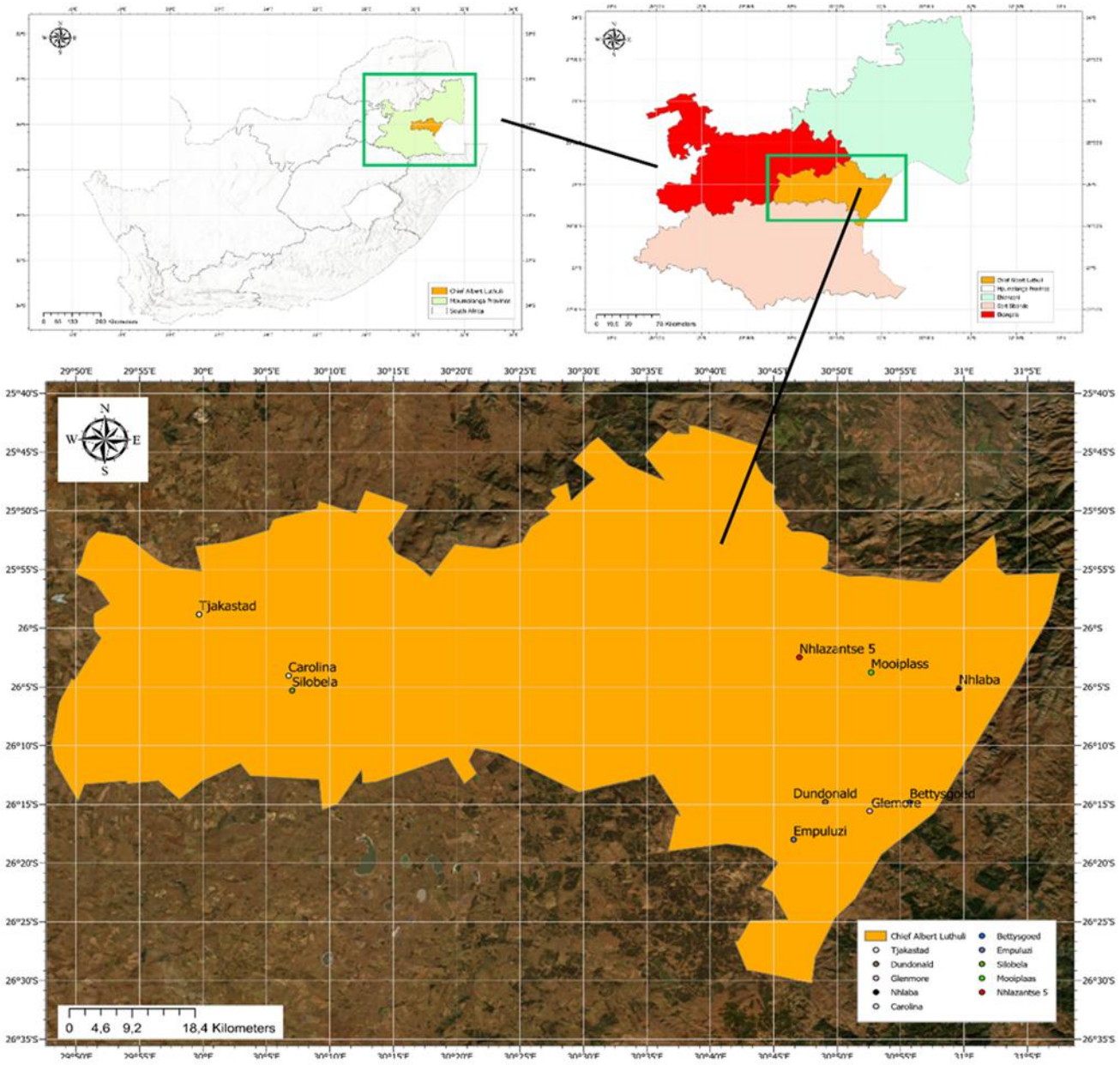

Figure 3: Map of Chief Albert Luthuli Local Municipality designed using AcrGis

Source: (Author, 2024)

3.3 Research design

A quantitative research design was used to conduct the study, aiming to systematically explore the factors influencing SHMFs' choice of innovative market channels. The approach is commonly used to identify constraints and social issues, enabling the collection of numerical data and its conversion into meaningful insights, such as frequencies, percentages, and regression results (Rana, Gutierrez, and Oldroyd, 2021; Suhaila, 2021). Additionally, moving beyond descriptions and examining the relationships between SHFs' socio-economic factors, their access to AES, testing causal effects, and how these elements influence farmers' choice of market. Rana *et al*. (2021) define a research design as an overall plan or strategy for investigating a research problem, serving as a blueprint for conducting a study. A research design refers to a structured series of steps followed to gather, analyse, and generalise findings from a larger population (Bauer, Churchill, Mahendran, Walwyn, Lizotte and Villa-Rueda, 2021). Its purpose is to guarantee that the data collected allows the researcher to provide a concise answer to their initial question. Moreover, Suhalia (2021) argued that quantitative design involves a methodical approach to studying observable phenomena by collecting measurable data and utilising computational, mathematical and statistical methods. The research design has been strongly supported in comparable studies carried out by Zondi, Ngidi, Ojo, and Hlatshwayo (2022) and Zondo and Ndoro (2024).

Quantitative research methods offer significant benefits for researchers across various sectors, enabling the use of structured questionnaires, as illustrated in Appendix 8, to collect data. This strategy improves objectivity by minimising the influence of personal biases on data interpretation. Additionally, the strategy ensures that all 272 participants respond in a consistent order. This standardisation was critical to ensuring that responses were comparable and reducing the risk of bias during interviews. The questionnaire collected data on farmers' demographics, farm operations, and marketing strategies, which were then used in econometric models such as Propensity Score Matching (PSM) and Multinomial Logistic Regression (MNL). The choice of a quantitative design was particularly fitting given the large sample size of 272 participants from ten villages within the Chief Albert Luthuli Municipality. Recording the data in numerical format enabled identification of trends and differences among the villages (see Appendix 5 for details on the village distribution in the study). Through this approach, the research effectively compared farmers with access to AES with those without and assessed the likelihood of opting for innovative marketing channels, such as contracts, cooperatives, or e-commerce.

3.4 Sampling and population

3.4.1 Target population

The target population refers to the specific group of individuals the researcher aims to study and draw conclusions from (Hossan, Dato' Mansor, and Jaharuddin, 2023). The findings of the study will be applicable to a wider population (Hossan *et al*., 2023). A specific target population enables narrowing research objectives, refining data collection methods, and applying suitable statistical techniques (Suhalia, 2021). This enhances the precision and accuracy of the study's findings, as the investigation is customised to the characteristics and attributes of the group of interest (Hossan *et al*., 2023). Suhalia (2021) indicated that establishing a target population in a quantitative research study improves the study's validity, reliability, efficiency and comparability.

The study targets SHMFs registered and receiving AES, production inputs, and training opportunities within the province, residing in Chief Albert Luthuli. There are 928 registered SHMFs, as listed in a document received from a Grain SA Agricultural Advisor for Mpumalanga (Grain SA, 2023). Using the list provided by Grain SA, which assisted in ensuring that the study included actively engaged and verifiable maize farmers who are expected to participate in current support initiatives, such as receiving AES, production inputs, and training on maize production and marketing. The listing of SHMFs in Grain SA's database for administrative and outreach purposes is referred to as 'farmer registration' in this study. By registering, Grain SA can find and contact possible recipients for upcoming extension, input support, or training initiatives. A farmer, however, does not always receive AES just because they are registered. Only registered group members who actively participated in mentorship programs, technical advisory sessions, or training were considered to have received treatment (receiving AES), whereas the control group consisted of registered members who did not participate in any AES-related activities.

3.4.2 Sampling method

In this study, the probability sampling method was employed, ensuring that every individual in the population has an equal opportunity to be selected. This research adopted a three-stage technique to select respondents. A multistage design is a technique that involves dividing the population into different stages and selecting samples from each stage (Hossan *et al*., 2023; Makwana, Engineer, Dabhi, and Chudasama, 2023). This method is commonly used when the target population is large and geographically dispersed (Hossan *et al*., 2023; Makwana *et al*., 2023).

Furthermore, it allowed the researcher to obtain a representative sample by systematically selecting participants from various stages or subgroups within the villages in Chief Albert Luthuli, as displayed in Appendix 5. The multistage sampling method was used as follows: In the first stage, Chief Albert Luthuli was purposively selected based on the potential of SHMFs across different villages. The selection of participants was based on specific criteria relevant to the research questions. Secondly, Chief Albert Luthuli was divided based on administrative boundaries, such as villages and communities. Ten villages were proportionally selected from the second stage (see Appendix 5). The villages were randomly selected to represent the number of villages in Chief Albert Luthuli's area. Therefore, bias was reduced, increasing the chances of obtaining a representative sample.

In the third stage, SHMFs were selected within the villages. This third stage involved selecting specific SHMFs within a village. Again, a random sampling approach was used to choose a representative number of SHMFS from the Chief Albert Luthuli. This was achieved by using the list of SHMFs in each selected village from a confidential document of 928 registered SHMFs who are receiving AES from the National Department of Agriculture and Grain SA to calculate the sampling fraction. The proportional selection fraction was used to randomly select participants from villages to determine the required number of participants:

$$\text{Sampling fraction} = \frac{272}{928} = 0.2931 \ (29.31)$$

Therefore, the Proportional allocation to villages (29.31%) overall sampling fraction.

Table 1 represents the summary of the sampling size using a multistage sample. It further indicates the enumerators who administered the questionnaires in each village, thereby clarifying the allocation of data collection responsibilities among the researcher and the three trained enumerators (Ms Sibande, Mr Maseko, and Ms Nkosi).

Table 1: Summary of the Sampling Size

1st stage: Purposively selection of local municipality in the district	**2nd Stage: Random selection of villages**	**Total smallholder maize farmers' population**	**3rd Stage: Random selection of 29.31% of the smallholder maize farmers in the selected villages**	**Enumerator(s) who collected data**
Chief Albert Luthuli Local Municipality	**Selected 10 villages**	**Total smallholder maize farmer population**	**Selected Sample size**	
	Bettysgoed	34	10	Ms Sibande
	Carolina	44	13	Mr Maseko and Researcher
	Dundonald	152	45	Ms Sibande and Researcher
	Glenmore	27	8	Ms Sibande
	Mooiplas	286	84	Ms Nkosi, Mr Maseko and Researcher
	Mpuluzi	50	15	Ms Nkosi
	Nhlaba/ Oshoek	68	20	Mr Maseko
	Nhlazantse 5	155	45	Ms Nkosi and Researcher
	Silobela	46	13	Mr Maseko
	Tjakastad	66	19	Ms Nkosi and Researcher
Total sample size			**272**	

3.4.3 Sampling size

It is essential to determine a suitable sample size that accurately represents the target farmers when conducting a research study. A sample size is defined as the number of elements or units that constitute the sample (Hossan *et al*., 2023). The size of a sample is determined by several factors, including the study's objective and scope, the population's characteristics, the sampling method, and the estimation process. A Raosoft sample size calculator was used to determine the sample size of smallholder maize producers involved in the study.

This online tool enables researchers to determine an optimal sample size based on characteristics such as population size, desired confidence level, margin of error and estimated proportion within the population (Raosoft Inc., 2023). Multiple parameters were used to calculate the specified sample size. The sample size must be sufficient to ensure a certain level of confidence in the results. Secondly, it must determine the margin for standard procedures and for testing errors. A confidence level of 95% was desired, accompanied by a 5% margin of error (Raosoft Inc., 2023). The Raosoft Corporation was recommended as a sizing calculator to ascertain the sample size. The calculator calculates the sample size, n, utilising the subsequent equations:

$$N = {}^{N\,x}/_{((N-1)E^2 + x)} \quad \ldots\ldots 1$$

$$x = Z({}^{c}/_{100})^2 r(100-r) \quad \ldots\ldots 2$$

$$E = \mathrm{Sqrt}[{}^{(N\,-\,n)x}/_{n(N-1)}] \quad \ldots\ldots 3$$

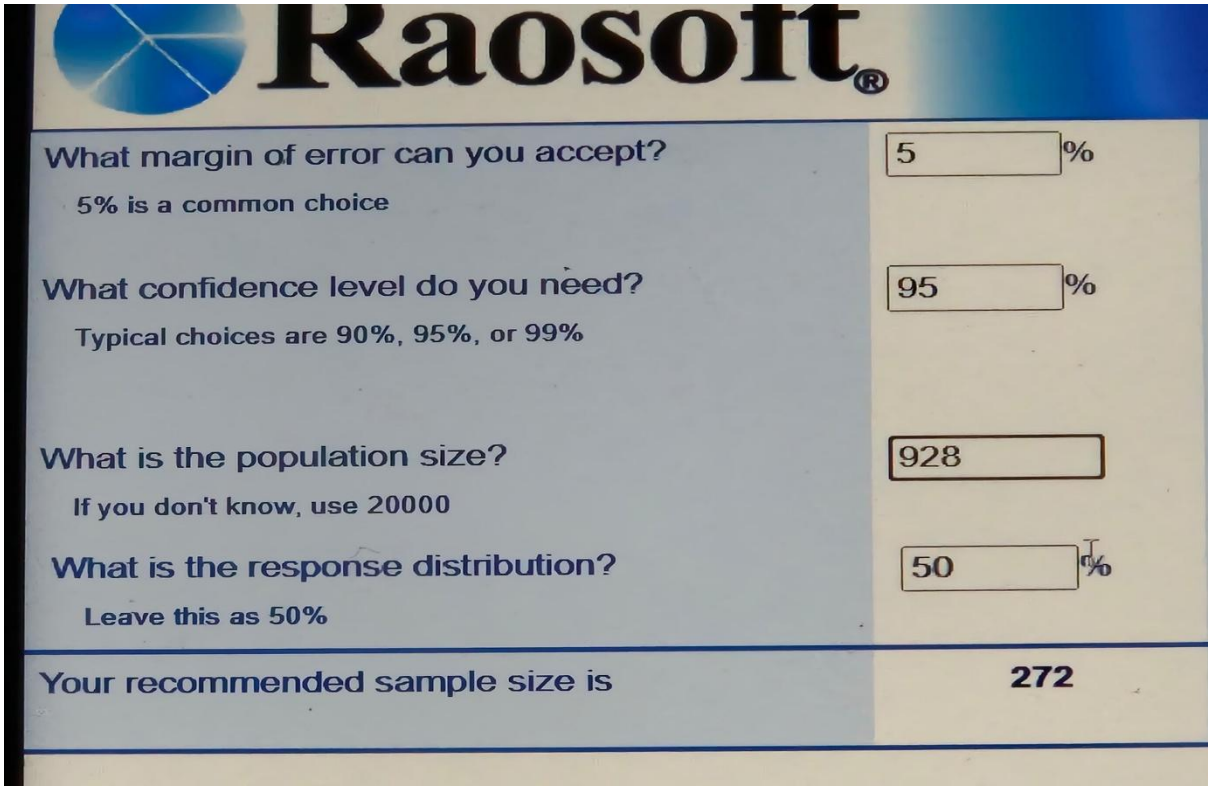

Figure 4: Raosoft Sample Size Calculator

Where N is the population size, E is the margin of error (5%)

r is the fraction of responses (50%) and

Z(c/100) is the critical value of confidence level c (5%)

The population size of (N) registered smallholder maize farmers is 928 individuals, who are registered to receive AES (Grain SA, 2023). For a population (N) of 928 smallholder maize farmers, using the Raosoft online calculator with a margin of error of 5% and a fraction (r) of interest of 50%, the sample size was 272 respondents. Those who willingly volunteered to participate in the study.

The benefit of using the Raosoft sample size calculator is in its provision of a statistically robust method for ascertaining an appropriate sample size for research. Using the Raosoft sample size calculator, researchers can quickly and efficiently obtain sample size estimates, thereby optimising their time and resources. Additionally, the Raosoft sample size calculator benefits researchers by being precise, adaptable, efficient and enhancing generalizability. Thus, enabling researchers to make informed judgments about their study design while optimising resources. This program obviates the necessity for intricate human computations, minimising potential errors and conserving crucial research time. Establishing an adequate sample size is essential for obtaining credible research results that adequately represent the characteristics of the target population.

3.5 Data collection

A structured questionnaire was used to collect the primary data. Suhalia (2021) characterised a structured questionnaire as a research tool comprising a predefined collection of questions presented to participants in a particular order. This approach is frequently used in surveys and other data-collection methods to obtain information from individuals (Suhalia, 2021). Structured questionnaires comprise a consistent format and phrasing of the questions. The questions are structured so that respondents have a range of answer choices (see Appendix 8). This facilitated a more straightforward analysis and comparison of data, as the responses were quantified and categorised.

The benefits of using structured questions are varied; they provide clear, consistent data collection, as every participant is presented with an identical set of questions and response choices (Suhalia, 2021). This facilitates the comparison and analysis of responses, ensuring reliable results. Rana *et al*. (2021) argued that structured questionnaires enhance data processing efficiency, as responses can be readily coded and entered into statistical analysis. This facilitates significant comparability across studies or populations, as the questions remain consistent. Consequently, they are frequently viewed as more efficient and cost-effective than alternative approaches such as open-ended interviews.

The study hired three trained enumerators, in addition to the researcher, to assist with data collection. The researcher conducted a one-day training workshop at the University of Mpumalanga prior to fieldwork. During the workshop, enumerators were oriented on the study objectives and taken through each questionnaire item. Additionally, enumerators were trained in accurate translation into local languages and guided on the proper administration and collection of structured questionnaire responses to ensure reliable, standardised data collection. The respondents were in villages such as Bettysgoed, Carolina, Nhlazantse 5, Dundonald, Glenmore, Nhlaba, Mooiplas, eMpuluzi, Oshoek, and Silobela, which were identified as having higher populations of registered SHMFs receiving AES (see Appendix 5). Fieldwork photographs (see Appendix 6) provide further evidence of data collection activities in the selected villages, demonstrating the engagement of respondents and the researcher during the data collection period. The trained enumerators who collected the data ensured that all questions were correctly interpreted in the respondents' mother tongues. Clear roles and village allocations were assigned to the researcher and each of the three enumerators to ensure accountability and precise documentation of who administered questionnaires in each village.

Despite facing constraints during data collection, such as respondents being unavailable and incomplete questionnaires, enumerators successfully gathered 272 completed questionnaires. Before data collection began, a pilot study was conducted in March 2024 across three villages: Nhlazantse 5, Carolina, and Tjakastad, involving 27 participants. This pilot was conducted to improve the clarity, relevance, and efficiency of the questionnaire, and to record the time required to complete one questionnaire (25 to 40 minutes). The structured questionnaire was divided into four sections: respondents' demographics; innovative market channels used; access to and impact of AES; and constraints encountered in choosing innovative market channels, all using the sustainable livelihood framework.

Data collection took place from April 1, 2024, to the end of July 2024 (participants filled in the questionnaires, later coded and analysed). The list of registered SHMFs was divided equally per village, with each enumerator assigned a specific number to administer the questionnaire. The process presented numerous challenges, including the unavailability of participants. However, if a respondent was unavailable, withdrew, or failed to complete the questionnaire during face-to-face administration, the questionnaire was discarded, and a new respondent was selected from the provided list of farmers. Data were collected through the administration of structured questionnaires during farmers' days, and the questionnaires were completed under the supervision of the enumerator and the researcher.

The researcher and trained enumerators personally administered the questionnaire and stayed throughout the process to address any questions or concerns that arose during times convenient for the respondent, including weekends. These efforts helped achieve the full target of 272 SHMFs, although the process was time-consuming. All the surveys were interpreted in the respondent's home language. Moreover, all trained enumerators were expected to share their live locations and geographic coordinates for every farm they visited to maintain accountability and spatial accuracy during fieldwork. The researcher verified that enumerators were physically present in the designated villages by receiving their coordinates in real time via WhatsApp. A geospatial map was created using the recorded coordinates to show the precise locations where data were collected across the 10 sampled villages (see Appendix 5 for the mapped data collection points). Upon completion of data collection, the researcher cleaned (correcting errors, inconsistencies, and missing values) in each questionnaire and coded the data into a codebook, digitising the responses numerically into Microsoft Excel before exporting them to SPSS and STATA for analysis.

3.6 Data analysis

Data analysis is the method of organising, arranging, and interpreting extensive datasets to establish structure, context, and significance (Suhalia, 2021). Bauer *et al*. (2021) contend that data analysis involves a methodical approach to collecting, evaluating, and interpreting data through various statistical and logistical methods and processes. Quantitative data analysis, as articulated by Suhalia (2021), entails the scrutiny of numerical data or information that can be easily converted into numerical representation without compromising its relevance. Primary data was gathered from registered SHMFs in Chief Albert Luthuli, and thereafter, underwent coding, cleaning and arrangement in a Microsoft Excel spreadsheet. The data was later transferred from the Excel spreadsheet into STATA version 15 for analysis. The analysis used Multinomial Logistic Regression, Propensity Score Matching and descriptive statistics. The following are comprehensive descriptions of the utilisation of certain analytical instruments

3.6.1 Econometric Specification

The choice of marketing channels was crucial for SHMFs, requiring a thorough evaluation of conditions to support informed choice-making. The choice of a producer's marketing channel was guided by RUM. The model proposed that the choice to engage in a marketing channel depended on the maximisation of an underlying utility function, with SHMFs choosing a channel based on their individual expected utility (Greene and Hensher, 2010). Greene (2024) indicated that a typical farmer is expected to recognise marketing channel options.

This study analyses SHMFs' access to four marketing outlets: contract, collective, e-commerce and farmgate. The utility of SHMFs involved in marketing channel choice j was represented by Uij. Smallholder maize farmers projected marginal benefit-cost calculations depend on the utilities derived from selling their products through diverse marketing channels. The utility formula for Uij is expressed as follows:

Ui(j=k)= ßj=k Xij+ Eij ……..……...…….1

The utility Uij for each SHMF choosing a specific channel for marketing is expressed as a linear function of the vector of marketing channel choice parameters βj, the attributes of that alternative Xij and a stochastic error component ϱij.

The utilities were not directly observable; nonetheless, an SHMF chose the option that yielded greater utility (Greene, 2024). The probability of selecting an alternative is contingent upon the utility of that alternative being greater than or equal to the utilities of all other alternatives in the choice set. A SHMF identifies an innovative marketing channel j = k under the following conditions:

Ui(j=k) greater Ui(j=k) AK=j ……..…….2

Uij represents a random utility linked to marketing channel choice j = k; βj=kXij represents an index function that captures the producer's average utility regarding this option; and ϱij indicates a random error specific to the utility preference of a producer.

3.6.2 Multinomial logit model for innovative market channel choices

The MNL model was utilised to assess the factors influencing marketing channel selection. The study extensively utilised the model, with multiple-choice questions serving as dependent variables. Greene (2024) indicated that if the probability of the ith farmer selecting the jth of four choices is Pij, the probability of a farmer selecting alternative j can be represented by the MNL model as follows:

$$Pij = \frac{\exp(ßjXi)}{1+\sum_{j}^{4}=1\ exp(ßjXi)} \qquad \text{For j= 1, 2, 3, 4}\ldots\ldots..\ldots\ldots\ldots.3$$

Xi represented a vector of all independent variables influencing the marketing channel choice of the ith farmer, while βj denoted a vector of regression parameter estimates associated with alternative j. The selection of marketing channels is denoted as follows: j = 1 indicates a farmer has chosen category 1, j = 2 indicates a choice of category 2, j = 3 indicates a selection of category 3, and j = 4 indicates a selection of category 4.

The coefficients for the independent variables in the omitted or reference category were set to zero to estimate conditional probabilities of marketing channel choice, specifically for category 3 (Greene, 2024). By setting β4 = 0, the probabilities for the ith farmer across the three other categories are defined as j = 1, j = 2 and j = 3. We estimated as follows:

$$Pi(j=m/xi) = \frac{\exp(ßjXi)}{1+\sum_{j}^{3}=1\ exp(ßjXi)} \qquad \text{For } 0 < m > 4 \ldots\ldots 4$$

The coefficients in the MNL model were assessed to identify positive and negative associations with marketing channels.

A positive association with a farmer enhanced the probability of selecting it as a marketing channel while reducing the likelihood of choosing a reference category. A negative sign indicated that a relationship with a farmer reduced the likelihood of selecting it as a marketing channel, while increasing the likelihood of selecting the reference category. The marginal effect of probability on each independent variable was examined in relation to the price-volume relationship that influenced the marketing channel. Consequently, a formula for the marginal effect is presented below.

$$\frac{aPj}{aXi} = Pj\ [ßj - \textstyle\sum_{j}^{4} = 0\ Pjßj] = Pj[ßj - ß]^{-} \ldots\ldots 5$$

Pj represented the probability that a farmer selected a particular market, indicating a choice of market channel. j and ß represent a vector of regression parameter estimates associated with alternative j (Greene, 2024).

Dependent variables

The dependent variables represent three innovative marketing channel options utilised by SHMFs in the study area for selling their products: (1) contract, (2) collective, (3) e-commerce, and) traditional market channel 4 the farmgate. The MNL model estimation predicted the relative probability of SHMFs selecting one of four categories based on the independent variables. The farmgate channel was established as the reference category.

Independent variables

All independent variables were assigned based on the foundational theory of the market participation behaviour model, which is premised on utility maximisation. The model's fundamental assumption posits that a farmer, aiming to maximise utility as a seller, operates as a function of exogenous variables.

The variables encompassed public-private goods and services, including household socioeconomic characteristics, demographic characteristics, road quality, extension services, marketing information, and commodity prices, which may influence output.

The research utilised 12 independent variables, including gender (GEN), age (AGE), educational level (EDU), farm size (SIZE), farm experience (EXP), type of farming (TYPFAR), storage facility (STOR), hired farm implements (HIREDIMP), agricultural extension services (AES), distance to the market centre (DIST), training received (TRAN) and mode of transport to the market centre (MODETRA). The empirical MNL model addressing the factors influencing marketing channel choices among smallholder maize farmers is presented below:

$$\text{Pij} = \ln\left(\frac{Pj}{P1}\right) = \beta 0 + \beta 1 \times \text{GEN} + \beta 2 \times \text{AGE} + \beta 3 \times \text{EDU} + \beta 4 \text{ X SIZE} + \beta 5 \times \text{EXP} + \beta 6 \text{ X TYPFAR} + \beta 7 \text{ X STOR} + \beta 8 \text{ X HIREDIMP} + \beta 9 \text{ X AES} + \text{B10 XDIST} + \text{B11 X TRAN} + \text{B12 X MODETRAN}$$

Where $\beta 0 \ldots \beta 12$: The MNL COEFFICIENTS were estimated; Pij was the probability of marketing channel choices j being selected by each smallholder maize farmer i = Individual (1, 2, 3…., 272); and j = categories:

j = 1 for contract sales

j = 2 for collective sales

j = 3 for e-commerce sales

j = 4 for farmgate sales

Table 2: Description of dependent and independent variables

Table 2 summarises the dependent and independent variables used in the Multinomial Logistic Regression model and their anticipated effects on the choice of innovative market channels. This table outlines the variable names, provides explanations on how they are measured and describes the nature of these variables and their expected signs (Green, 2024). A positive (+) sign indicates that the probability of choosing an innovative market channel is anticipated to increase as the value of those variables rises. On the other hand, a negative (-) sign indicates that a rise in that variable is linked to a decreased likelihood of choosing an innovative market channel.

Table 2: Description of the Dependent and Independent Variables

Variable Name	**Explanation of the variable**	**Measurement**	**Nature of the variable**	**Expected sign**
Dependent variable				
Innovative market channel	Sales to contract, collective and e-commerce		Categorical	+
Independent variable				
GEN	Gender of the farmer	1=Female 2= Male	Categorical	-
AGE	Age of the farmer	Years	Continuous	+/-
EDU	The highest level of formal education of a farmer.	Completed level	Categorical	+
SIZE	Total land used for maize production	Hectares	Continuous	+
EXP	Years of farming experience	Years	Continuous	+
TYPFAR	Type of farming	1= Rainfed 2= Irrigated	Categorical	-
STOR	Type of storage facility for the maize produce	1= None 2= Grain mud huts 3= Metallic silo	Categorical	+
HIREDIMP	Hired farm implements	1= None to 13= Thresher	Categorical	+/-
AES	Access to agricultural extension services	1= Yes 2= No	Categorical	+
DIST	Distance to the desired market centre	Kilometres	Continuous	+
TRAN	Vehicle ownership	1= None 2= Bakkie 3= Car	Categorical	_
MODETRAN	Mode of transport to the market centre	1= None 2=Own 3= Individual Hire 4= Collective hire 5= Public transport	Categorical	+

In the model, the choice of innovative market channel comprises twelve independent variables, which are discussed below.

Gender of the farmer (GEN)

Gender is expected to negatively influence market channel preferences among SHMFs in the study area. The gender of the SHMFs was recorded in a category. Male SHMFs demonstrate a greater propensity to engage in innovative market channels, attributed to superior access to resources, social networks and mobility (Mmbando *et al.*, 2016). In contrast, female SHMFs frequently face constraints, including limited land ownership rights and insufficient access to market information, which restricts their engagement in innovative market opportunities (Nangobi and Mugonola, 2018). Consequently, male SHMFs exhibit a stronger inclination to select contemporary marketing methods such as e-commerce or contract sales.

Farmer's age (AGE)

The age of a farmer is expected to have both positive and negative influences on the selected market channel. The age of the SHMFs was recorded as a continuous variable. Young SHMFs demonstrate a greater propensity to adopt innovative avenues, such as e-commerce, by leveraging technology to expand their market access (Arinloye, Pascucci, Linnemann, Coulibaly, Hagelaar, and Omta, 2015). Equally, older SHMFs favour traditional local markets due to their lower technological demands and reduced perceived risks (Arinloye *et al.*, 2015). Consequently, age is expected to exert a differential influence: younger SHMFs are inclined towards innovation, whereas older SHMFs prefer farmgate sales.

Level of education (EDU)

Education is expected to positively influence market channel preferences among SHMFs in the study area. The SHMF education was categorised. Education enhances SHMFs' ability to obtain and analyse market information, thereby facilitating improved decision-making regarding market channels. Individuals with higher education are more likely to engage in collective sales or e-commerce due to their enhanced negotiation abilities and competent market risk assessment (Andaregie, Astatkie, and Teshome, 2021). In maize farming, educated farmers are more likely to utilise marketing platforms that enhance profitability and reduce transaction costs.

Total area used for maize production (SIZE)

Farm size is expected to positively influence market channel preferences among SHMFs in the study area. The farm experience of the SHMFs was recorded as a continuous variable. The extent of a farmer's land significantly influences their selection of market channels. SHMFs with larger plots are better at producing surplus crops for commercial use, and research suggests that these farms often engage more in formal markets, such as contractual agreements or cooperatives, reaping the advantages of economies of scale (Abate, Mekie, and Dessie, 2019). Similarly, smaller farms are sometimes limited to local or informal markets because of their constrained production capacity.

Farmers' experience (EXP)

Farm experience is expected to positively influence market channel preferences among SHMFs in the study area. The farm experience of the SHMFs was categorised. Experience shapes SHMFs' perceptions of market dynamics and improves their ability to establish enduring relationships with buyers. Individuals with substantial expertise are more likely to participate in collective or contract sales owing to the trust they have established with stakeholders and their access to advanced market information (Abate *et al*., 2019). Moreover, seasoned SHMFs leverage their knowledge to obtain favourable conditions in emerging markets.

Type of farming (TYPFAR)

The type of farming is expected to negatively influence market channel preferences among SHMFs in the study area. The type of farming practised by the SHMFs was recorded as a categorical variable. Agricultural systems, whether rainfall-dependent or irrigated, significantly influence productivity and market channel choices. Rainfed SHMFs commonly experience production fluctuations, prompting them to adopt risk-averse strategies such as direct selling at the farm gate (Nangobi and Mugonola, 2018). In contrast, irrigated agriculture enables more reliable harvests, allowing SHMFs to explore more robust and innovative marketing avenues, such as contractual agreements or e-commerce platforms.

Access to storage facility (STOR)

Access to storage is expected to positively influence market channel preferences among SHMFs in the study area. Access to SHMF storage was categorised. The accessibility of storage facilities is essential for market engagement. SHMFs utilising modern storage options, such as metallic silos, are more likely to engage in collective or contract sales because they can retain food until market conditions improve (Grain SA, 2023). In contrast, those lacking sufficient storage often opt to sell promptly at reduced prices via informal channels.

Hired implements (HIREDIMPL)

Access to hired implements was categorised and expected to have both positive and negative influences on market channel selection. Access to and use of rented agricultural equipment, such as tractors, planters, and threshers, can significantly influence SHMFs' market channel choices. Renting such implements often increases productivity and efficiency, enabling engagement with innovative market channels, such as contract farming or collective sales. Reducing labour intensity and enhancing timeliness in agricultural operations by enabling SHMFs to access machinery enables them to produce higher-quality goods, which is essential for entering formal, profitable markets. However, the costs associated with acquiring these tools may hinder SHMFs, limiting their competitiveness in high-value markets (FAO, 2023).

Access to agricultural extension services (AES)

Access to AES was categorised and expected to have a positive influence on market channel selection. Extension services improve SHMFs' market awareness and technological competencies, encouraging participation in innovative channels. SHMFs who utilise these services demonstrate a greater tendency to opt for collective sales or e-commerce, attributed to enhanced marketing and quality control capabilities (Kalogiannidis and Syndoukas, 2024). These programs mitigate barriers to market entry and enhance decision-making processes.

Distance to marketplace centre (DIST)

Distance to the market was coded as a continuous variable and was expected to positively influence market channel selection. Proximity to markets affects transportation costs and overall profitability. SHMFs situated near urban centres demonstrate a greater propensity to utilise e-commerce or direct sales channels, thereby minimising logistical costs (Buckmaster, 2012). Conversely, SHMFs located farther away typically rely on traditional marketplaces or collective selling strategies that offer economies of scale.

Vehicle ownership (TRAN)

Vehicle ownership was categorised and was expected to negatively influence market channel selection. The possession of a vehicle improves mobility and facilitates access to distant, significant markets. SHMFs that possess their own transportation are more inclined to participate in e-commerce or contract sales, thereby reducing their dependence on intermediaries (Buckmaster, 2012). In contrast, individuals without access to vehicles often rely on public or shared transportation, which can limit their market opportunities.

Transportation (MODETRA)

The mode of transport for hired implements was categorised and expected to have a positive influence on market channel selection. The choice of transport to market centres influences both expenses and accessibility. SHMFs that use individual or collective transportation are more likely to participate in formal markets, such as cooperatives, that rely on dependable supply chains (Buckmaster, 2012). Conversely, individual's dependent on public transportation frequently face logistical challenges that impede their competitiveness in innovative sectors.

3.6.3 The Propensity Score Matching Model (PSM)

The study used PSM to assess the influence of AES on SHMFs' selection of innovative market channels in the region. According to Williamson and Forbes (2014) and Jagadeesh, Mzuyanda, and Letsoalo (2024), PSM refers to pairing treatment and control units with similar values on the propensity score and possibly other covariates, and discarding all unmatched units (Greene, 2024). It is primarily used to compare two groups of subjects but can be applied to analyses of more than two groups. Generally, if a treated subject and a control subject have the same propensity score, the observed covariates are automatically controlled for.

Therefore, any differences between the treatment and control groups will be accounted for and will not be due to the observed covariates. Williamson and Forbes (2014) argued that a statistical matching technique is used to estimate the likelihood of treatment participation and then match participants (treated) and non-participants (control) with similar propensity scores. This allows for an unbiased comparison of outcomes such as market channel adoption between farmers who received extension services and those who did not, controlling for observable differences.

PSM denotes a conditional probability of SHFs adopting new technology, contingent on pre-adoption characteristics (Mdoda *et al*., 2022). Therefore, it is essential to minimise potential bias arising from the selection problem when utilising non-experimental data (Ndoro, Mudhara, and Chimonyo, 2014). PSM is a technique that pairs treatment and control units based on similar propensity scores and additional covariates, while omitting any unmatched units. This method has become increasingly popular for evaluating effects Ndoro *et al*., 2014; Wordofa, Hassen, Endris, Aweke, Moges, and Rorisa, 2021; Mdiya *et al*., 2023; Loki and Mdoda, 2023; Jagadeesh *et al*., 2024).

A comparison group is established, consisting of individuals with observable characteristics like those receiving treatment. Each treated observation (receiving AES) is paired with households in the corresponding control group (not receiving AES) using a weighted-average method. The average shows an inverse relationship with the distance between the two groups' propensity scores. Each treated observation is matched with its nearest control counterpart based on the propensity score. The scores indicate the probability that each farmer will receive AES. The p-scores produced by the probit model in the initial stage regression range from 0 to 1. A score closer to one indicates a higher likelihood of receiving AES, whereas a score closer to zero indicates a lower likelihood.

Loki and Mdoda (2023) stated that PSM is based on the confounding assumption, also known as the conditional independence assumption. This suggests that when Z is considered, access to the extension group is determined by randomness and is not correlated with outcome variables. Under these conditions, it is crucial for the treatment to be exogenous; thus, any systematic differences in outcomes between groups receiving different treatments while sharing identical characteristics can be attributed solely to the treatment itself.

The second assumption, referred to as common support or overlap, guarantees that individuals or groups with the same values for characteristic X have a positive probability of being classified as both SHMFs who receive access to extension services and those who do not. Thus, PSM serves as an effective approach for assessing the influence of agricultural extension services on smallholder maize farmers' choices regarding innovative marketing channels, informed by their production volumes and sales data. SHMFs with access to extension services constituted the treatment group, whereas those lacking such access formed the control group. The average effect of accessing extension services on SHMFs' income was assessed by matching and comparing their farm incomes. The probability of receiving treatment, contingent upon pre-treatment characteristics, is detailed below:

$P(X) = P_R [D = \frac{1}{X}] = E [\frac{D}{X}]$ ……1

In this context, D = [0,1] represents the degree of treatment exposure, while X denotes pre-treatment characteristics. The treatment's effect illustrates the variability of SHMFs' welfare based on their access to AES. Consequently, T is assigned a value of 1 for SHMFs with access to AES, and 0 for those without such access.

$\mathbf{T} = Y_i(1) - Y_i (0)$……....2

Let Y_i^T represent the quantity produced by the group that received treatment (SHMFs receiving AES) and Y_i^C denote the quantity produced by the control group (SHMFs not receiving AES). The difference in quantity produced between the treated and control groups can be expressed as:

$\Delta \mathbf{i} = Y_i^T - Y_i^C$ ……3

Where Δi is the change in quantity produced due to having access to AES. Equation 4 denotes the Average Treatment Effect for the population (ATE):

$\Delta \mathbf{ATE} = E (\Delta i) = E (Y_i^T / D = 1) – E (Y_i^C / D = 0)$ ……4

ATE indicate the effect of quantity produced by SHMFs.

Where:

$E ((Y_i^T / D = 1)$: Quantity produced for individuals who have access (Di =1) or with treatment

$E (Y_i^C / D = 0)$: Quantity produced for individuals without access to AES. Then the average effect of treatment on the treated (ATT) will be

ATT = E (E (Y_i^T - Y_i^C / D = 1) E (Y_i^T/ D = 1) – E (Y_i^C / D = 0) …….5

The successful implementation of PSM requires the assumption of conditional independence and common support. Conditional independence means that the sole determinants of assigning treatment (access to extension services) should be observable, quantifiable factors. Simultaneously, the presumption of common support guarantees that SHMFs with equivalent covariate values possess comparable odds of either obtaining or not accessing extension services. The first step in utilising PSM is to estimate the propensity scores. The scores are encapsulated in a single index number obtained from multiple factors that affect an individual's probability of receiving the treatment. Before generating these propensity scores, it is crucial to select a suitable econometric model.

Table 3: Covariates used in the probit model and their anticipated outcomes, their measurement, nature, and expected signs used in PSM

Table 3 summarises the covariates used in the probit model and their expected effects. This table outlines the variable names, explains how they are measured, and describes the nature of these variables and their expected signs.

Table 3: Covariates used in the Probit Model and their Anticipated Outcomes

Variable Name	**Explanation of the variable**	**Measurement**	**Nature of the variable**	**Expected sign**
Dependent variable				
AES	SHMFs who received access to the treatment (AES) constitute the treated group, while those without this access serve as the control group.	1= Yes 0= No	Categorical	+
Independent variable				
GEN	Gender of the farmer	1=Female 2= Male	Categorical	-
AGE	Age of the farmer	Years	Continuous	+/-
EDU	The highest level of formal education of a farmer.	Completed level	Categorical	+
SIZE	Total land used for maize production	Hectares	Continuous	+/-
EXP	Years of farming experience	Years	Continuous	+
TYPFAR	Type of farming	1= Rainfed 2= Irrigated	Categorical	-
MAIZETYP	Type of maize cultivar produced	1= White 2= Yellow 3= Both	Categorical	-
HIREDIMP	Hired farm implements	1= None to 13= Thresher	Categorical	+/-
SOURCINF	Primary source of agricultural market information	1= Agricultural extension agents 2=Farmer- to-farmer 3= Social media groups	Categorical	+/-
SRCCRDT	Main source of credit	1= None To 6= MEGA	Categorical	+
LANDOWN	SHMFs' land ownership	1= Communal 2= Leased 3= Land Reform 4= Own	Categorical	_
DIST	Distance to the desired market centre	Kilometres	Continuous	+
TRAN	Vehicle ownership	1= None 2= Bakkie 3= Car	Categorical	_
MODETRAN	Mode of transport to the market centre	1= None to 5= Public transport	Categorical	+

Matching methods

PSM enables the estimation of the average treatment effect on the treated (ATT), which represents the change in crop yield resulting from the use of innovative market channels. Only matched observations were retained for the final estimation of treatment effects, thereby improving causal inference and reducing bias. The estimated treatment effect is calculated as

Radius, nearest-neighbour, and kernel-matching methods were used to match SHMFs receiving AES to those not receiving AES, using P-score values to estimate ATET.

To estimate the ATT, three PSM methods were employed:

(a) Kernel-based matching: This matches each treated observation with a weighted average of all control observations within the common support region (Heckman,Ichimura and Todd, 1997)

(b) Nearest neighbour matching: This pairs each treated unit with the control unit that has the closest propensity score (Becerril and Abdulai, 2010).

(c) Radius matching: This match treated units with control units that fall within a specified calliper (range) of propensity scores (Zeweld, Huylenbroeck, Hidgot, Chandrakanth, and Speelman, 2015).

The use of multiple matching techniques helps compare results and assess their robustness. Consistent findings across methods indicate reliability in estimating the treatment effect of innovative market channel choice on maize yields. For each method, the statistical significance of the average treatment effect on the treated (ATT) was evaluated using the t-statistic, yielding a p-value.

3.6.4 Descriptive statistics

The results of the exploration of the constraints SHMFs face when accessing innovative market channels were presented in descriptive statistics. Suhalia (2021) defined descriptive statistics as a branch of statistics that involves summarising, organising, and describing data to gain insights into its main characteristics. Additionally, descriptive statistics is a quantitative summary that encapsulates characteristics of collected data using frequency, averages, percentages and standard deviation (Makwana *et al.*, 2023). Thus, providing a way to represent and analyse data in a meaningful and interpretable manner.

3.7 Ethical consideration

A collection of procedures established to protect research subjects from unethical behaviours relates to ethical issues (Fleming and Zegwaard, 2018). Ethical considerations are crucial for maintaining integrity and safeguarding participants' well-being (Fleming and Zegwaard, 2018). Consequently, this study underwent evaluation and approval by the Research Ethics Committee at UMP, School of Agricultural Sciences, under protocol reference number UMP/Cossa/201734672/MAGR/2023. This study complied with the following ethical principles: informed consent, beneficence, nonmaleficence, and justice.

3.7.1. Informed consent

The principle of informed consent requires obtaining the voluntary, fully informed agreement of participants before their involvement in a research study (Fleming and Zegwaard, 2018). This entails supplying participants with essential information regarding the objective, processes, potential dangers and benefits, as well as the publication of pictures taken during data collection, confidentiality protocols, and participants' rights (Fleming and Zegwaard, 2018). Participants were informed of the research objective before consenting to participate.

The permission statement conveyed the anticipated burden and any potential pain that may arise from participation, including distress stemming from the sensitivity of the questions. The consent statement outlined the potential benefits the survey could confer on both the individual and society. Informed consent requires a clear and concise explanation of the study's voluntary and confidential aspects. This ensured that participants comprehended the nature of the research and provided their consent voluntarily.

3.7.2. Beneficence

The ethical principle that requires researchers to maximise the potential benefits for participants is referred to as beneficence (Bauer *et al.*, 2021). Greene (2024) asserts that it is the researcher's obligation to explicitly delineate the study's objective and the benefits to the participants. (Fleming and Zegwaard, 2018) contended that beneficence is a fundamental element of research ethics, requiring researchers to maximise benefits while minimising potential harm to participants in a study. This project aimed to produce significant, relevant data that enhance scientific knowledge and elucidate the selection of marketing channels, AES, and market restrictions by SHMFs under investigation. Facilitating SHMFs' access to diverse creative market channels for maize sales.

3.7.3. Justice

Justice is defined as the fair and equitable allocation of rights, resources, opportunities and consequences among individuals or groups within a society (Fleming and Zegwaard, 2018). It necessitates ensuring equitable treatment for all individuals, devoid of bias and that they obtain their rightful entitlements in alignment with these principles (Fleming and Zegwaard, 2018). The researcher continually ensured the maintenance of justice throughout the research process, ensuring it was free from any bias or discrimination. The researcher ensured equitable and fair treatment of all participants from the initial recruitment stage through the entire process. All participants received the same questionnaire. All respondents and participants in the research were treated with respect and received appropriate care, with verbal consent obtained at each stage of the process.

3.7.4. Non-maleficence

Non-maleficence is a principle in research ethics necessitating that researchers implement all necessary precautions to avert harm or injury to study participants (Bauer *et al.*, 2021). In survey research, nonmaleficence mandates that researchers must guarantee that the survey questions and processes do not inflict bodily or psychological harm on participants (Fleming and Zegwaard, 2018). To comply with the principle of nonmaleficence in this survey research study, the following measures were considered. This involved refraining from sensitive or stigmatising inquiries and ensuring that the survey did not disrupt participating in everyday routines. The questionnaire explicitly stated that no risks or harms have been identified associated with this research. Participants were permitted to ask about any unclear aspects and could withdraw from the study at any time without providing justification. Furthermore, the questionnaire consisted of closed-ended questions to prevent discomfort or coercion when disclosing personal information.

3.8 Validity and reliability

3.8.1 Reliability of the questionnaire

Reliability in a quantitative survey refers to the degree to which a questionnaire consistently yields stable, dependable results (Yin, 2009). It aims to minimise errors and bias, reflecting the extent to which the instrument yields the same outcomes when administered under similar conditions or repeated with the same respondents (Sheppard, 2004). The questionnaire's reliability was evaluated by an expert panel in agricultural extension and research. The panel consisted of a lecturer in agricultural extension and researchers.

To ensure the consistent quality of the questionnaire. Creswell and Creswell (2017) assert that conducting a pretest is crucial for ensuring the dependability of a study. Pretesting functions as a preliminary trial of the research prior to the dissemination of its questionnaire. This stage is essential since it verifies that all research instruments are properly functional before conducting the primary investigation. Executing a pilot test instils trust in researchers by pre-emptively testing instrument functionality, a crucial factor given the absence of a common design for all scenarios.

As stated by Bauer et al. (2021), interpreting participant surveys is essential, as addressing any possible misunderstandings becomes difficult once they are completed and submitted. The questionnaire was meticulously examined to confirm its alignment with the study's specified objectives. The University of Mpumalanga's research ethics committee granted consent, affirming that all inquiries had been addressed. The structured nature of the questionnaire and pretesting procedures minimised the potential for harm or misunderstanding. As this was a quantitative survey involving non-sensitive agricultural and socioeconomic questions, there was no foreseeable risk or harm to participants.

3.8.2 Validity of the questionnaire

Validity refers to the effectiveness of the research design and questionnaire in accurately assessing a particular variable (Leedy and Ormrod, 2005; Yin, 2009). Verifying the validity of the research instrument ensures that the utilised concepts correspond with the anticipated results of the study (Creswell and Creswell, 2017). The validity of an instrument also determines its design effectiveness. Formulates and assesses the optimal concept in accordance with research standards. Yin (2009) categorised validity testing into three types: content validity, criterion-related validity and construct validity. Data triangulation was employed to identify differences and similarities in the collected data, which was presented through factor analysis. All participants were informed of their right to withdraw at any time during the data collection process if they felt uncomfortable doing so, in accordance with ethical standards. This guarantees adherence to ethical research principles and voluntary participation. To ensure that the questionnaire remained valid, dependable, and morally sound, great care was taken in its wording and sequencing to prevent bias or distress.

3.9. Theoretical framework

3.9.1. Random Utility Maximisation model theory

The study adopted a Random Utility Maximisation (RUM) Model, which serves as a fundamental theoretical framework in choice-making research, especially in the analysis of discrete choices. The theory suggests that individuals make choices by selecting the option that yields the highest perceived utility, influenced by their preferences and constraints (Greene and Hensher, 2010; Greene, 2024). In the context of SHMFs, RUM helps understand the determinants that shape their selection of IMC, such as contracts, collective, and e-commerce. The model hypothesises that each SHMF assesses available options based on observable characteristics (such as access to information) and unobservable factors, including preferences.

The random component in RUM accounts for unobserved factors affecting choice, making it an appropriate tool for examining the complexities and diversity in SHMFs' market-channel preferences. Jagadeesh *et al*. (2024) showed that a typical farmer i was presumed to identify marketing channel choices. In this study, a SHF is exposed to N (4) marketing outlets: contract, collective, e-commerce, and farmgate. The utility of the SHMFs who participated in marketing channel choices j was represented by Uij.

The benefit-marginal cost calculations were expected by SHMFs that depend on the utilities derived from selling their products through one marketing channel or another. The utility framework of RUM is characteristically expressed as:

Ui(j=k) = ßj=k Xij+ Eij ……...…….……...1

Where Uij: was the utility of each farmer selecting a particular alternative was specified as a linear function of the vector of marketing channel choice specific parameters βj and the attributes of that alternative Xij and a stochastic error component ϱij.

We could not directly observe the utilities, but a farmer was shown a choice and indicated which one offered the larger utility (Greene, 2024). The probability of selecting an alternative was equal to the probability that the utility of that alternative was larger than or equal to the utilities of all other alternatives in the choice set. A farmer opted a marketing channel j = k if:

Ui(j=k) greater Ui(j=k) AK=j …….…….2

Where Uij: was a random utility related to marketing channel choice j = k; βj=kXij: was an index function showing the producer's average utility related to this alternative; and ϱij: was a random error specific to the utility preference of a producer.

3.10 Chapter summary

This chapter presented a summary of the research materials and methods used in this study. The methodology outlines a comprehensive framework for investigating the factors influencing SHMFs' selection of innovative market channels in the Chief Albert Luthuli Local Municipality, Mpumalanga, South Africa. The chapter commences with an overview of the study area, emphasising its demographic, geographic and economic attributes. The study employs a quantitative research design to systematically collect and analyse primary data to understand the factors affecting SHMFs' choices of innovative market channels. Employing a multistage sampling technique ensures a representative sample of smallholder maize farmers, thereby enhancing the study's validity and generalizability.

Ethical issues emphasise the necessity of protecting participants' welfare, ensuring informed consent, promoting beneficence, avoiding harm (non-maleficence), and ensuring fairness throughout the study process. Additionally, the chapter outlines the data-gathering methodologies, highlighting the use of structured questionnaires to effectively collect primary data. Primary data were collected efficiently and consistently through the administration of structured questionnaires by trained enumerators. The collected data were analysed using multinomial regression, descriptive statistics, and propensity score matching to elucidate the correlations between diverse independent variables and SHMFs' selections of innovative market channels. The chapter also addresses sample size calculation using the Raosoft sample size calculator, ensuring statistical rigour and reliability alongside the study's reliability, validity, and theoretical framework. The following chapter presents the findings, interprets the results, and examines their importance in relation to the outcomes of other studies.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the results and discussion of an analysis of field survey data collected in the Chief Albert Luthuli Local Municipality, focusing on the factors influencing SHMFs' choices of innovative market channels. A total of 272 SHMFs registered with GrainSA who are receiving extension and advisory services participated in the study. Three enumerators were hired and trained to assist with collecting data from the participants. During data collection, incomplete questionnaires were discarded, and the enumerators continued collecting data from other available participants until 272 complete questionnaires were obtained for analysis. This ensured that only accurate and fully completed responses were included in the final dataset. The socio-demographic and institutional factors are presented in this chapter. Additionally, a comprehensive analysis of the use of innovative market channels by smallholder maize farmers is presented. The influence of AES on the selection of these channels and the constraints encountered in accessing them are also critically analysed. The results are presented using descriptive statistics, a multinomial logistic model, and propensity score matching. Maximum and minimum values, mean, frequencies and standard deviation are used in this chapter to delineate descriptive statistics. This chapter concludes with a chapter summary.

4.2 Demographic information of the participants

The demographic information presented in this section includes socio-economic factors such as gender, age, marital status, highest educational level, cooperative membership, and the name of the cooperatives. Additionally, we examined various farm and production factors, including farm size, farm experience, type of maize produced, type of storage facility, land ownership, and type of farming implements owned and hired. Moreover, institutional and market factors, such as the source of credit, cooperative membership, access to market channel information, access to maize price information, main source of information, distance to the market centre, vehicle ownership, and mode of transport to the market, are presented here.

4.2.1 Gender of the participants

Figure 5 shows the gender of smallholder maize farmers in Chief Albert Luthuli Local Municipality.

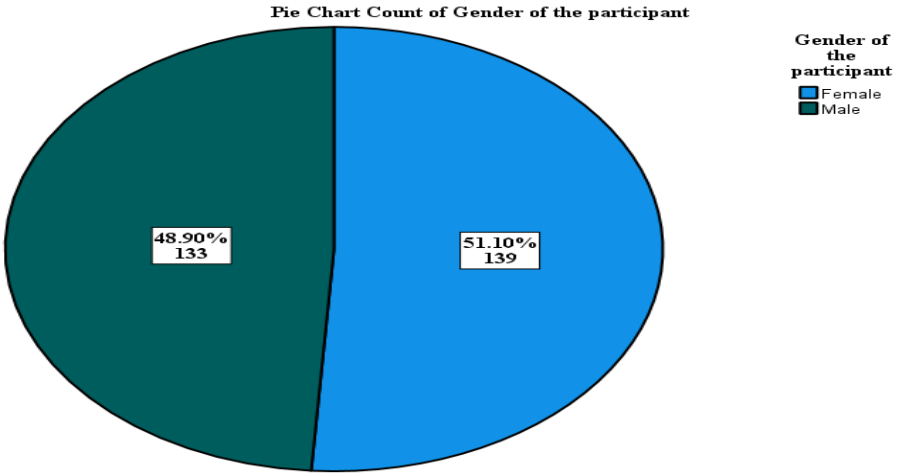

Figure 5: Gender of the participants

Source: Field survey data (2024), analysed by the author using STATA

Figure 5 illustrates the gender distribution of participants, showing that 51.09% (139) were female. On the contrary, 48.90% of the participants (133) were males. The results presented in Figure 5 reveal a modest gender balance, with females constituting over half of the SHMFs, while males constitute a minority compared to their female counterparts. Despite notable advancements in development and gender equity in African nations such as South Africa, the gender distribution of SHMFs in this study effectively illustrates the persistent constraints within our societies. In contemporary African society, women remain integral to agriculture, particularly in Mpumalanga and Limpopo (Hlatshwayo *et al*., 2021; Kalauba, 2019). Smallholder farming relies heavily on women, who play a crucial role in caregiving and providing nutritious food to their families, thereby constituting an essential component of this sector. Research indicates that a significant proportion of women engage in agriculture; however, they necessitate access to market opportunities to enhance their skills and confidence, thereby improving their agricultural practices (Hlatshwayo *et al*., 2021; Kalauba, 2019).

4.2.2 Socio-economic and demographic factors (age, farm experience, farm size and distance to the market centre)

Table 4: Frequency distribution of the socio-economic characteristics

The socio-economic demographics of 272 registered SHMFs at Chief Albert Luthuli are displayed in Table 4. The descriptive analysis reveals that SHMFs are characterised as follows: age, farming experience, farm size, and distance to the market centre. All variables were collected as continuous categories and coded numerically for analysis. Therefore, the reported mean values represent average coded categories, not actual ages, years, hectares, or kilometres.

Table 4: Frequency Distribution of the Socio-economic Characteristics

Categories	Frequency (numbers)	Percentages (%)	Statistics
Age of the participants (years)			
18-35	51	18.8	X=2.15
36-55	130	47.8	σ= .709
56 and above	91	33.5	Min= 1
Total	**272**	**100**	Max= 3
Farming experience (years)			
Less than 5	74	27.2	X=2.03
6-15	133	48.9	σ= .843
16-20	47	17.3	Min= 1
21+	18	6.6	Max= 4
Total	**272**	**100**	
Farm size (hectares)			
Less than 2	57	20.96	X=2.01
3-10	157	57.72	σ= .668
11-20	56	20.59	Min= 1
21+	2	0.74	Max= 4
Total	**272**	**100**	
Distance to the market centre (kilometres)			
Less than 40	64	23.5	X=2.10
41-80	130	47.8	σ= .805
81-120	66	24.3	Min= 1
121+	12	4.4	Max= 4
Total	**272**	**100**	
Please note that: **X**=mean, **σ**= standard deviation, **min**= minimum and **max**= maximum All variables were collected in continuous categories and numerically coded in Excel for analysis. The mean (X) represents the average coded category, not the actual values.			

Source: Field survey data (2024), analysed by the author using STATA

Age

Table 4 displays the age details of the respondents, categorised into 3 groups. The majority of respondents (130) are middle-aged, with 47.8% (36-55). This is followed by the old-age (56 and above) category, which accounts for 33.5% (91). In addition, the SHMF category with the smallest group was 18-35, accounting for 18.8% (51). The mean age is 2.15, with a standard deviation of 0.709. This distribution therefore indicates a predominance of the middle-aged population among the registered SHMFs in Chief Albert Luthuli Local Municipality. Age is a crucial factor in agriculture, particularly in shaping the adoption of innovative market channels. This finding suggests a balance between the youth and the elderly in the sample who are actively involved in maize farming.

Similar results were reported by Pickson and He (2021), who found that among China's SHFs, 51.4% are aged 35-55. In contrast, Masuka *et al*. (2016) found that 62.79% of the participants were aged 31 to 60. Likewise, Omotayo et al. (2021) reported that SHFs in the Northwest Province of South Africa were predominantly aged 31-55 years. In contrast, Zondo and Ndoro (2024) found a higher representation of youth farmers (aged 35 or younger) in parts of Bushbuckridge Local Municipality, suggesting regional variations in farmer age distributions. The results show that the study covered a cross-section of registered SHMFs at Chief Albert Luthuli Local Municipality.

Farm experience

The distribution of farm experience shown in Table 4 reveals that most of the participants, 48.9% (133), have work experience of 6-15 years. Subsequently, 27% (74) of the participants have less than 5 years of farming experience, and 6.6% (18) have 21 years or more of work experience. Additionally, 17.3% (47) have 16-20 years of farm experience. The mean coded value was 2.03 ($\sigma = 0.843$), indicating moderate variation across categories. It was also noted that only 27% of the registered SHMFs are still relatively new in the sector, with 70% having more than 5 years of experience. Similar results were reported by Nxumalo, Oduniyi, Antwi, and Tekana (2019); Nwafor (2020); and Ntsoane, Ndoro and Wayi-Mgwebi (2025).

Moreover, the research conducted by Haile *et al*. (2022) in Southwest Ethiopia emphasised the role of SHMFs' experience as a critical determinant of market participation, indicating that such experience enhances choice-making capabilities. Subsequently, Nxumalo *et al*. (2019) reached similar conclusions, indicating that 85% (53) of SHFs have accumulated more than 5 years of farm experience, which enhances the adoption of market strategies among SHFs in the Northwest province. Smallholder Farmers with extensive farming experience tend to be more progressive and skilled at evaluating new technology, which helps them make more efficient choices. This will assist SHMFs at the Chief Albert Luthuli Local Municipality in using innovative market channels. On the other hand, experienced farmers feel more confident in their existing knowledge and traditional market channels, while beginners in farming may require additional information on innovative market channels.

Farm size

Table 4 results show that the majority of the respondents (57.72% = 157) are producing on land of 3-10 hectares, followed by those with less than 2 hectares (20.96% = 57). The minority group comprises 0.74% (2) of participants, and the second-largest group comprises 20.59% (56). The mean is 2.01 with a standard deviation of 0.843. This distribution shows that small- to medium-sized landholdings predominate among registered SHMFs in the Chief Albert Luthuli Local Municipality. The results align with those of Nwafor (2020); Mdoda and Mzuyanda (2022), who found that most participants produce in an area of 3-10 hectares. Extensive land allocation for maize cultivation can enhance yields, thereby providing SHMFs with improved access to more suitable market channels. Subsequently, research, including the study by Nxumalo *et al*. (2019), indicates that farm size significantly influences market channel selection; smaller farms typically experience limited output and diminished bargaining power relative to larger landholdings.

Distance to the market centre

Table 4 displays the distance participants travelled to the market centre. Most respondents travel 41-80 km to reach the market, representing 47.8% (130). These results are followed by 81-120km, represented by 24.3% (64). The smallest group, 4.4% (2), travelled a distance of over 121km. and the second-to-last is 23.5% (64) for less than 40km. The mean is 2.10 with a standard deviation of 0.805. The results are in line with Nwafor (2020), who found that 69% (120) of farms are located more than 10km away. Research indicates that SHMFs located closer to urban areas are more inclined to sell their produce than those farther away (Buckmaster, 2012; Masuka *et al*., 2015; Nwafor, 2020). This distribution is attributed to their better understanding of the market dynamics and reduced transaction cost (Baloyi, 2010; Masuka *et al*., 2015; Nwafor, 2020). Subsequently, proximity to markets improves market participation.

4.2.3 Marital status of the participants

The results shown in Figure 5 display smallholder maize farmers' marital status in the study area.

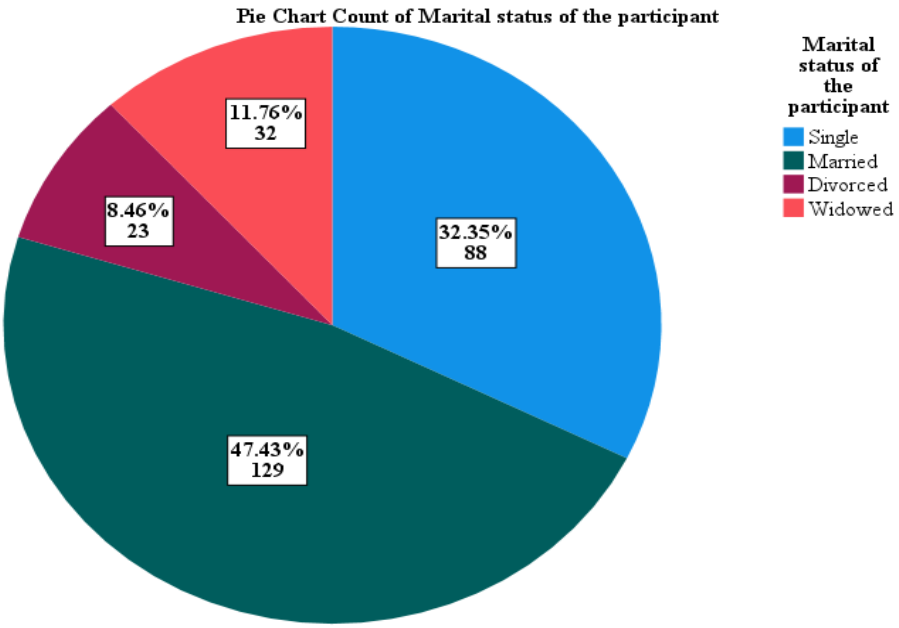

Figure 6: Marital status of the participants

Source: Field survey data (2024), analysed by the author using STATA

Figure 6 shows the marital status of the participants in the study area. Married participants in the study comprised the largest category, accounting for 47.43% (129). The second group was represented by a single group, comprising 32.35% (88) of respondents. Moreover, the pie chart indicates that the widowed group comprised 11.76% (32), while the divorced group accounted for the smallest share, 8.46% (23), of the respondents. The relatively high frequency and percentage of married individuals further reflect the older demographic makeup of the sample. Tambo *et al*. (2019) found that married couples tend to adopt ICT more than single males and females, possibly due to their shared decision-making process. This could assist SHMFs in making more informed choices when selecting innovative market channels such as e-commerce. Similarly, other studies indicate that married farmers use information and communication technologies more than single, divorced, or widowed farmers (Levi *et al*., 2015; Adepoju, 2017; Muhammad *et al*., 2019).

4.2.4 Highest educational level of the participants

Figure 7 displays the highest educational level of smallholder maize farmers in the study area.

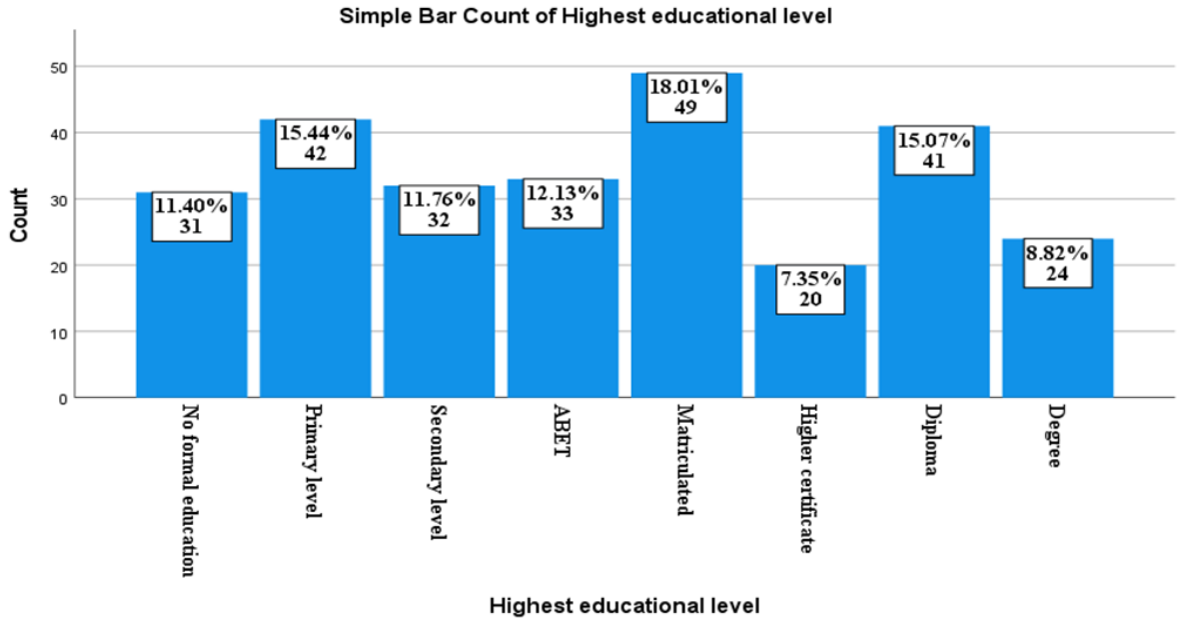

Figure 7: Highest educational level

Source: Field survey data (2024), analysed using STATA

Figure 7, displayed as a bar graph, shows the range of the highest educational level of the participants. Matriculated individuals comprise the largest percentage, at 18.01% (49), while those with higher certificates make up only 7.3% (20), marking the smallest group mentioned therein. SHMFs with no formal education are represented by 11.40% (31). SHMFs with a primary level of education were the second highest, at 15.44% (42 participants), followed by SHMFs with a degree, at 15.07% (41), and ABET, at 12.13% (33). Moreover, SHMFs with a degree comprised 8.82% (24), and those with a secondary level of education made up 11.76% (32). The level of education directly influences SHMFs' decision-making by adopting and utilising innovative market channels, leading to enhanced crop productivity and increased market participation. These results are supported by Jagadeesh *et al*. (2024) and Das Nair and Landani (2020). Interestingly, matriculated individuals accounted for the largest share of participants (18.01%), while those with higher certificates comprised the smallest group (7.3%), as shown in Figure 3.

This distribution reveals an important trend: SHMFs' use of agricultural technologies and practices can be influenced by their educational attainment. Research suggests that education is crucial for the adoption of agricultural innovations. One example found that higher education levels are linked to a greater likelihood of adopting standardized planting methods (Jagadeesh *et al*., 2024). Thus, indicating that matriculated SHMFs may be more open to innovative agricultural practices compared to those with lower educational backgrounds. One important aspect affecting SHMFs' agricultural production and marketing is their level of education. Education plays an important role in shaping SHFs' production methods, decision-making, and overall agricultural performance. Shabangu (2015) states that levels of schooling among smallholder farmers vary widely across communities and that these levels are often used to describe farmers' access to information and participation in agricultural activities.

Education forms part of the background characteristics of SHFs and is commonly described in agricultural studies to show farmers' general ability to read, write and engage with extension services. In many rural settings, formal education coexists with practical farming experience, and both contribute to how farmers conduct their daily activities. Therefore, to promote effective market engagement and sustain food security, educational programs that combine literacy development with hands-on agricultural skills should go beyond basic literacy.

4.2.5 Cooperative membership

Figure 8 below displays cooperative membership of the smallholder maize farmers in the study area.

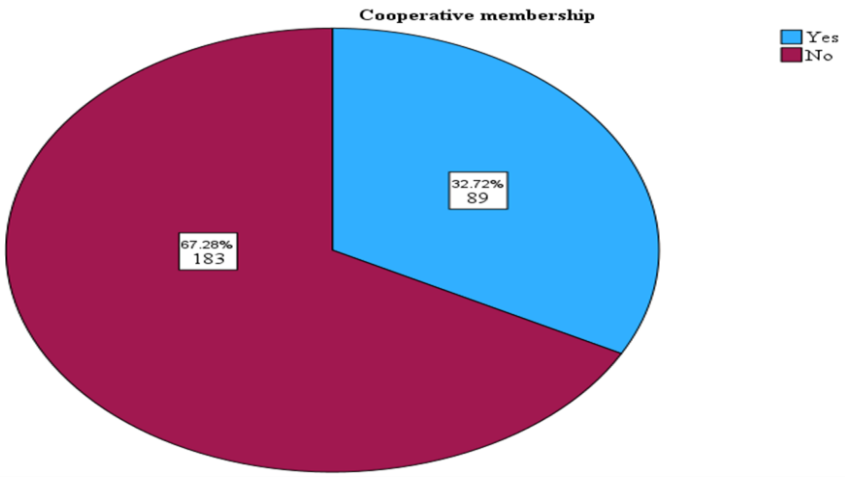

Figure 8: Cooperative membership

2.4.6. Name of cooperative

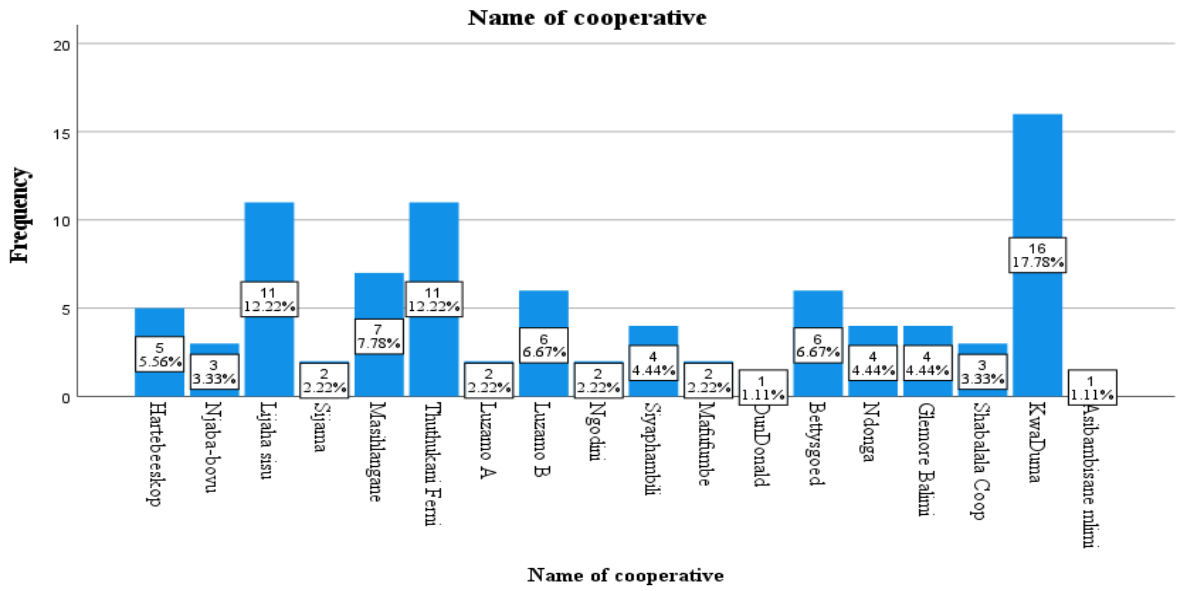

Figure 9: Name of cooperative

Figure 9 displays the participants' results for cooperative membership. The results show that 67.2% (83) of the respondents do not belong to any cooperative. In contrast, 32.72% (89) of the respondents indicated that they belong to a farmers' cooperative. The results align with those of Kiprop et al. (2020), who found that 72.7% of respondents were not part of farmer groups. Similarly, Wanasinghe and Sachitra (2022) found that most participants in their study did not belong to such groups either. Subsequently, Zondo and Ndoro (2024) found that 82.9% (180) of their study participants do not belong to cooperatives.

Figure 9 below shows that 89 participants belong to 18 cooperatives. Many SHFs in South Africa are registered with organisations such as the Department of Agriculture or Grain SA to be recognised, receive extension services, gain access to production inputs, or be eligible for various programs. However, this does not always imply that they are members of farmer cooperatives. Whereas cooperative membership is a voluntary organisational decision based on farmers' interests, benefits, or local structures, registration usually serves administrative and support functions. Most of the participants belong to KwaDuma represented by 17.78% (16). These results are followed by Lijaha-sisu and Thuthukani-Ferni, each at 12.22% (11), and Masihlangane at 7.78% (7). Luzamo B and Bettysgoed are represented by 6.67% (6), Hartebeeskop by 5.56% (5), Siyaphambli, Ndonga, Glenmore Balimi represented by 4.44% (4), Njaba-bovu and Shabalala Coop at 3.33% (3).

Sijama, Luzamo A, Ngondini and Mafufumbe represented by 2.22% (2). Dundonald and Asihlangane Mlimi are represented by 1% (1). Therefore, the data presented in Figure 8 indicate a distribution between individuals participating in cooperative organisations and those who do not. Individuals who are not members may forfeit access to shared resources, collective bargaining advantages, and the support commonly provided by cooperatives. The absence may lead to disadvantages in market competitiveness, financial support, and resource distribution, which are typically improved through cooperative membership. Thus, as noted by Agole *et al*. (2022) and Nyawo and Olorunfemi (2023), it is essential to raise awareness and educate individuals about the benefits of joining cooperatives to accelerate agricultural intensification.

2.4.7. Land Ownership

The results presented in Figure 10 were obtained from survey data for smallholder maize farmers' land ownership status.

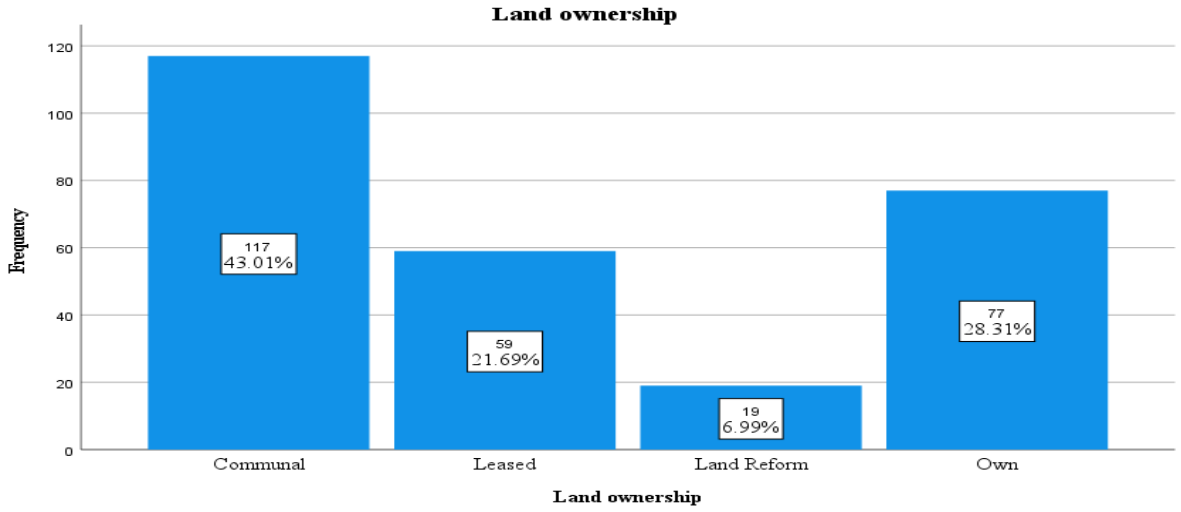

Figure 10: Land ownership

Source: Field survey data (2024), analysed by the author using STATA

Land is a crucial factor that determines the total yield a farmer produces, making land availability a significant determinant of whether a farmer sells or not. Of the 272 participants, 43% (117) SHMFs produce on communal land and have permission to occupy (PTO) papers. The leased land is represented by 21.69% (59). The results also indicate that 28.31% (77) produce on land they own. The second-to-last is rented land, represented by 21.69% (59). The smallest group is represented by 6.99% (19), producing on land reform.

The distribution of different types of land access among SHMFs highlights the crucial role secure land tenure plays in shaping production choices and market participation. Communal land use, at 43%, indicates a strong reliance on traditional systems that grant usage rights but often lack security for SHMFs. This scenario can affect market channel choices and productivity due to the absence of formal ownership structures. Research by Magakwe and Olorunfemi (2024) supports these observations, demonstrating that SHFs with communal or insecure tenure are less motivated to adopt high-investment practices. The distribution further shows that SHMFs who operate on leased land through rental arrangements are represented by 21.69%,

Carelsen *et al.* (2023) underscore this situation as well. While leasing allows those without inheritance rights to engage in farming, it may limit productivity gains compared to owning land outright. SHMFs who own their land (28.31%) can invest more confidently in yield-enhancing practices, as ownership typically correlates with better access to credit and higher investment levels. Other studies show that owning land is often associated with increased productivity and a greater willingness to explore diverse market channels. Land accessed through reform programs represents the smallest category, comprising only 6.99%. This suggests either limited availability or potentially complex administrative processes within land redistribution policies. Research by Oluwatayo *et al*. (2021) reveals varied outcomes in these situations, often contingent on the support structures provided to new landholders.

Table 5 presents the farm production demographics of smallholder maize farmers in the study area

Table 5: Farm Production Demographics

Variables	Frequency (counts)	Percentage (%)
Type of maize produced		
White	52	19.1
Yellow	108	39.2
Both (white and yellow)	112	41.2
Total	272	100.0
Type of farming		
Rainfed	135	49.6
Irrigated	137	50.4
Total	272	100.0
Implements and machinery owned		
None	4	1.5
Hand-held tools (e.g. hoes)	203	74.6
Planter	5	1.8
Tractor	34	12.5
Harrow	3	1.1
Tined cultivators	1	0.4
Boom sprayer	5	1.8
Ripper	3	1.1
Tiller	5	1.8
Plough	2	0.7
Combine harvester	1	0.4
Corn sheller	2	0.7
Thresher	4	1.5
Total	272	100.0
Hired farming implements and machinery		
None	22	8.1
Hand-held tools (e.g. hoes)	2	0.7
Planter	15	5.5
Tractor	179	65.8

Harrow	4	1.5
Tined cultivators	3	1.1
Boom sprayer	8	2.9
Ripper	1	0.4
Tiller	2	0.7
Plough	5	1.8
Combine harvester	27	9.9
Corn sheller	3	1.1
Thresher	1	0.4
Total	272	100.0
Type of storage facility		
None	103	37.9
Grain-mud huts	69	26.5
Metallic silo	72	9.6
Off-farm storage (on top of the roof)	26	9.6
Off-farm storage (home garage)	1	0.4
Off-farm storage (outside the home yard)	1	0.4
Total	272	100.0

Type of maize produced

Table 5 presents a summary of farm production demographics; most participants grow both white and yellow maize, accounting for 41.2% (112). These results are followed by yellow maize producers, represented by 39.2% (108). Participants producing white maize account for 19.1% (52). Similar findings were also observed by Zuma, Kolanis, Modi, and Mbhenyane, (2023), who reported that 23 respondents produced white maize in Bulwer. Therefore, this distribution might suggest that SHMFs should produce more white maize to balance production between the two cultivars in the area.

Type of farming

The distribution of farming methods among the smallholder maize farmers (SHFs) in the study area is presented in Table 5. The results show that 137 farmers (50.4%) practice irrigated farming, while 135 (49.6%) practice rainfed farming. This indicates that the sample is almost evenly divided between the two farming methods, with only a marginally higher number using irrigation. The distribution suggests that both rainfed and irrigated farming are important practices among the sampled farmers. Tura and Hamo (2018) reported that SHFs often utilise both rainfed and irrigated systems depending on local conditions. Similarly, Statista (2024) notes that water resources remain a critical factor in agricultural production, although this study does not directly measure water availability or rainfall adequacy.

Implements and machinery owned

The response rate of participants' owned farm implements is presented in Table 5. The majority of the participants, 74.6% (203), are using basic handheld tools such as hoes. Participants who use advanced machinery, such as tractors, account for 12.5% (34), while planters, boom sprayers, and tillers each account for 1.8% (5). The second-to-last is represented by 1.1% (3) for participants owning both a harrow and a ripper. The least owned machinery is a combine harvester and a tined harvester, represented by 0.4% (1). Furthermore, tractors are the most frequently rented machinery, represented by 65.8% (179), followed by the combine harvester, which is represented by 9.9% (27). These results align with those of Mdoda *et al*. (2022), who found that hand tools were the second most widely used form of agricultural mechanisation. The use of hand tools is common in most rural farming, as farmers began using them in their childhood while working in their home gardens and on their family farms.

Hired farm implements and machinery

The results in Table 5 present the distribution of hired farming implements and machinery among the 272 sampled SHMFs in Chief Albert Luthuli Local Municipality. A total of 22 farmers (8.1%) reported not hiring or renting any implements or machinery. Among those who hired equipment, the tractor was the most frequently hired implement, reported by 179 farmers (65.8%). This was followed by the combine harvester, hired by 27 farmers (9.9%). Other machinery types were hired by smaller proportions of farmers, including planters (15 farmers; 5.5%), boom sprayers (8 farmers; 2.9%), ploughs (5 farmers; 1.8%), harrows (4 farmers; 1.5%), tined cultivators (3 farmers; 1.1%), corn shellers (3 farmers; 1.1%), tillers (2 farmers; 0.7%), and hand-held tools such as hoes (2 farmers; 0.7%).

Very small proportions hired a ripper (1 farmer; 0.4%) or a thresher (1 farmer; 0.4%). These results indicate that while most farmers access large machinery, smaller or simpler implements are hired much less frequently. Hired implements and machinery refer to equipment accessed through local service providers, neighbouring farmers, farmer groups, or community-based machinery sharing arrangements. The low frequency of small implements, such as hoes or tillers, reflects their occasional use for specific tasks, which may be shared or borrowed among farmers rather than owned. Therefore, the distribution reflects the range of equipment farmers temporarily used during maize production rather than long-term ownership. The high proportion of tractor hiring observed in this study aligns with the findings of Win, Belton and Zhang (2020), who reported that a significant number of smallholder paddy-farming families accessed large-scale machinery such as tractors and combine harvesters. The government should assist farmers in purchasing implements and machinery to increase ownership rather than relying on renting.

Storage facilities

Table 5 also displays the results of storage facilities used by the registered SHMFs at Chief Albert Luthuli to temporarily store dry maize before taking it to the market. The results show that 37.9% (103) do not have buildings to store their produce. Despite this, grain-mud huts are the most widely used, representing 26.5% (69) of the area, while metallic silos are used by around 9.6% (26). Off-farm storage options, such as rooftops, home garages, and those located on top of the home roofs, account for 10.4% (28).

The results align with those of Thakur, Mehta, Devi, Sharma, Singh, Yadav, Lal, Raghav, Kapoor, and Mishra (2023), who found that participants in their study lacked storage facilities. This distribution therefore suggests that SHMFs either do not have storage at all or use traditional off-farm storage, such as mud granaries, rooftops, and home garages, which are common in rural areas. Manandhar, Milindi, and Shah (2018) argued that access to a good storage facility is pivotal.

Table 6: Institutional and market demographics of the respondents

Table 6 displays the market and institutional factors (access to credit and source of credit, access to market channel information, access to maize price information, main source of information (maize channels and maize prices), vehicle ownership and mode of transport to the market for smallholder maize farmers in Chief Albert Luthuli Local Municipality

Table 6: Institutional and Market Demographics of the Respondents

Variables	Frequency (counts)	Percent (%)
Source of credit		
None	162	59.6
Standard bank	24	8.8
Land bank	33	12.1
Absa	26	9.6
NYDA	11	4.0
MEGA	11	4.0
Nedbank	5	1.8
Total	272	100.0
Access to market channel information		
Yes	247	90.8
No	25	9.2
Total	272	100.0
Main source of information (maize price and market channel)		
Agricultural extension agents	131	48.2
Word of mouth	49	18.0
Social media groups	30	11.0
Indigenous knowledge (Experience)	62	22.8
Total	272	100.0
Vehicle ownership		
None	141	51.9
Bakkie	107	39.3
Car	24	8.8
Total	272	100.0
Mode of transport to the market		
None	88	32.4
Own	100	36.7
Hire (individual and collectively)	66	24.3
Public transport	18	6.6
Total	272	100.0

Source: Field survey data (2024), analysed by the author using STATA

Access to credit

Table 6 displays that the majority of the respondents, 59.6% (162), do not have access to credit. Land Bank emerges as the most preferred source of credit, chosen by 12.1% (33), followed closely by Absa with 9.6% (26), and Standard Bank ranks third with 8.8% (24). Both NYDA and MEGA are used by 4% (11) respectively. The minority group is Nedbank at 1.8% (5). This distribution is not unexpected in South African smallholder systems, where credit uptake often remains low because many farmers rely on self-financing or informal borrowing rather than formal institutions (Mabuza *et al*., 2013; Khapayi and Celliers, 2016). These studies similarly reported that the majority of SHFs did not use formal credit sources, reflecting longstanding barriers such as collateral requirements and limited financial outreach in rural areas.

Furthermore, access to credit plays a crucial role as it empowers SHMFs to make informed choices about the optimal timing and location for selling their commodities (Teame and Yacob, 2023). Subsequently, investigations revealed that access to credit enables SHFs to readily obtain inputs, thereby increasing their output and facilitating bulk sales (Mmbando *et al*., 2016; Wordofa *et al*., 2021). This distribution suggests that formal agricultural credit remains a limited component of financial decision-making for most SHMFs in the study area. Therefore, efforts to expand financial access could be considered a formal credit system to serve as a primary resource for everyday farming operations.

Access to market information

The results reveal that 90.8% (247) of respondents have access to market channel information, highlighting its notably high availability among them. Respondents with no access comprise 9.2% (25). The results align with those of Xaba and Masuku (2013), Ouma et al. (2020), and Changalima and Ismael (2022), who found that the majority of their respondents indeed have access to timely and relevant market information. This distribution suggests that access itself is not a major limitation for registered SHMFs in the area. Therefore, there is a need to develop a framework or model that focuses on how farmers understand, interpret, and apply the market information they receive in a timely and practical manner.

Primary source of agricultural information

According to Table 6, the primary source of agricultural information is presented of registered SHMFs in the area. Agricultural extension agents are the primary source of market information, represented by 48.2% (131). Famer-to-farmer (word of mouth) follows as the second-most common source, at 18% (49). Additionally, indigenous knowledge or experience is used by 22.8% (62), while social media is used by 11% (30). The findings align with those of Musara *et al*. (2018), who identified extension officials as a primary source of information for poultry SHMFs. In contrast, Nwafor (2020) reported that only about 6% of respondents cited extension practitioners as their primary information source, while 57.4% relied on ICT tools, such as social media, for market data. Although AES play a vital role in informing SHMFs, access is often restricted by limited personnel and resources, particularly in rural areas. To address this issue, enhancing these services through the integration of ICT tools and community-based strategies can effectively expand outreach to more SHMFs. Consequently, it becomes clear that increasing the ratio of extension agents is necessary to improve SHF access to both agricultural production knowledge and market information.

Vehicle ownership

Table 6 presents the results for vehicle ownership. The majority of respondents (51.9%, or 141) do not own vehicles. Within the group that owns vehicles, owning bakkies remains more popular, at 39.3% (107), followed by respondents who own a car, at 8.8% (24). Table 6 further indicates the results for the mode of transport to the desired marketplace. The results reveal that 32.4% (88) do not have any means of transportation to the market, while those who own vehicles use their own cars, accounting for 43.2% (118). Notably, hired transportation accounts for 17.6% (48) of the market, while 6.6% (18) use public transport. This distribution suggests that, among the sampled SMHFs, vehicle ownership remains a significant constraint, potentially increasing transaction costs. The results are like those of Ndoro *et al*. (2014), who reported that most SHMFs lack means of transport to the market centre.

Mode of transport to the market

Transport availability is a crucial factor for SHFs, as inadequate or unreliable transportation can lead to delays and hinder the smooth movement of produce to markets (Mdlalose, 2016). The results in Table 6 show that SHMFs who actively transport produce to market centres using their own transport in the area account for 36.7% (100). This distribution is similar to Mzuyanda (2014) and Mohammed Kassaw, Birhane, and Alemayehu (2019), who found that the majority of respondents in the area used their own transport to take produce to the market. Among respondents, the lack of transport use is noted, with 32.4% (88) indicating they do not use any mode of transport. This distribution might suggest that SHMFs rely on the farm gate to sell maize produce.

Hired transport, whether individually or collectively arranged, accounts for 24.3% (66), representing that SHMFs still rely on external support to move their produce. Public transport is represented by the smallest category at 6.6% (18), a distribution commonly observed among SHFs managing perishable or bulk produce, for whom public transport may be impractical. Similar distributions were reported by Mdlalose (2016) and Mashaphu (2022), who found that many SHFs prefer local sales or rely on hired transport due to the high costs and logistical challenges associated with owning their own transport. These distributions therefore reflect a mix of transport modes used by SHMFs in the study area, with own and hired transport emerging as the main active modes for accessing markets.

4.3 Choice of innovative market channels used by SHMFs

4.3.1 Variance Inflation Factor

To analyse the results for innovative market channels used by smallholder maize farmers, a multinomial logistic regression was used to assess the socio-economic factors influencing their choices, with an emphasis on odds ratios to determine which factors are more significant and to measure the extent of their influence on smallholder maize farmers' choices. The study first used a Variance Inflation Factor (VIF) to assess multicollinearity among the independent variables (Greene, 2024). A regression analysis was performed using 66 variables and 272 observations. With an R-squared of 0.6007, the independent variables in the model account for approximately 60% of the variation in the dependent variables (innovative market channels). In terms of degrees of freedom, the F-statistic is 9.40 with 18 and 253. Moreover, the model is statistically significant, as indicated by the Prop>F = 0.0000, which is less than 0.05.

Table 4 presents the mean VIF value, which is 1.53. The VIF results were obtained by cleaning the data and checking for errors through outlier and missing-value analysis. Therefore, the estimates of the regression coefficients are dependable.

Table 7: The Multicollinearity for VIF

Number of observations = **272** F (18, 253) = **9.40** Prop >F= **0.0000** R-squared (R^2) = **0.6007**		
Variable	VIF	1/VIF
Age	2.79	0.358867
Educational level	2.00	0.500490
Farm experience	1.97	0.508283
Source of information	1.73	0.576463
Vehicle ownership	1.66	0.602638
Cooperative membership	1.61	0.622920
Marital status	1.56	0.641571
Farm size	1.47	0.679904
Distance to the market	1.46	0.684249
Type of maize cultivar	1.37	0.727989
Mode of transport	1.34	0.744718
Source of credit	1.33	0.751966
Type of farming	1.25	0.799512
Own machinery and implements	1.23	0.811217
Hired machinery and implements	1.22	0.818194
Land ownership	1.20	0.830234
Gender	1.18	0.847193
Storage	1.16	0.859657
Mean VIF	1.53	
PLEASE NOTE THAT: **Prop**= probability values, **>** = greater than, **F**= F-statistics,		

MARKET CHANNEL CHOICE	FREQUENCY	PERCENTAGES (%)
1. Contract	**95**	**34.9**
1.1. Short-term	62	22.8
1.2. Medium-term	27	9.9
1.3. Long-term	6	2.21
2. Collective	**88**	**32.4**
2.1. Cooperative	32	11.8
2.2. Farmer associations	23	8.5
2.3. Farmer groups	30	11
3. E-commerce	**69**	**25.4**
3.1. Phone calls	36	13.2
3.2. Social media	36	13.2
4. Farmgate	**10**	**3.7**
5. Not selling	**10**	**3.7**
TOTAL	**272**	**100**

R-squared (R^2) = coefficient of determination, **VIF**= Variance Inflation Factor

Table 8: Frequency and Percentage of Market Channels Used

Table 8 above displays the frequency and percentages of SHMFs' innovative market channel choices. Contract market channels comprise the largest group, accounting for 34.9% (95) of the overall market. Short-term contracts are the most common, at 22.8% (62), while long-term contracts are the least common, represented by 2.21% (6). These results are followed by collective market channels, accounting for 32.4% (88), comprising cooperatives (11.8% [32]), farmer associations (8.5% [23]) and farmer groups (11% [30]). This percentage appears to be greater than the percentage of people who reported being formally members of a cooperative.

However, the two numbers are not anticipated to match up exactly. Selling through collective channels does not require farmers to be formal members of a cooperative. In many cases, when a market requires quantities that exceed what one farmer can supply, neighbouring farmers temporarily combine their harvests to meet the demand and share the income according to each farmer's contribution. Similar results were found by Fred, Gabriel, and Robert (2020), who noted that most SHMFs use collective arrangements to market their produce, such as farmer groups and cooperatives. This distribution suggests that collective marketing in the study area operates largely through informal cooperation, offering SHMFs a practical way to meet market requirements despite low levels of formal group membership.

E-commerce also plays a significant role, accounting for 26.4% (72), with phone calls and social media each contributing equally at 13.2% (36). The results are similar to those of Zhang and Berghall (2021) and Widhiarini, Ekasani, Mahendra, Dewi, Wijana, and Syafri (2023), who found that e-commerce plays a crucial role in connecting SHMFs to broader markets, thereby increasing income and improving market visibility. On the other hand, farmgate sales and opting not to sell share the smallest percentage at just 3.7% (10). This distribution differs from Nwafor (2020) findings, which found that the majority (89 out of 174) of respondents use Farmgate as their main channel for selling. This comparison shows that, unlike in some contexts where farmgate marketing dominates, farmers in the present study appear to rely more on e-commerce and other market channels.

4.3 Multinomial logit model results

Table 9 summarises the MNL results for contracts, collective, and e-commerce, with farmgate as the base category. The results present the coefficient, standard error, Wald statistic, and probability value at 1%, 5%, and 10% significance levels.

Table 9: The Multinomial Logit Regression Model Results

Multinomial logistic regression Number of obs = 272
LR chi2(48) = 247.20
Prob > chi2 = 0.0000
Pseudo R2 = 0.3434

Log likelihood = -236.34688

VARIABLE CODE	**CONTRACT 95 (34.9%)**				**COLLECTIVE 88 (32.4%)**				**E-COMMERCE 69 (25.4%)**			
	(*B*-value)	**Std. Err.**	**Wald**	**(*P*-value)**	**(*B*-value)**	**Std. Err.**	**Wald**	**(*p*-value)**	**(*B*-value)**	**Std. Err.**	**Wald**	**(*p*-value)**
Demographic factors												
GEN	-2.493923	1.1373013	-1.82	0.069*	-2.311621	1.378733	-1.68	0.094*	-2.917126	1.351329	-2.16	0.031**
AGE	-3.752275	1.63696	-2.29	0.022 **	-4.169467	1.639498	-2.54	0.011***	-3.826038	1.610795	-2.38	0.018**
EDU	-1.438738	.674976	-2.13	0.033**	-1.526963	.6752868	-2.26	0.024**	-1.500938	.6722262	-2.23	0.026**
Farm and production factors												
SIZE	2.382668	1.245229	1.91	0.056 *	1.939248	1.24182	1.56	0.118	1.185962	1.228857	0.97	0.334
EXP	0.0622633	1.058032	0.06	0.953	-.0640291	1.06312	-0.06	0.952	-.495523	1.039635	-0.48	0.634
TYPFAR	.2107695	1.703585	0.12	0.902	.5449823	1.70691	0.32	0.750	.9285684	1.685395	0.55	0.582
STOR	17.89326	1356.081	0.01	0.989	17.64311	1356.081	0.01	0.990	17.29926	1356.081	0.01	0.990
HIREDIMP	1.196687	0.8981819	1.33	0.183	1.156809	.8980339	1.29	0.198	1.056251	.8986355	1.18	0.240
Institutional and market factors												
AES	-.5519137	1.696316	-0.33	0.745	1.817895	1.72574	1.05	0.292	-1.095051	1.686897	-0.65	0.516
DIST	2.995885	1.726763	1.73	0.083*	2.815118	1.728082	1.63	0.103*	2.69226	1.71973	1.57	0.117
TRAN	4.050295	2.278698	1.78	0.075*	3.584901	2.277918	1.57	0.116	3.802368	2.269678	1.68	0.094*
MODETRA	1.119155	.9230968	1.21	0.225	1.058603	.9260499	1.14	0.253	1.141107	.9087784	1.26	0.209
Cons	-19.41084	1356.095	-0.01	0.989	-17.53466	1356.095	-0.01	0.990	-13.0504	1356.094	-0.01	0.992

(*B*-value) = coefficient, Std. Err. = Standard error Wald= Wald, (*P*-value) = probability value

Note that *, **, *** denotes statistically significant at 10%, 5% and 1% respectively.

Farmgate was used as a base category

This study used the multinomial logit model to analyse the likelihood of using innovative market channels relative to the base category, that is, the traditional (farmgate) marketing channel. Table 9 presents the results for the multinomial logit model, highlighting only the significant (gender, age, education level, farm size, distance to the market centre, vehicle ownership) determinants of maize market channel choice. The consequences of participating in these market channels included demographic, farm and production, institutional, and market factors. Multinomial logistic regression analyses the likelihood of different outcomes in relation to predictor variables. In this analysis, the logistic regression model was fitted to 272 observations. The LR chi-square statistic of 247.20, with a p-value of <0.0000, suggests that the model effectively predicts the outcome variable, implying that the predictors have a substantial effect. Additionally, the pseudo-R-squared value of 0.3434 suggests that the model aligns closely with the data, explaining approximately 34.34% of the outcome's variability.

4.3.2.1 Demographic factors

Gender (GEN):

The gender coefficient is negative for all innovative market channels used by SHMFs in the study area. The results show a statistically significant influence on e-commerce (B = -2.917126, p = 0.031). This indicates that female (1) SHMFs are significantly less likely to choose e-commerce than male (2) SHMFs. Gender also affects participation in contract (B = -2.493923, p = 0.069) and collective channels (B = -2.311621, p = 0.094), though these effects are only marginally significant. The coefficient of -2.917126 for gender in e-commerce suggests that female SHMFs experience a decrease of approximately 2.9 units in the log-odds of selecting this channel compared to their male counterparts, holding other factors constant. The findings suggest potential gender-based challenges, suggesting that men may face limited access to digital resources or play distinct roles in marketing decisions. In contrast, Nwafor (2020) found that gender was not statistically significant in any of the available market channels. As analysed by Palacious Lopez and Lopez (2015), Farnworth and Calverson (2015), and Me-Nsope and Larkin (2016), who found that market participation in agriculture is influenced by gender and that male and female farmers have unequal access to socioeconomic opportunities. The findings from these studies suggest that gender constraints may affect women's market channel choice, with women preferring informal markets due to lower transaction costs (Olumeh *et al*. 2018). Gender represents differences in market orientation between male and female farmers.

The results, therefore, suggest that, with adequate support, women's participation in innovative trading platforms is likely to increase.

Age (AGE):

The coefficient for age is both negative and statistically significant across all three innovative market channels: contract (B = -3.752275, p = 0.022), collective (B = -4.169467, p = 0.011) and e-commerce (B = -3.826038, p = 0.018). The coefficient of -4.169467 for collective marketing indicates that each additional year of age results in a reduction of approximately 4.2 units in the log-odds of selecting this channel, when other variables are held constant. This finding suggests that older SHMFs in the area are less inclined to adopt innovative market channels due to resistance or challenges associated with new technology. These results are in contrast with Nwafor (2020), who found age to be a significant factor among farmers who make their own sales at the farm gate. This may be due to older farmers being reluctant to engage with outside markets, often selling in smaller quantities. Encouraging younger farmers to become more enthusiastic and eager to explore market opportunities, regardless of their location.

Education (EDU):

The level of education significantly reduces the likelihood of SHMFs choosing contract (B = -1.438738, p = 0.033), collective (B = -1.526963, p = 0.024), and e-commerce channels (B = -1.500938, p = 0.026). Specifically, the coefficient for contract markets (-1.438738) indicates that with each additional unit increase in educational attainment, the log odds of selecting contract markets decrease by approximately 1.4 when all other variables remain unchanged. These results concur with those of Nwafor (2020), who found that education was significant for those SHFs using formal market channels. Education enhances the ability to receive and interpret relevant and timely market information, thereby influencing the likelihood of participating in the market.

According to Kassaw *et al*. (2019), education increases farmers' productivity, which in turn strengthens their linkages with formal market channels. Nevertheless, this trend may suggest that more educated SHMFs tend toward market options that increase the likelihood of greater independence, such as e-commerce, contracts, or export channels, rather than opting for farmgate.

4.3.2.2 Farm and Production Elements

Farm size (SIZE):

There is a positive correlation between farm size and the probability of selecting contract channels (B = 2.382668, p = 0.056) and collective channels (B = 1.939248, p = 0.118), whereas its effect on e-commerce channels is not statistically significant (B = 1.185962, p = 0.334). For contract markets, each additional hectare increases the likelihood of choosing these markets by about 2.38 when all other factors remain unchanged, indicating that larger farms can better meet the volume and quality demands associated with structured markets, such as contracts, to correctly and avail themselves of the necessary business services for consistent income streams. These findings align well with Nwafor (2020), who demonstrated that farm size was significant for both informal retailers and formal wholesalers. In contrast, Ketema and Lika (2023) found that the results were not statistically significant, indicating that farmers prefer not to sell directly to consumers; a decrease in land ownership decreases the likelihood of using the formal market.

4.3.2.3 Institutions and market factors

Distance to the market centre (DIST):

The factor associated with proximity to the market remains positive across all channels, showing statistically significant effects in contract markets (B = 2.995885, p = 0.083) and collective channels (B = 2.815118, p = 0.103). The contract markets indicate that, with each unit increase in distance (e.g., kilometres), the likelihood of opting for contract markets increases by about 3-fold. These findings demonstrate that channel selection is influenced by physical proximity and mobility constraints, with transport access mitigating the negative effects of distance (Ibikoule *et al*., 2024; Mdoda *et al*., 2024). Past studies have shown that the farther away the farmer was located, the less produce they brought to the market and the more they sold at the farm gate (Buckmaster, 2012; Tura and Hamo, 2018). Smallholder maize farmers located farther from marketplaces may prefer structured arrangements, such as contracts, because these often provide logistical support, including transportation services.

Vehicle ownership (TRAN):

Vehicle ownership is associated with a higher likelihood of opting for innovative market channels, exhibiting a marginally significant effect in e-commerce (B = 3.802368, p = 0.094). Similarly, the coefficients for contract markets (B = 4.050295, p = 0.075) and collective markets (B = 3.584901, p = 0.116) are positive but not statistically significant.

For e-commerce settings, the coefficient of about '3' demonstrates that possessing a vehicle increases the likelihood of participating by threefold when all other factors remain constant. This aligns with Mothiba, Mthombeni, and Antwi (2023), who found that vehicle ownership was significant at a 5% significance level, and an increase in the number of vehicles owned by the smallholder farmer increased the likelihood of the smallholder farmer selling at an urban market rather than the farmgate and local market. This suggests that the availability of transportation facilities significantly helps alleviate long market distance constraints, thereby limiting the depth of marketing choices. Thus, highlighting transportation's crucial role minimises dependence on external development firms, especially when reaching distant or city-based marketplaces. Collectively, these findings underscore the crucial role of farmers' demographic characteristics, institutional factors, and transaction cost variables in facilitating smallholder market integration. Policies that strengthen these determinants are likely to enhance both the breadth and depth of market participation among rice producers.

4.4 Propensity score matching

4.4.1 Econometric model estimation results: yield produced and quantity sold.

A multicollinearity check was conducted on the exogenous variables before conducting the econometric analysis. Since the data were not experimentally designed, to evaluate the effects of agricultural extension services on selecting innovative market channels for selling maize, propensity score matching (PSM) was used. Propensity Score Matching provides researchers with a two-step methodology. Initially, it enables them to identify the factors that contribute to access to agricultural extension services using probit regression. In the second step, it evaluates the influence of these extension services on the choice of innovative market channels, such as contract market channels, by estimating the effects before and after the intervention using PSM. The PSM was used to obtain unbiased estimates of the relationships between the treated group (receiving agricultural extension services = 1) and the control group (not receiving agricultural extension services = 0) while controlling for covariates (socioeconomic factors).

4.4.2 Propensity score estimation

Table 10: Probit regression model results

Table 10 presents the findings from a probit regression analysis of 272 observations. This analysis investigates the statistical significance of multiple predictors (farm experience, source of credit, land ownership, hired farm implements and distance to the market centre), yielding a likelihood-ratio chi-square value and a pseudo-R-squared that reflect the model's explanatory strength.

Table 10: The Probit Logit Regression Model Results

Probit regression					**Number of observations = 272**	
					LR chi2(14) = 194.26	
					Prob > chi2 = 0.0000	
Log likelihood = -83.803704					**Pseudo R2** = 0.6660	
	Coef.	**Std. Err.**	**Z**	**P>/z/ P>/z/**	**95% Conf. Interval**	
Gender	.004395	.2355959	0.02	0.985	-.4573645	.4661545
Age	.2056469	.2238195	0.92	0.358	-.2330313	.6443251
Edulvl	.0619612	.0679932	0.91	0.362	-.713031	.1952255
Farmexp	-.3744036	.1902223	-1.97	0.049**	-.7472325	-.0015747
Srccrdt	.1021986	.0794561	1.29	0.104*	-.0535325	.2579297
Landown	-.30884878	.0968568	-3.18	0.002***	.0124751	.3921467
Farmsize	.2490736	.1899934	1.31	0.190	-.1233066	.6214539
Maizetyp	.109286	.163508	0.67	0.504	-.2111837	.4297558
Sourcinf	-1.033379	.1298867	-7.96	0.000***	-1.287952	-.7788058
Hiremch	-.816054	.0424653	-1.92	0.055*	-.1648357	.001625
Typfarm	.1716223	.2461534	0.70	0.486	-.3108296	.6540742
Distmark	.0210786	.1620534	0.13	0.010***	-.2965403	.3386975
Modetran	-.0136854	.1047147	-0.13	0.896	-.2189224	.1915516
_cons	**1.846194**	**1.051104**	**1.76**	**0.079**	**-.2139321**	**3.90632**
Note that *, **, * denotes statistically significant at 10%, 5% and 1% respectively Coef.:** Coefficient**; Std. Err.:** Standard Error**; Z.:** Z-statistic**; P > |z| :** P-value **; 95% Conf. Interval:** Confidence Interval						

The propensity score-matching results for the determinants of receiving AES agricultural SHFs for maize sales are presented in Table 8. The propensity scores were estimated for each observation based on 12 covariates (Gen, Age, Edu, Exp, Size, Cred, Landown, Maiztyp, Sourcinf, Hiredimp, Typfar, Distmark and Modetran). A logistic regression model was used to predict the likelihood of receiving the treatment (AES) using covariates calculated from a probit model, distinguishing between the AES treatment group and the control group (those not receiving AES).

The variables selected included the influence of farm production factors, institutional and market factors, and socio-economic factors. The probit regression analysis shows significant insights into the factors affecting the propensity score, using data from 272 observations. The model produced an LR chi-squared value of 194.26, indicating a robust fit. The model accounted for a significant level of variability, as evidenced by the pseudo-R2 value of 0.6668.

Experience in farming (FARMEXP)

As hypothesised, farming experience in smallholder maize production was negatively and significantly associated with the likelihood of receiving AES ($p = 0.049$). This suggests that farmers with extensive experience are more likely to engage profitably in market participation and therefore require AES support to enhance their decision-making in innovative markets. The findings imply that a one-year increase in farming experience improves the probability of accessing innovative market channels by approximately 5%. These results are consistent with the work of Kangogo (2024), who found that greater farming experience has a positive influence on smallholders' participation in output markets. Similarly, Mzuyanda (2014), using PSM, demonstrated that AES strengthens the capacity of experienced farmers to utilise diverse market options by highlighting the profitability advantages of innovative channels.

Source of credit (SRCCRDT)

As hypothesised, access to credit was statistically significant at 10% ($p = 0.104$), indicating that farmers with alternative financial sources may be more capable of participating in innovative markets when supported by AES. The positive relationship indicates that a unit increase in access to credit increases the odds of market participation by a factor and increases the quantity of maize supplied to the market. The positive sign suggests that access to credit enhances a farmer's readiness to invest in improved marketing practices.

Comparable findings from Mzuyanda (2014); Claude, Ngigi, and Majiwa (2025), who used PSM, illustrate that AES complements credit access by enabling farmers to allocate borrowed funds toward productive and value-adding activities. Their study showed that AES participation strengthens the financial decision-making of SHMFs, ultimately increasing their ability to engage in innovative market channels. Mzuyanda (2014) noted that credit is a crucial instrument for enhancing the welfare of the poor, directly through consumption smoothing, which reduces their vulnerability to short-term income fluctuations.

Land ownership (LANDOWN)

Contrary to the hypothesis, land ownership was found to be highly statistically significant at 1% ($p = 0.002$), suggesting that landowners may be more inclined to rely on innovative marketing channels and less likely to depend on traditional markets. The positive relationship indicates that ownership of land increases the odds of market participation by a factor and increases the quantity of maize supplied to the market. This finding is supported by Danso-Abbeam *et al*. (2018), who observed that landowners receiving AES were more willing to integrate marketing innovations aimed at improving farm profitability. Thus, while landowners may initially exhibit more interest in innovative channels, AES has the potential to enhance their market-oriented decision-making. Claude *et al*. (2025) noted that the significance of land ownership in the agricultural market lies in its ability to manage larger land areas, thereby facilitating higher productivity and market access.

Primary source of agricultural information (SOURCINF)

The source of agricultural market information was highly statistically significant at the 1% level ($p = 0.000$). This strong inverse relationship suggests that better-informed farmers may already be positioned to make strategic marketing decisions without additional extension support. Supporting evidence from Mzuyanda (2014) indicates that AES plays a crucial role in reducing information asymmetry, particularly for farmers with limited access to reliable agricultural information. The study demonstrated that AES empowers less-informed SHMFs to adopt marketing innovations by strengthening information flow and improving decision-making. Kalogiannidis and Syndoukas (2024) noted that access to knowledge of the agricultural market is crucial for agricultural growth, thereby enhancing global development and increasing farm productivity.

Hired equipment (HIREMECH)

The use of hired implements was statistically significant at the 5% level ($p = 0.055$), suggesting that using hired machinery may have a positive influence on innovative market channel choices. Agricultural extension services can counteract this by offering training on economically efficient mechanisation strategies. Mdoda *et al*. (2022), using PSM, found that SHMFs who received AES support were more likely to adopt labour- and cost-saving technologies, reducing their dependency on hired services and increasing their capacity to explore innovative marketing options.

Market distance (DIST)

As hypothesised, the distance to the market centre was statistically significant at the 1% level ($p = 0.010$), indicating that the farther the farm is from the market, the lower the probability of market participation due to high transport costs and logistical constraints. SHMFs located farther from markets might prefer using innovative market channels. This finding aligns with Kangogo (2024), who found that the distance from the farm to the market negatively affected the extent of market participation. This implies that for every additional kilometre from the market, the quantity sold decreases by a certain percentage. This is because a longer distance would result in higher transportation costs, leading to smaller quantities being sold. Similarly, Haile *et al*. (2022) state that the longer the distance, the more costly and time-consuming it becomes for farmers to transport the output.

4.4.3 Summary of generated propensity scores

Table 11: Summary of Generated Pscores

Variable	Group	Observations	Mean	Standard deviation	Minimum	Maximum
Pscore	Treatment	168	.8480231	.2007329	.0521649	.9991061
Pscore	Control	104	.2399692	.2852002	.0024253	.9829481
Pscore	Combined	272	.6155319	.3786589	.0024253	.9991061

The Probit score (Pscore) data clearly show differences between the treatment and control groups. The propensity score results illustrate how the 168 farmers who received AES (treatment group) were statistically matched with the 104 farmers who did not receive AES (control group) based on their estimated likelihood of receiving AES. This ensured that farmers with similar characteristics were paired before impact estimation. The matching process pairs individuals with similar Pscores from both groups, ensuring comparisons closely mimic a randomised experiment. The treatment group consists of 168 observations with an average Pscore of 0.85 and a standard deviation of 0.20. This suggests that this group often exhibits higher propensity scores, with a minimum and maximum Pscore of 0.05 and 0.99, respectively. On the other hand, the 104-observation control group's much larger standard deviation of 0.29 and average Pscore of 0.24 suggest greater variability in their propensity scores.

These disparities are further highlighted by the mean Pscore of 0.62 and the standard deviation of 0.38 obtained from the pooled data across both groups, comprising 272 observations. These results demonstrate notable disparities in the Pscore distribution between the two segments; individuals in our assigned experimental team regularly display greater numbers than those in the pure comparison group. It is essential to note that these patterns may reveal specific factors that have a distinct impact on participants' elevated pitch levels.

4.4.4 Distribution graph of the entire population

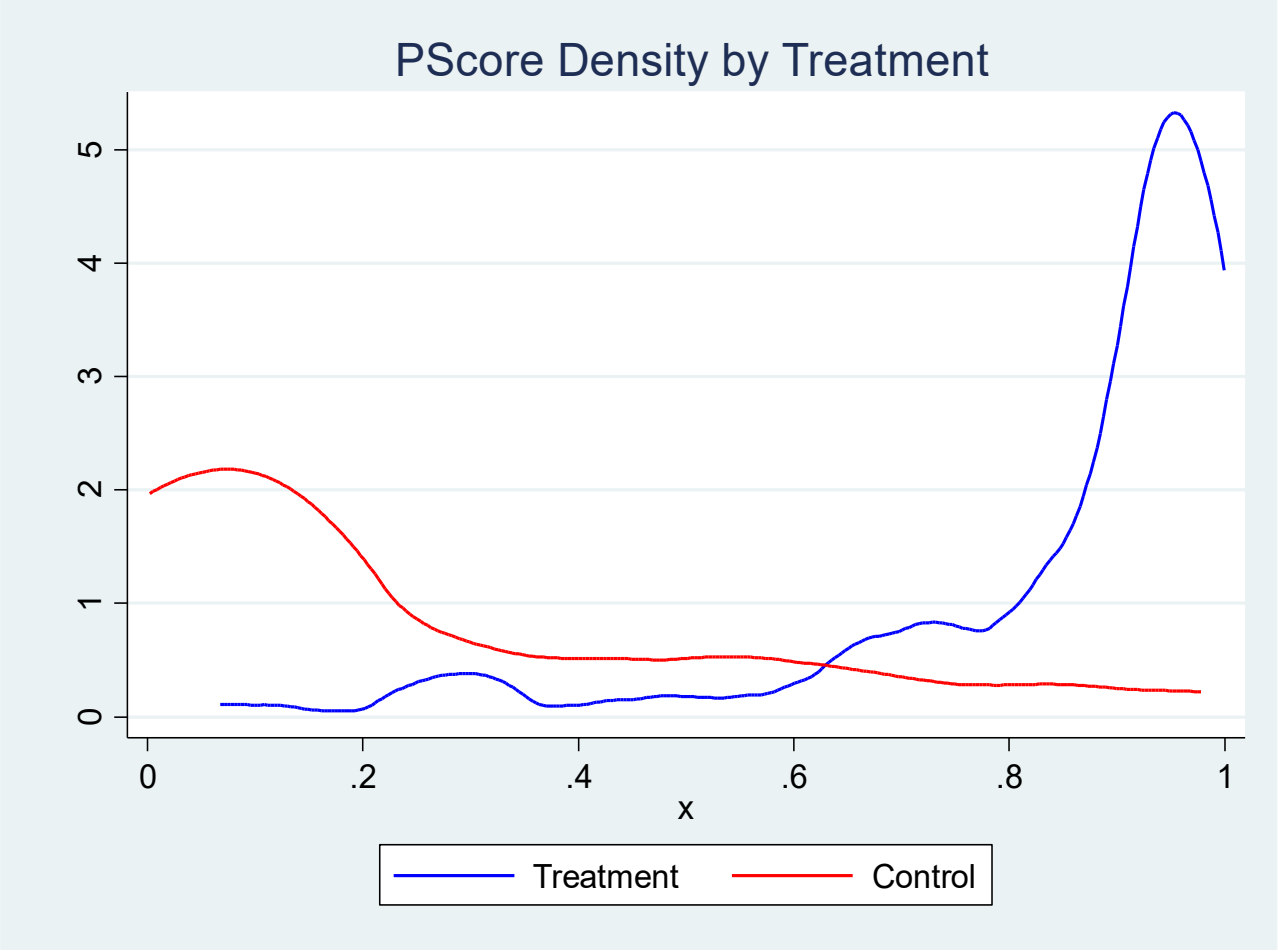

Figure 11: Distribution graph for the treatment and control group

Source: Field survey data (2024), analysed by the author using STATA

The graph in Figure 11 illustrates the distribution of propensity score densities for two groups: individuals who received the treatment (SHMFs who received agricultural extension services) and those who did not (SHMFs who did not receive agricultural extension services). This distribution used kernel density estimates to illustrate the concentration of propensity scores within each group. The graph presents propensity scores along the x-axis.

The scores indicate estimated probabilities, ranging from 0 to 1, that a subject will receive treatment based on characteristics. The y-axis represents density, showing the frequency of observations at each level of propensity score within each group. The blue line represents the data for participants who receive agricultural extension services, while the red line represents the data for participants who do not.

4.4.4.1 Evaluation of Results

The distribution indicates a clear difference in the concentration of receiving and not receiving agricultural extension services across the propensity-score range. Participants who do not receive AES (indicated by a red line) exhibit higher densities at lower propensity scores, particularly between 0.1 and 0.2. This observation implies that these individuals had a reduced likelihood of receiving AES based on their socio-economic characteristics. In addition, participants who receive AES, represented by a blue line, show a peak near the upper end of the spectrum at approximately 1, suggesting that participants in this category were more likely to receive AES.

4.4.4.2 Overlap of Distributions (Common Support)

Effective propensity score matching requires the existence of a common support area where the propensity scores of receiving AES and NOT receiving AES intersect. The graph in Figure 10 shows significant overlap in the middle range (0.2-0.6), while demonstrating minimal overlap at the extremes. A total of 168 participants received AES scores near 1, while those not receiving AES showed limited corresponding observations. Conversely, numerous controls had scores below 0.2, with minimal representation from those receiving AES treatment in the study area. The limited overlap suggests constraints in identifying appropriate matches between participants who received AES and those who did not, which may affect the reliability of the results. The absence of substantial overlap suggests that further refinements may be necessary to enhance the matching process. Removing observations outside the common support area, such as treatment subjects with extremely high scores and control subjects with extremely low scores, may improve the dataset's balance. This step may mitigate biases that could arise from comparing individuals with significantly different propensity scores.

4.4.5 An average Treatment Effect on the Treated (ATT) Analysis

Table 12: Analysis of ATT for quantity sold (Quant3)

According to Table 12, results of ATT for maize quantity sold are presented, using nearest-neighbour, radius and kernel matching models.

Table 12: Analysis of ATT for Quantity Sold (Quant3)

Matching Method	**Sample**	**Treated Mean**	**Control Mean**	**Difference**	**Standard Error**	**T-statistic**
Nearest Neighbor	Unmatched	24.33	19.31	5.03	2.35	2.13
	ATT	23.96	23.32	0.64	4.75	0.13
Radius Matching	Unmatched	24.33	19.31	5.03	2.35	2.13
	ATT	23.96	19.31	4.65	1.79	2.61
Kernel Matching	Unmatched	24.33	19.31	5.03	2.35	2.13
	ATT	23.96	22.01	1.95	4.72	0.41

The comparison of quants3 between participants who received AES and those who did not indicates a difference: the treated group averages 24.33, while the control group averages 19.31. The analysis shows a statistically significant difference of 5.03, with a T-statistic of 2.13. Prior to applying matching, we observed that individuals receiving treatment had higher quant3 values than those in the control group. This discrepancy may suggest pre-existing disparities rather than being exclusively attributable to the intervention's effects; thus, conducting matches is essential for appropriately adjusting baseline differences.

The Average Treatment Effect on the Treated (ATT) was calculated for quants3 using nearest-neighbour matching, yielding a value of 0.64. Moreover, the observed values from the treated group (mean = 23.96) and the control group (mean = 23.32), with a standard error of 4.75. This leads to a T-statistic of 0.13, indicating statistical insignificance. After adjusting for baseline differences using this matching method, the treatment does not appear to significantly influence quants3 outcomes. Post-matching assessments indicate minimal divergence between the treated and control groups concerning quants3 metrics.

Radius matching indicates an Average Treatment Effect on the Treated (ATT) of 4.65, demonstrating a positive disparity between the treated and control groups. The standard error of this method is 1.79, which is lower than that of nearest neighbour matching, yielding a statistically significant T-statistic of 2.61. Radius matching shows a significant improvement in quants3 scores, indicating that individuals who received the treatment have higher values compared to their matched counterparts in the control group, even after adjusting for baseline characteristics.

Kernel matching yields an average treatment effect on the treated (ATT) of 1.95, with a standard error of 4.72 and a T-statistic of 0.41, indicating a lack of statistical significance. The mean for the treated group is 23.96, whereas the mean for the control group is 22.01, indicating a minor difference between the two groups. Similar to nearest-neighbour matching, kernel matching shows no significant difference in quants3 between the treated and control groups, indicating that the treatment effect remains close to zero. Therefore, the results in Table 12, which compare the three matching methods, demonstrate the sensitivity of the treatment effect to the technique employed. Radius matching has a strong positive influence on quants3, indicating that the treated group benefits from this outcome variable when radius matching is applied. In contrast, neither nearest neighbour nor kernel matching shows a substantial treatment effect.

4.4.6 Matching outcomes

Matching was performed by pairing the treated (receiving extension services = 1) and control (not receiving extension services = 0) SHMFs based on their propensity scores. This resulted in comparable groups based on the covariates. The matching results are presented above. Of the sampled participants, 104 control observations fell within the area of common support and were successfully matched with treated farmers. This means that each of the 104 non-AES farmers was matched to a treated farmer with a similar propensity score, ensuring similarity in observable characteristics. After matching, balance diagnostics showed that the treatment and control groups were sufficiently comparable. This ensured that the differences in outcomes between the two groups could be attributed to the treatment rather than pre-existing differences. The variance ratios were closer to 1, indicating that the variability of covariates is similar between groups. Moreover, the p-values were greater than 0.5, indicating that the covariates were not significantly different between groups.

4.4.7 Multinomial Logistic regression results

After matching, a multinomial logistic regression was used to examine the relationship between the treatment (extension service) and the categorical outcome (market choice). The outcome variable is the market choice (contract to e-commerce), and the main independent variable of interest is whether the farmer received the extension service. The covariates (age, gender, farm type, and farm size) were also included in the model to control their effects.

Table 13: The Multinomial Logit Regression Results of PSM

Independent variables	1= Contract	2= Collective	3= e-commerce
xAGE	0.100*	0.087	0.145
xGender	0.089	0.097	0.040**
xEduLvl	0.084	0.057**	0.280
xFarmSize	0.033**	0.051**	0.038**
xExper	0.274	0.348	0.665
xTypfarm	0.782	0.889	0.962
xStorag	0.993	0.000*	0.001***
xAES	0.961	0.960	0.050**
xDIST	0.025**	0.025**	0.057
xTrain	0.960	0.960	0.960
XMode of trans	0.010*	0.012**	0.010
Tr	-2.616	0.521	2.349
	0.073	1.684	10.474
Constant	3.220	4.169	-3.389
	25.032	64.622	0.034
Akaike Inf. Crit.	606.469	606.469	606.469
Note that *, **, * denotes statistically significant at 10%, 5% and 1%, respectively.** **Farmgate** is used as a base category			

4.4.7.1 Nominal Variable Interpretation

The outcome variable is market choice, which is nominal in nature. The model compares the likelihood of choosing each market (1 = contract, 2 = collective, 3 = e-commerce) relative to the base market (4 = farm gate).

4.4.7.2 Treatment Interpretation (Extension Service)

The treatment variable is binary (0 = no service, 1 = service). The odds ratios for extension services indicate how receiving extension services affects the likelihood of choosing a market relative to the base market.

4.4.7.3 Covariates Interpretation

For each covariate, the model provides the effect on the probability of choosing one market over the base market.

4.4.7.4 Significant variables:

There were seven statistically significant variables: gender, farm size, educational level, storage facility, distance to the market, AES and mode of transport. Gender was significant at 5% level of significance (p-value < 0.04), whereas farm size for all the channels was significant at (p-value < 0.33, 0.051, 0.038), respectively. Storage facilities were significant at the 1% level (p-values < 0.000 and 0.001) for collective and e-commerce, respectively. Moreover, extension services were significant at 5% level of significance (P = 0.050) for e-commerce. It is essential to note that while gender was significant only in market 3 (e-commerce), farm experience, hired implements, and type of farming were not significant across all markets and are therefore not interpreted or discussed further. The extension service was significant only for e-commerce. Moreover, only the odds ratios are interpreted, which were derived by exponentiating the coefficients of the multinomial logit model. The results are interpreted as per the type of market.

4.4.7.5 Farmgate in contrast to (Contract)

Both farm size and extension services were identified as crucial factors for SHMFs when choosing a market. The odds ratio for farm size was 0.560 ($p < 0.05$), suggesting that larger farms are less likely to choose Farmgate choices over the Contract market. This implies that farmgate sales may be preferred by these businesses due to the logistical or operational advantages they offer when managing large volumes of maize directly with customers. Furthermore, an odds ratio of 0.073 ($p < 0.01$) indicates a significant inverse link between selecting the contract market and obtaining extended services. This suggests that, despite receiving expert advice through these services, individuals who benefit from them are less likely to adopt contract-based selling strategies than those who use traditional direct sales at farmgate markets. They may view contracts as more restrictive or less favourable than traditional direct transactions.

4.4.7.6 Farmgate Market vs. Collective Market

Farm size and gender significantly influenced the choice of the collective market. The gender odds ratio was 0.489 ($p < 0.10$), indicating that gender may influence the choice between the collective market and farmgate. Furthermore, market selection was significantly influenced by farm size, with an odds ratio of 0.243 ($p < 0.05$). This suggests that smaller farms may find collectives more appealing, as they can access improved resources and collective bargaining power under this model, whereas larger farms are less likely to opt for collectives over farmgate marketplaces. Furthermore, the collective market option was not significantly influenced by extension services, suggesting that SHMFs would benefit from such assistance, but this does not encourage them to make it their first choice.

4.4.7.7 Farmgate in contrast to E-commerce

Both farm size and extension services significantly influence the decision to choose e-commerce as a market option. Larger farms are significantly less likely to choose e-commerce over farmgate sales, as indicated by the odds ratio for farm size, which was 0.089 ($p < 0.01$). This could be because handling smaller operations on digital platforms is typically more logistically feasible, with distribution and packaging dynamics often better suited to e-commerce setups with lower transaction volumes. On the other hand, an odds ratio of 10.474 ($p < 0.05$) indicates that extension services significantly influence users' choice of e-commerce. E-commerce was significantly more likely to be chosen by SHMFs who received these services than by Farmgate outlets, highlighting the role that such support plays in encouraging SHMFs to use creative marketing strategies. These results suggest that extension services play a crucial role in equipping SHMFs with the skills and information they need to successfully navigate and thrive in online marketplaces.

4.5 Farmers constraints using the sustainable livelihood framework.

Table 14: Smallholder Maize Farmers' Constraints

Table 14 presents constraints encountered when selecting different market channels. The results are presented in Likert scale format for frequency and percentages. A sustainable livelihood framework was used to check the five pillars of sustainable livelihood.

Table 14: Smallholder Maize Farmers Constraints using the SLF

CONSTRAINTS STATEMENTS	**SA (%)**	**A (%)**	**N (%)**	**D (%)**	**SD (%)**	**X**	**Σ**
FINANCIAL CONSTRAINTS							
It is costly to transport farm produce to the desired market centre	193 (70.96%)	47 (17.28%)	22 (8.09%)	6 (2.21%)	4 (1.47%)	4.540	0.849
Unavailability of financial institutions influences SHMFs' ability to access different market channels	198 (72.79%)	55 (20.22%)	7 (2.57%)	4 (1.47%)	8 (2.94%)	4.585	0.859
It is expensive to obtain relevant market information using online platforms	188 (69.12%)	31 (11.40%)	28 (10.29%)	14 (5.15%)	11 (4.04%)	4.364	1.112
It is costly to buy packaging materials (sacks) to properly package maize produce	172 (63.24%)	47 (17.28%)	19 (6.99%)	12 (4.41%)	22 (8.09%)	4.232	1.248
Limited access to grants, donations and supports influences SHMFs' participation in maize marketing	178 (65.44%)	71 (26.10%)	7 (2.57%)	11 (4.04%)	5 (1.84%)	4.493	0.876
PHYSICAL CONSTRAINTS							
The tarmac road has potholes, making it difficult for SHMFs to use when transporting maize produce	93 (34.19%)	77 (28.31%)	10 (3.68%)	27 (9.93%)	65 (23.90%)	3.390	1.601
Farmers' find it difficult to use the gravel road during rainy days which influences the driving of farm machinery and	105 (38.60%)	94 (34.56%)	6 (2.21%)	20 (7.35%)	47 (17.28%)	3.699	1.475

vehicles causing delays in farming operations and deliveries.							
Inadequate storage facilities result into SHMFs' maize produce spoilage	148 (54.41%)	81 (29.78%)	17 (6.25%)	18 (6.62%)	8 (2.94%)	4.261	1.035
Limited access to production resources (e.g. farm machinery, implements and tools) hinder SHMFs' ability to enhance maize productivity	148 (54.41%)	86 (31.62%)	10 (3.68 %)	20 (7.35%)	8 (2.94%)	4.272	1.034
NATURAL CONSTRAINTS							
Unreliable water supply for irrigation influences SHMFs' productivity	189 (69.49%)	46 (16.91%)	6 (2.21%)	21 (7.72%)	10 (3.68%)	4.408	1.093
Insufficient arable land restricts SHMFs' options for expanding maize farms	159 (58.46%)	47 (17.28%)	4 (1.47%)	29 (10.66%)	33 (12.13%)	3.993	1.458
Unfavourable weather conditions affect SHMFs' maize production resulting into low yield	167 (61.40%)	60 (22. 06%)	4 (1.47%)	17 (6.25%)	24 (8.82%)	4.393	3.334
SOCIAL CONSTRAINTS							
I receive poor support for resolving conflicts related to water rights	75 (27.57%)	63 (23.16%)	12 (4.41%)	37 (13.60%)	85 (31.25%)	3.022	1.652
There are conflicts within our farmer groups/ cooperatives	34 (12.50%)	40 (14.71%)	12 (4.41%)	63 (23.16%)	123 (45.22%)	2.261	1.466
I receive inadequate training on maize production	95 (34.93%)	81 (29.78%)	6 (2.21%)	56 (20.59%)	34 (12.50%)	3.540	1.455
I receive insufficient training on maize marketing which influences my choice of innovative market channel	100 (36.76%)	85 (31.25%)	9 (3.31%)	47 (17.28%)	31 (11.40%)	3.647	1.414

I receive inadequate relevant market information influencing my decision to select profitable markets	98 (36.03%)	80 (29.41%)	11 (4.04%)	48 (17.65%)	35 (12.87%)	3.581	1.448
HUMAN CONSTRAINTS							
I receive insufficient extension service assistance/ support	103 (37.87%)	60 (22.06%)	12 (4.41%)	46 (16.91%)	51 (18.75%)	3.434	1.573
I receive inadequate technical assistance for compliance with market entry regulations	110 (40.44%)	59 (21.69%)	5 (1.84%)	48 (17.65%)	50 (18.38%)	3.482	1.589
Lack of formal education influence SHMFs' choice for maize marketing	91 (33.46%)	59 (21.69%)	13 (4.78%)	64 (23.53%)	45 (16.54%)	3.320	1.536
Insufficient network infrastructure hinders SHMFs' ability to use online platforms for marketing maize	100 (36.76%)	85 (31.25%)	21 (7.72%)	42 (15.44%)	24 (8.82%)	3.717	1.335
Insufficient marketing skill(s) limit SHMFs' ability to effectively choose innovative market channels for selling maize.	102 (37.50%)	79 (29.04%)	6 (2.21%)	52 (19.12%)	33 (12.13%)	3.607	1.451
PLEASE NOTE THAT: **N= 272** **SD**= STRONGLY DISAGREE, **D**= DISAGREE, **N**=NEUTRAL, **A**= AGREE, **SA**= STRONGLY AGREE **%**= PERCENTAGE, **X**=MEAN, **Σ**= STANDARD DEVIATION,							

Table 14 presents the constraints encountered by smallholder maize farmers when using innovative market channels. The constraints were grouped according to the sustainable livelihood framework's assets: financial, physical, natural, social, and human. The results are displayed on a 5-point Likert scale, where 1 indicates 'strongly disagree', and 5 indicates 'strongly agree'. In line with Shemfe and Oladele (2018), the mean ratings for each limitation were calculated using the Likert scale (5, 4, 3, 2, 1) to assess their relative severity. The mean was calculated as represented below:

- 5 + 4 + 3 + 2 + 1 = 15
- 15/5=3

Therefore, a mean score of 3 or higher indicates that participants agree that the statement is a constraint, whereas any value below this threshold is not considered an influential constraint.

4.5.1 Financial constraints encountered by smallholder maize farmers when selecting innovative market channels.

Table 14 presents the distribution of financial constraints reported by SHMFs regarding participation in innovative market channels. The constraint's statements summarise various financial barriers faced by SHMFs, particularly in relation to transportation costs, access to financial institutions, limited funding and the affordability of market information and packaging materials.

Adequacy of financial institutions

Table 14 shows that 93.01% (253) of participants agreed that there is a lack of adequate financial institutions in their area. A smaller proportion, 4.41% (10), disagreed, while 2.57% (7) remained neutral. The mean score for this item is 4.540, with a standard error of 0.849. This distribution indicates that, in this sample, smallholder farming remains constrained by inadequate financial institutions, including a lack of collateral, and the perceived high risk associated with smallholder farming, which restricts farmers' access to formal credit. Chaiya, Sikandar, Pinthong, Saqib, and Ali (2023) and FAO (2023) argued that agricultural credit can be utilised to purchase inputs such as fertilisers, labour, and seeds, or to acquire equipment such as irrigation systems or delivery trucks, to enhance farm operations. Consequently, Qwabe (2014),

Sebola (2018) and Chaiya *et al*. (2023) reported that rural farmers commonly experience gaps in institutional support, with financial providers being scarce or distant in many developing regions. There is a need for long-term strategic partnerships for effective collaboration between these institutions and SHFs. A clear framework should be in place before any funding commences to accommodate additional SHFs.

Limited access to funds and support grants

Table 14 further displays results for limited access to funds and support grants among the study participants. The majority, 91.54% (249) of the sampled participants, agreed that limited access and support grants affected their selection of innovative market channels. Only 5.88% (16) disagreed with the statement. The mean average score is 4.493, and the standard error is 0.876. Meanwhile, 4.04% (11) of participants remained neutral to the statement. This distribution suggests that financial support for grants among SHFs remains a constraint limiting their participation in innovative market channels. The study findings align with Aliber and Hall (2012), who noted that many SHFs in developing countries face a lack of financial support, a global challenge that affects productivity and market participation among SHFs in developing regions. Ngcobo (2019) found that 92% of SHFs in the study area agreed that a lack of financial support constrained their participation in structured markets. According to Maziku and Mashenene (2024); Teame and Yacob (2023), the agricultural sector in SSA faces an estimated agricultural financing shortfall. This gap hampers SHFs' abilities to expand their operations and participate fully in formal markets.

Cost of buying packaging materials

The distribution for the cost of purchasing packaging materials, such as sacks, 80.52% (219) of participants agreed with the statement. Meanwhile, 12.50% (34) disagreed, and 6.99% (19) remained neutral. The mean for this item is 4.232, with a standard error of 1.248. This distribution indicates that a large share of respondents identifies packaging costs as a constraint. Abass et al. (2014) noted that packaging challenges often increase handling costs for small-scale farmers. Mulaudzi, Olorunfemi and Agholor (2016) documented high packaging expenses as a hindrance to market readiness among SHFs. Pickson and He (2021) also observed that packaging limitations reduce the presentation of product quality, particularly for maize and grains.

Cost of accessing relevant and timely market information

The distribution further shows that 80.52% (219) agreed that accessing timely market information is costly, while 9.19% (25) disagreed and 10.29% (28) remained neutral. The mean score for this item is 4.364, with a standard error of 1.112. These figures reflect respondents' ratings of the affordability of market information. Ssajakambwe *et al*. (2019) reported that rural farmers often rely on irregular and expensive information sources. In contrast, Changalima and Ismail (2022) and Mdoda *et al*. (2024) noted that the affordability of digital tools continues to impact the accessibility and flow of market information.

Transport cost

Transportation costs were also highlighted as a major constraint, with 88.24% (240) of respondents agreeing that transporting produce to markets is costly. Only 3.68% (10) disagreed, while 8.09% (22) remained neutral, and the mean score for this item is 4.540. This pattern suggests that many participants shared similar views on transport cost challenges. Previous studies widely acknowledge transportation as a significant financial burden for smallholder farmers. Abass *et al*. (2014) and Mulaudzi *et al*. (2016) identified transportation as one of the most expensive components of smallholder market participation. Pickson and He (2021) noted that high transport costs are associated with long distances between farms and markets, while Teame and Yacob (2023) reported similar logistical costs in smallholder supply chains.

4.5.2 Physical constraints encountered by smallholder maize farmers when selecting innovative market channels.

Limited access to production resources

Table 14 presents the distribution of physical constraints experienced by SHFs regarding agricultural production and the use of innovative market channels. One notable constraint reported by respondents is limited access to production resources such as farm machinery, implements, and tools. A large proportion, 86.03% (234), agreed that access to production resources is limited, while 10.29% (28) disagreed and 3.68% (10) remained neutral. The mean score of 4.272 and a standard error of 1.034 indicate that most participants agreed with this constraint. Previous studies have similarly documented shortages in essential production resources among smallholders. Mulaudzi *et al*. (2016) observed that the lack of appropriate equipment impedes farming operations, while Abass et al. (2014) noted that inadequate tools and machinery contribute to inefficiencies in production.

Inadequate storage facilities

The results further indicate that the distribution of storage facilities remains a common physical challenge. A total of 84.19% (229) agreed that inadequate storage facilities contribute to producing spoilage, 9.56% (26) disagreed, and 6.25% (17) were neutral. The mean score of 4.261 and a standard error of 1.035 indicate that most respondents agreed regarding the effect of limited storage. Past studies reflect similar concerns. Abass *et al*. (2014) highlighted that poor storage leads to substantial post-harvest losses among smallholder farmers. Mdoda *et al*. (2024) also noted that limited storage infrastructure reduces product shelf life and market readiness, particularly for maize and other staple crops.

Gravel road condition

Road infrastructure also appears prominently among the constraints identified. Regarding the condition of gravel roads during rainy periods, the distribution shows that 73.16% (199) agreed that these roads become difficult to use, affecting the movement of farm machinery and delaying farm operations. In contrast, 24.68% (67) disagreed, and 2.21% (6) remained undecided. Previous studies have described similar conditions in rural agricultural areas. Tamene and Megento (2019) reported that poor road quality during rainy seasons hampers the movement of produce and disrupts agricultural schedules, while Nwafor (2020) noted that weather-related road challenges are common among rural smallholder farmers across Sub-Saharan Africa.

The tarmac road

Regarding tarmac roads, the distribution shows that 62% (170) of participants agreed that the tarmac roads they use have potholes, making transportation of produce difficult. A total of 33.83% (92) disagreed, while 3.80% (10) remained undecided. The mean score of 3.699 and standard deviation of 1.601 reflect varied responses but show that many respondents selected agreement. Similar observations have been made in earlier research. Ngcobo (2019) reported that pothole-ridden roads hinder the delivery of produce and increase transportation time. Pickson and He (2021) further noted that damaged road surfaces challenge farmers' ability to transport their produce to formal markets. Previous studies, such as those by Tamene and Megento (2019) and Nwafor (2020), have shown that inadequate road infrastructure contributes to high transportation costs, thereby limiting market access.

Similarly, Abass *et al*. (2014) reported that physical barriers, such as poor road networks, increase logistical burdens for SHFs. The findings reflect the distribution of responses regarding physical limitations affecting SHMFs' marketing activities.

4.5.3 Natural constraints encountered by smallholder maize farmers when selecting innovative market channels.

Unreliable water

The findings clearly demonstrate that natural resource constraints play a crucial role in shaping the production outcomes of SHMFs and, consequently, their market channel choices. The distribution shows that a considerable proportion of farmers (86.4%) reported not having access to an unreliable irrigation water supply. This strong level of agreement is supported by the high mean score (M = 4.408, SD = 1.093), suggesting that access to consistent irrigation remains a major challenge. The results align with studies such as Chuma, Mudhara, and Govereh (2020), who emphasised that access to reliable water sources remains a major constraint in developing regions.

Unfavourable weather conditions

Unfavourable weather conditions emerged as a dominant constraint. Majority of farmers (83.46%) agreed that weather extremes affect their maize production and marketing prospects, confirmed by the high mean score (M = 4.393). These findings reinforce the argument by Tafesse *et al*. (2023), who noted that climate-related shocks, such as drought and erratic rainfall, significantly reduce yields and increase vulnerability among SHFs, ultimately affecting the consistency and quality of produce supplied to markets.

Access to land

Access to arable land was additionally identified as a limiting factor, with 75.74% of farmers indicating that insufficient land restricts their ability to expand maize production. Although the mean score (M = 3.993) reflects substantial agreement, it also highlights disparities in land distribution that hinder scaling of operations. Related challenges were noted by Chuma *et al*. (2020), who found that limited land availability forces SHFs to operate on small plots, thereby reducing their capacity to adopt improved technologies and consistently supply high-value markets.

Beyond natural constraints, the study also identified infrastructural barriers, particularly storage facilities and road networks, as major determinants shaping SHFs' production and marketing capabilities. Insufficient storage facilities were cited by 84.19% of respondents, findings consistent with those of Tafesse *et al*. (2023), who reported that inadequate storage leads to post-harvest losses, forcing farmers to sell prematurely at low prices. Similarly, Chuma *et al.* (2020) argued that farmers without proper storage infrastructure are highly exposed to market volatility, limiting their ability to negotiate better prices or wait for favourable market conditions.

Poor road conditions further exacerbate these challenges. The results show that 73.16% of farmers face difficulties transporting produce during the rainy season, making roads a major barrier to effective market access. This is consistent with Ngcobo (2019) and Changalima and Ismail (2022), who highlighted that inadequate rural transport systems increase travel time, transportation costs, and spoilage risks. Furthermore, the issue of pothole-filled tarmac roads, highlighted by 62% of respondents, resonates with findings from Mashaphu (2022), who reported that poor road infrastructure significantly limits farmers' ability to reach buyers. Cele and Mudhara (2020) similarly observed that rural farmers often experience delays and high logistical burdens due to deteriorated roads. These collective findings point to a critical need for improved rural road infrastructure within the Gert Sibande District to enhance efficient market participation for smallholder maize farmers.

4.5.4 Social constraints encountered by smallholder maize farmers when selecting innovative market channels.

The social constraints are categorised into 5 groups, namely, support for resolving conflicts related to water rights, conflicts within our farmer groups and cooperatives, social training on maize production, training on maize marketing, which influences SHMFs' choice of innovative market channels and relevant market information influencing my decision to select profitable markets.

Poor support for resolving conflicts related to water rights

The findings indicate that social constraints constitute a significant challenge for SHFs when selecting innovative market channels. The results indicate that 50.73% of respondents (75 strongly agree; 63 agree) reported receiving poor support in resolving conflicts related to water rights. A smaller proportion, 18.01% (37 disagreed; 12 strongly disagreed), felt that adequate support exists, while 31.25% (85) remained neutral on the matter.

The mean score of 3.022 (SD = 1.652) indicates moderate agreement, suggesting that water-related conflict resolution remains a significant challenge for smallholder maize farmers. These findings highlight a common issue in rural agricultural communities, where competition over water resources often leads to poorly managed disputes due to weak institutional support. Studies such as Ncube *et al*. (2021) and Fanadzo and Ncube (2018) note that unresolved water conflicts can reduce productivity, limit cooperation among farmers, and strain relationships within irrigation schemes. Additionally, these distributions align with previous studies by Maponya *et al* (2018) and Maziku and Mashenene (2020), who highlighted that unresolved conflicts over water rights can pose challenges to cooperative and community-based farming arrangements. Without effective mediation mechanisms and clear water governance structures, farmers struggle to ensure equitable access to water. Therefore, systems for conflict resolution and transparent water allocation need to be strengthened to support harmonious and efficient farming operations among SHFs.

Conflicts within farmer groups/cooperatives

Another important social constraint identified is inadequate access to relevant market information. The results show that 27.21% of respondents (34 strongly agree; 40 agree) acknowledged conflicts within their farmer groups or cooperatives. In contrast, 68.38% (63 disagreed; 123 strongly disagreed), suggesting that most respondents do not perceive internal conflicts as a major challenge. Only 4.41% (12) remained neutral. The mean score of 2.261 (SD = 1.466) confirms that internal conflicts are generally not viewed as a predominant constraint. This distribution suggests that, in this sample, farmer groups and cooperatives are operating relatively effectively. Cooperative theory suggests that strong internal governance, clear roles, and shared objectives help minimise internal disputes (Ortmann and King, 2007). The low level of perceived conflict may indicate good organisational cohesion, effective communication among members, or successful leadership structures. However, the minority who reported conflict may reflect isolated cases in which mismanagement, unequal participation, or challenges to benefit sharing occur, issues commonly highlighted in the cooperative literature.

Inadequate training on maize production

Inadequate training also emerged as a significant concern. A total of 64.71% of respondents (95 strongly agree; 81 agree) stated that they receive inadequate training on maize production. Only 33.09% (56 disagreed; 34 strongly disagreed) felt that training was sufficient, and 2.21% (6) remained neutral. The mean score of 3.540 with a standard deviation of 1.455 indicates a strong perception of inadequate technical capacity-building. This result highlights the persistent gap in extension services reported in several developing agricultural sectors. According to Anderson and Feder (2007) and Sebola (2018), limited training on modern production techniques restricts farmers' ability to improve productivity, adapt to climate change, and adopt innovative technologies. For maize farmers, the lack of training may hinder their skills in areas such as soil fertility, pest management, climate-smart practices, and the efficient use of inputs. Strengthening extension services, improving access to agronomic training, and utilising participatory approaches could significantly enhance farmers' production capacities.

Insufficient training on maize marketing influences the choice of market channel

The data reveal that 68.01% of respondents (100 strongly agree; 85 agree) reported receiving insufficient training in maize marketing, which, in turn, affects their ability to select innovative and profitable market channels. On the contrary, 28.68% (47 disagreed; 31 strongly disagreed) disagreed with this statement, and 3.31% (9) remained neutral. The mean score of 3.647 (SD = 1.414) indicates a strong consensus on the inadequacy of marketing training. Marketing knowledge is essential for farmers to navigate modern market systems, including e-commerce, contract farming, and collective marketing. These distributions are similar to those reported in the literature by Barrett (2008), and Mabuza et al. (2022) emphasise that poor training in market dynamics leaves farmers ill-equipped to negotiate pricing, meet quality standards, or identify high-return channels. In this context, limited marketing literacy undermines farmers' ability to participate in innovative market channels and restricts their income potential. Enhanced marketing extension services, market intelligence systems, and farmer training programmes are therefore crucial for improving market participation.

Inadequate market information influencing the selection of profitable markets

The results show that 65.44% of respondents (98 strongly agree; 80 agree) reported receiving inadequate market information that affects their decision-making regarding profitable markets. Only 30.52% (48) disagreed or strongly disagreed that they had adequate market information, while 4.04% (11) were neutral. The mean score of 3.581 (SD = 1.448) confirms that access to reliable and timely market information is a significant constraint. Access to market information, including prevailing prices, demand conditions, transportation costs, and buyer requirements, is a key determinant of market success. According to FAO (2023), smallholder farmers often suffer from information asymmetry, leaving them vulnerable to exploitation, low prices, and poor market choices. The lack of credible and timely information prevents farmers from identifying profitable markets or adjusting their marketing strategies accordingly. Strengthening extension-market linkages, developing ICT-based market information systems, and integrating farmers into information networks could enhance their market decision-making and profitability.

4.5.5 Human constraints encountered by smallholder maize farmers when selecting innovative market channels

Insufficient extension service assistance/support

Table 14 shows that 37.87% (103) of participants agreed and 22.06% (60) strongly agreed that they received insufficient assistance or support from the extension service. A smaller proportion, 16.91% (46), were neutral, while 4.41% (12) disagreed and 18.75% (51) strongly disagreed. The mean score of 3.434 (SD = 1.573) suggests a moderately high perception of limited extension support among smallholder maize farmers. This distribution highlights a persistent challenge in agricultural development. Many smallholder farmers still lack effective, timely, and relevant extension services. Limited contact with extension agents results in constrained access to technical information, innovations, and market opportunities. Inadequate extension services hinder the adoption of technology, limiting farmers' ability to improve production and marketing outcomes. Poor extension-to-farmer ratios, limited mobility of extension officers, and insufficient training resources worsen this gap. These findings align with Raidimi and Kabiti (2019), who found that ineffective extension support weakens farmers' decision-making capacity and reduces productivity.

Extension services remain under-resourced in many African countries, restricting rural farmers' access to advisory support. Strengthening these services through increased funding, ICT-enabled advisory systems, and participatory approaches could improve farmers' production and marketing decisions.

Inadequate technical assistance for compliance with market entry regulations

According to Table 14, 40.44% (110) agreed, and 21.69% (59) strongly agreed that they received inadequate technical assistance to comply with market-entry regulations. Only 1.84% (5) disagreed, while 17.65% (48) were neutral and 18.38% (50) strongly disagreed. The mean score of 3.482 (SD = 1.589) reflects that inadequate technical support for market requirements is a notable challenge. This distribution of findings highlights the structural barriers that smallholder farmers encounter when attempting to participate in innovative markets. Certification, quality grades, food safety standards, and documentation processes often require technical knowledge that many smallholders lack. The lack of institutional guidance makes it difficult for farmers to meet these requirements, thereby excluding them from high-value markets. Studies by Zondi *et al*. (2022) and Shabangu (2015) confirm that insufficient technical training and regulatory support lead to smallholders' continued dependence on informal markets. Strengthening farmer training, simplifying compliance processes, and promoting cooperative engagement can enhance market access.

Lack of formal education influences SHFs' maize marketing choices

Table 14 indicates that 33.46% (91) agreed and 21.69% (59) strongly agreed that a lack of formal education influences market channel choices. A smaller number, 4.78% (13), disagreed, while 23.53% (64) were neutral and 16.54% (45) strongly disagreed. The mean score of 3.320 (SD = 1.536) suggests that education is a significant factor in marketing decisions. This distribution of findings suggests that lower levels of education can reduce farmers' ability to assess risks, negotiate prices, interpret market information, or use innovative channels, such as e-commerce or contracts. This can be due to their level of understanding of market rules and their ability to maintain the necessary records. Educational and digital skills training could therefore enhance smallholder participation in diverse market channels.

Insufficient network infrastructure hinders the use of online platforms for maize marketing

The results show that 36.76% (100) agreed and 31.25% (85) strongly agreed that poor network infrastructure limits online marketing. Only 7.72% (21) disagreed, while 15.44% (42) were neutral and 8.82% (24) strongly disagreed. The mean score of 3.717 (SD = 1.335) indicates strong agreement that infrastructure limitations are a major barrier. This distribution shows that reliable internet connectivity, electricity, and mobile data access are essential for digital platforms. When these infrastructures are weak or inconsistent, farmers cannot fully utilise online marketing opportunities such as WhatsApp trade groups, digital marketplaces, or e-commerce platforms. These results are supported by Cebiso and Mudhara (2022), who suggested that ICT use is primarily constrained by insufficient network infrastructure and can hinder online market participation. World Bank (2020) argues that rural infrastructure gaps remain a core constraint to digital transformation in agriculture. Improving rural connectivity and reducing data costs could enable smallholders to utilise digital marketplaces more effectively.

Insufficient marketing skills limit SHFs' choice of innovative market channels

The final item shows that 37.50% (102) agreed and 29.04% (79) strongly agreed that limited marketing skills restrict farmers' ability to choose innovative market channels. Only 2.21% (6) disagreed, while 19.12% (52) were neutral and 12.13% (33) strongly disagreed. The mean score of 3.607 (SD = 1.451) suggests strong agreement on this constraint. This distribution suggests that Marketing skills, including bargaining, understanding consumer demand, interpreting market trends, and contract management, are crucial for effective market participation. Ndlovu and Masuku (2021) argued that limited knowledge and capacity to meet market requirements (including marketing skills) limit small-scale farmers' access to formal markets and market opportunities. Similarly, Khapayi and Celliers (2016) identify a lack of marketing skills and information as one of the primary factors limiting the transition of emerging farmers to commercial markets and enhancing their market participation. Farmers lacking these skills might rely on traditional market channels, such as farm-gate sales or spot markets, which often offer lower prices. Building capacity in marketing, financial literacy, and agribusiness could empower SHFs to engage more competitively in the market.

4.6 Chapter summary

Chapter 4 provides a comprehensive analysis of the factors influencing SHMFs' choice of innovative market channels, drawing on data from 272 participants, with a focus on Chief Albert Luthuli. The demographic results of the study indicated a balanced gender balance with 51.09% of individuals identifying as female. In terms of age, 47.8% comprised middle-aged (35-55years), and the smallest group was 18.8% (18-35 years). Furthermore, farm size distribution showed that majority was presented by 57.72% (3-10Ha). A total of 43% distribution displays that sampled SHMFs produced on communal land. Furthermore, the MNL results revealed that gender, age, vehicle ownership, farm size, distance, and educational level significantly influence the likelihood of selecting innovative market channels over the farmgate market channel. Farmgate served as the base category in the model in comparison with innovative market channels, with contract being the most used market channel. The base category is used as the reference point for all comparisons in a model (Greene, 2024).

Gender significantly influenced e-commerce participation ($p = 0.031$), indicating that females were less likely to participate in e-commerce. Gender was also marginally significant for contracts ($p = 0.069$) and collective channels ($p = 0.094$). Age demonstrated significance across all channels: contract ($p = 0.022$), collective ($p = 0.011$) and e-commerce ($p = 0.018$), suggesting that older SHMFs show lower participation rates. Farm size showed marginal significance for contract markets ($p = 0.056$), whereas distance to market ($p = 0.083$) and vehicle ownership ($p = 0.094$) demonstrated marginal significance for contract and e-commerce channels, respectively. The PSM results indicate significant differences in the likelihood that SHMFs choose innovative market channels, contingent on their access to AES. The receipt of AES significantly enhanced e-commerce adoption, as treated SHMFs showed a greater inclination to use this innovative channel rather than the farmgate. The findings highlight the essential role of AES in equipping SHMFs with the skills and information needed to navigate innovative markets effectively while addressing logistical and operational challenges. The descriptive analysis identified significant constraints influencing SHMFs' choice of innovative market channels. Financial constraints, including restricted access to financial institutions (93%, mean = 4.585) and transportation costs (88.24%, mean = 4.540), were significant. Physical barriers, such as insufficient storage facilities (84.19%, mean = 4.261) and inadequate road infrastructure (73.16%, mean = 3.699), along with natural constraints like an unreliable water supply for irrigation (86.4%, mean = 4.408), were significant factors. This chapter is followed by the conclusion and recommendations.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The marketing of agricultural products is crucial for advancing sustainable agriculture, ensuring food security, creating employment opportunities and reducing poverty, particularly among smallholder maize farmers. As a primary source of human caloric intake and animal feed worldwide, especially in developing countries, maize is of significant importance. This study examined the factors influencing SHMFs' choices to use innovative market channels, focusing on demographic characteristics, innovative market channels, the effect of agricultural extension services, and constraints due to economic and contextual variables. The primary objective was to highlight the determinants shaping SHFs' preferences for innovative market channels. It also summarises the results analysed and discussed in Chapter 4.

Using a random sample of 272 registered SHMFs at Chief Albert Luthuli Local Municipality, primary data were collected through the administration of structured questionnaires. Constraints were classified using the Sustainable Livelihood Framework, and descriptive statistics (frequencies, percentages, means, and standard deviations) were used to analyse the results. Multinomial Logit Regression and Propensity Score Matching. Descriptive analysis utilised comparisons of frequency, percentages, means, and standard deviations. The study applied the Random Utility Model and the Multinomial Logit regression to examine how socio-economic, institutional, and farm-level factors influence SHMFs' choices among four marketing channels- contract, collective, e-commerce, and farmgate. Propensity Score Matching was used to determine the effect of AES on the sampled SHMFs' choice of innovative marketing channels. Kernel, nearest-neighbour, and radius were used as matching techniques to produce robust and unbiased estimates. This chapter presents the main conclusions of this study. Based on the empirical results, the chapter also draws several recommendations. Furthermore, the final section of this chapter outlines the remaining knowledge gaps and suggests areas for future investigation.

5.2 Conclusion

The marketing of agricultural products is important for advancing sustainable agriculture, ensuring food security, creating employment opportunities and reducing poverty, particularly among SHFs. As a primary source of human caloric intake and animal feed worldwide, especially in developing countries, maize is of significant importance. This study examined the determining factors influencing the choice of innovative market channels of 272 registered SHMFs in the Chief Albert Luthuli Local Municipality. The study draws a conclusion by linking SHMFs' socio-demographic and institutional factors, such as age, gender, farm size, and storage, to the types of innovative market channels used (contracts, collective, and e-commerce).

Additionally, the study found that older SHMFs are less likely to use e-commerce, while larger farm sizes are associated with increased participation in contract markets. Cooperative membership encourages collective marketing, and receiving extension services supports engagement with innovative channels. The study further presents evidence that reveals that farmers weigh risk and profit, preferring contracts for stability and e-commerce for higher returns. The study's key findings on age distribution indicate that smallholder maize production in Chief Albert Luthuli Local Municipality is primarily dominated by farmers aged 35 to 55 years. The results further show that women are represented at 51.09%, resulting in a slightly balanced gender distribution. The distribution of land ownership indicates that communal land is predominantly used by sampled SHMFs, accounting for 43.01%. The farm size distribution shows that most of the sampled respondents produce maize on areas of 3 to 10 hectares, accounting for 57.72%.

Furthermore, most respondents lack access to storage facilities (37.9%). According to the survey, only a few SHMFs (50.4%) engage in irrigated agriculture and do not own vehicles (51.9%). The distribution also shows that majority (59.6%) of the sampled respondents do not have access to credit. A lack of adequate funding and grants is a major challenge, as it limits SHMFs' market participation. The gender disparity highlights the need for greater gender equality within the agricultural sector. The study also indicates that SHMFs in this area face resource constraints, which limit their ability to produce maize efficiently and negatively influence their choice of innovative marketing channels. Consequently, it can be inferred that those with better access to resources may be able to transport their maize harvests over longer distances, where they can obtain higher prices.

The multinomial logistic regression analysis revealed that socio-economic factors had a statistically significant effect on SHMFs' market channel choices. Gender, age, education, farm size, and vehicle ownership were key predictors. The results show that educated SHMFs tended to prefer collective and e-commerce platforms. The findings underscore the pivotal role education plays in fostering market participation. Improving SHMFs' literacy and digital skills can help close the gap between accessing market information and using it effectively. Farm size was positively associated with participation in the contract market. In addition, increased farm size led to a higher proportion of agricultural products available for contract market channels and greater willingness to sell, thereby increasing profits.

On the other hand, farming experience and AES showed limited statistical significance, suggesting potential inefficiencies in their implementation. The results also demonstrated that institutional factors significantly influenced SHMFs' decisions to use innovative marketing channels, such as direct farm-to-market sales. SHMFs who are in remote areas, far from extension practitioners and with poor roads, tend to use the farmgate marketing channel. Additionally, findings on vehicle ownership emphasise the importance of financial support mechanisms designed to help SHMFs acquire reliable transport solutions. The findings revealed that most (168) participants in the study area receive AES and market information. However, it is noted that most of the SHMFs who obtained market and price information lacked the skills to use it effectively. This may be due to SHMFs not receiving sufficient training in maize marketing, as well as the high ratio of extension staff to SHMFs.

The effect of AES on market participation was mixed; propensity score-matching showed varying treatment effects across methods. Radius matching indicated a statistically significant positive effect, whereas nearest-neighbour and kernel matching produced less definitive results, suggesting differences in AES effectiveness. The study concluded that limitations to market participation affect SHMFs' choices of innovative marketing strategies in Mpumalanga. The challenges include restricted access to mechanised tools, insufficient storage facilities, poor road conditions, high transportation costs, limited access to market information, distance from the market, not belonging to cooperatives receiving inadequate AES, and dependence on traditional market channels. To overcome these challenges, holistic interventions are necessary to strengthen SHMFs' capacity to engage effectively with innovative market systems, thereby promoting equitable and sustainable agricultural development.

Regarding the research hypotheses, the findings indicate that the null hypotheses specified in Section 1.8 of Chapter 1 should be rejected.

Hypothesis (i):

H0: There is no significant relationship between the socio-economic characteristics of smallholder maize farmers and their choice of innovative market channels using the Random Utility Maximisation model. This hypothesis should be rejected because the MNL results revealed that several socio-economic variables, including gender, age, education, farming experience, farm size, access to credit, land ownership, and information sources, significantly influenced farmers' probabilities of selecting contract, collective, e-commerce or farmgate channels. These findings confirm that socio-economic characteristics are key determinants of SHMFs' market channel choice.

Hypothesis (ii):

H0: Agricultural extension services have no significant effect on smallholder maize farmers' innovative market channel choices. This hypothesis should be rejected because results from the PSM analysis showed that access to extension services significantly increased farmers' likelihood of participating in innovative market channels. Extension exposure improved farmers' decision-making capacity, reduced information asymmetry, and enhanced their adoption of collective, contract, and e-commerce channels, indicating a strong positive effect on marketing behaviour.

5.3 Recommendations

The findings showed that the majority of SHMFs rely on contract market channels focused on maximising utility, indicating that SHMFs tend to switch between marketing channels as they find more favourable options. They have access to four different marketing channels, including farmgate sales. Among these, contract-based markets emerged as the most frequently used channel. Factors such as gender, age, education level, farm size, distance from the market and vehicle ownership significantly influenced their choice of this channel. Therefore, it is essential for SHMFs to receive education and support in adopting innovations and technologies to effectively explore new market opportunities.

Workshops should be periodically organised to educate SHMFs on using ICT to access e-commerce marketing platforms. Furthermore, regular capacity-building sessions should be conducted for both SHMFs and extension agents to enhance their marketing skills. Educational programs designed to equip SHMFs with digital skills can enhance their participation in e-commerce platforms, thereby increasing their opportunities for growth and success. Collaborations with technology providers can lead to the development of intuitive mobile applications for monitoring prices, accessing markets and conducting sales transactions. The Department of Agriculture in Mpumalanga, in collaboration with NAMC, Grain SA, research institutions, and Landbank, needs to prioritise investment in the development of local rural road networks, markets, and transportation systems to reduce the influence of market distance. Implementing subsidised transport programs and forming partnerships with logistics companies can offer SHMFs affordable ways to deliver them.

To enhance SHMFs' yields and income through improved maize production and marketing, extension services should expand their offerings to include more marketing support. One potential approach is to hire specialised agricultural marketing and extension agents, such as agricultural economists and Assistant Agricultural Practitioners, to work alongside general extension agents focused on production. Furthermore, the Department of Agriculture should develop a skill development facilitator forum to educate these agents about the importance of integrating marketing support with traditional agricultural advisory services. Moreover, public and private stakeholders should work together to implement a SHEP approach as a market-oriented agricultural extension program.

The government should implement policies to subsidise the cost of e-commerce for smallholder maize farmers, promoting inclusive technology. Additionally, extension organisations and rural advisory service stakeholders need to develop capacity-building programs designed to educate these SHMFs on effectively utilising online platforms for agricultural purposes. Moreover, peer learning among SHMFs through existing farmer groups, many of which they belong to, should be encouraged and facilitated. Those competent in online platforms should take the lead in educating their counterparts on how to maximise online platforms in their agricultural enterprises. This will significantly enhance their access to essential and timely information, resources and connections with extension agencies while also increasing opportunities to market their farm produce through more profitable channels beyond the farm gate.

The results revealed that those selling under contract supply milling companies located far from their farms. Thus, it increases their transportation cost and reduces their profit. As a result, those engaged in maize production should focus on ensuring that adequate measures are taken to establish and expand sales points (markets) within rural areas. This will help reduce the distance between farming regions and marketplaces, thereby enhancing SHMFs' ability to choose innovative market channels and participate actively in market activities. Moreover, collaboration among private owners, cooperative societies, and the government is crucial to improving the quality of transportation facilities and road conditions, particularly on feeder roads. Such improvements will lower transaction costs and ensure the timely delivery of maize to markets. Through the public-private partnership, SHMFs can collectively utilise human, financial, physical, and natural assets to boost agricultural productivity and enhance their access to innovative market channels.

Moreover, efforts to improve the distribution of marketing information should include straightforward methods, such as "instant WhatsApp messages" on smartphones, to update prices and alert potential buyers. Additionally, storage facilities must be established in every village and at market locations to facilitate the easy transportation and supply of maize when needed. This approach will help stabilise price fluctuations and ensure a consistent product supply. Financial institutions and government programs should offer low-interest loans and equipment-sharing initiatives to help SHMFs acquire modern farming tools. This approach can boost productivity and prepare SHMFs to satisfy the quality and volume requirements of innovative market channels. Therefore, smallholder maize farmers will be able to make a sustainable choice about profitable, innovative market channels.

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APPENDICES

UNIVERSITY OF MPUMALANGA

FACULTY OF AGRICULTURE AND NATURAL SCIENCES

Postgraduate Studies Committee

Certificate of Approval – Research Proposal

Date of this Approval:	**27 September 2023**

Student Details

1	Student Name:	Cossa, RT
2	Student Number:	201734672
3	School	School of Agricultural Sciences
4	Degree Registered for:	MAgric
5	Date of First Registration:	2023
6	Supervisor(s):	Drs JT Ndoro & M Musara

The research proposal entitled '**Determinants of smallholder maize farmers' innovative market channel choices: Chief Albert Luthuli Local Municipality**' has been evaluated and approved by the Postgraduate Studies Committee of the Faculty of Agriculture and Natural Sciences.

Chairperson: Prof. Victor Mlambo

Signature:

UNIVERSITY OF MPUMALANGA
28 -03- 2023
FACULTY OF AGRICULTURE AND NATURAL SCIENCES

Date & Official Stamp:

Appendix 1: Topic Approval

UNIVERSITY OF MPUMALANGA

Creating Opportunities

B Maoneke (PhD)

School of Computing and Mathematical Sciences

Mbombela Campus.

Dear Randy Tholakele Cossa

Protocol Reference Number: UMP/Cossa/201734672/MAGR/2024

Project Title: Determinants of Smallholder Maize Farmers' Innovative Market Channel Choices: Chief Albert Luthuli Local Municipality.

Approval Notification: In response to your application received on **15/01/2024,** The Research Ethics Committee Faculty Research Ethics Committee has considered the above mentioned application and the protocol has been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interviews 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 stored securely in the School/ division for a period of 5 years.

The Ethical Clearance certificate is only valid for a period of 3 years from date of issue. Thereafter, Recertification must be applied for on an annual basis.

Wishing you the best with your study.

Yours faithfully,

.....

B Maoneke (Chair)

Cc: Faculty Research & Innovation Committee Chair: ..... Mombe

DECLARATION OF INVESTIGATOR(S)

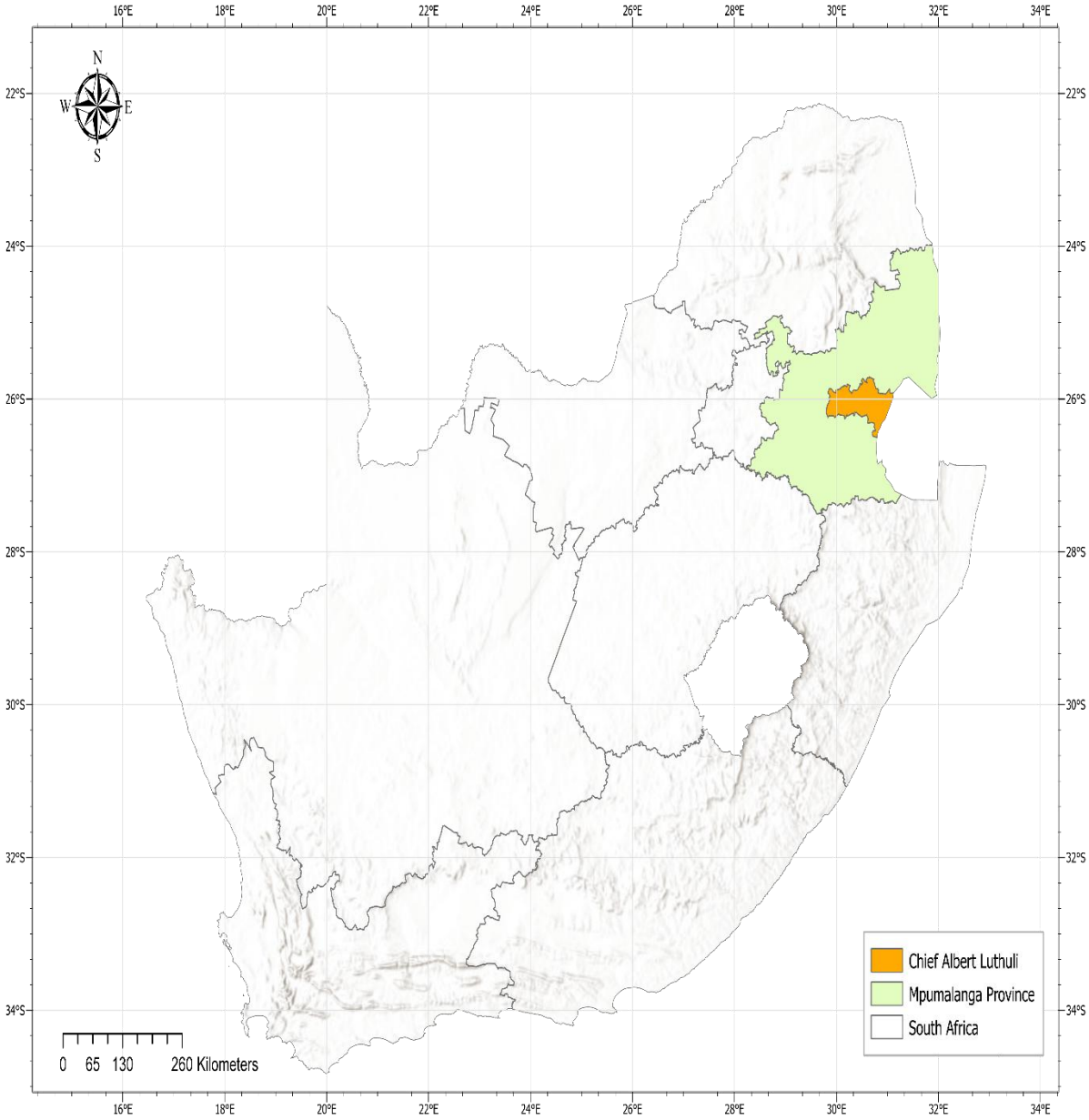
I/We fully understand the conditions under which I am/we are authorised to carry out the abovementioned research and guarantee to ensure compliance with these conditions. I agree to completion of a yearly progress report.

..... 04/03/2024

Signature Date

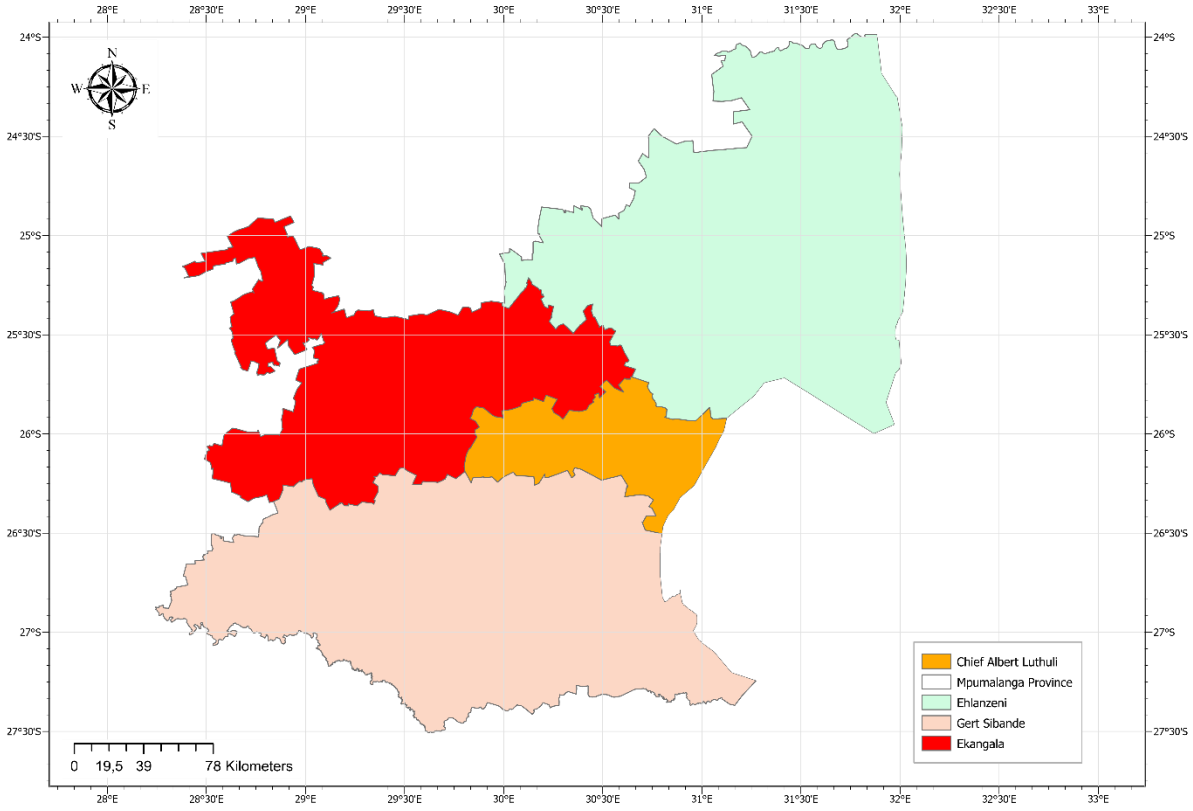
PLEASE QUOTE THE PROTOCOL NUMBER ON ALL ENQUIRIES

Appendix 2: Ethical Clearance Certificate



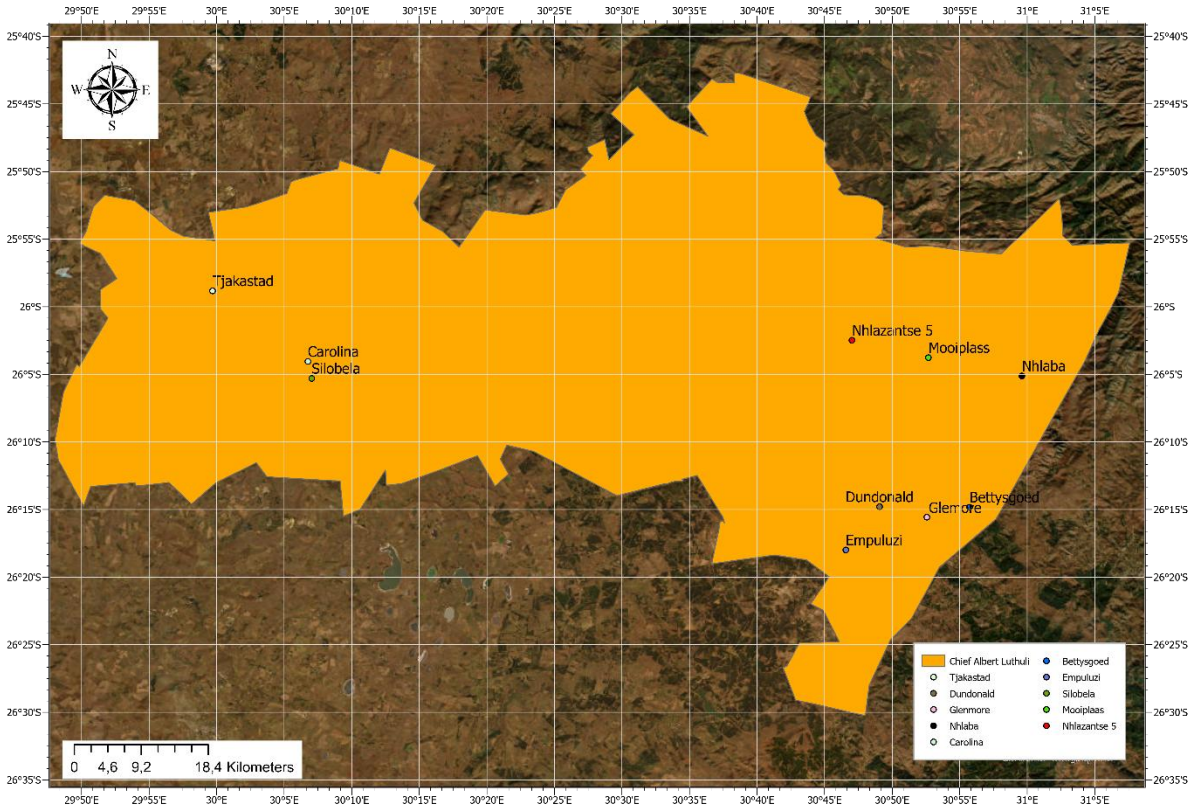
Appendix 3: South African Map Showing Mpumalanga Province

Source: Own design using ArcGIS pro, 2024



Appendix 4: Mpumalanga Province and its Districts

Source: Own design using ArcGIS pro, 2024



Appendix 5: Chief Albert Luthuli Local Municipality Villages

Source: Own design using ArcGIS pro, 2024

Appendix 6: Data Collection Pictures

Figure 12: Researcher and a Farmer at Oshoek

Figure 13: Researcher and a Farmer at Dundonald

Figure 14: Researcher and a Farmer at Tjakstad

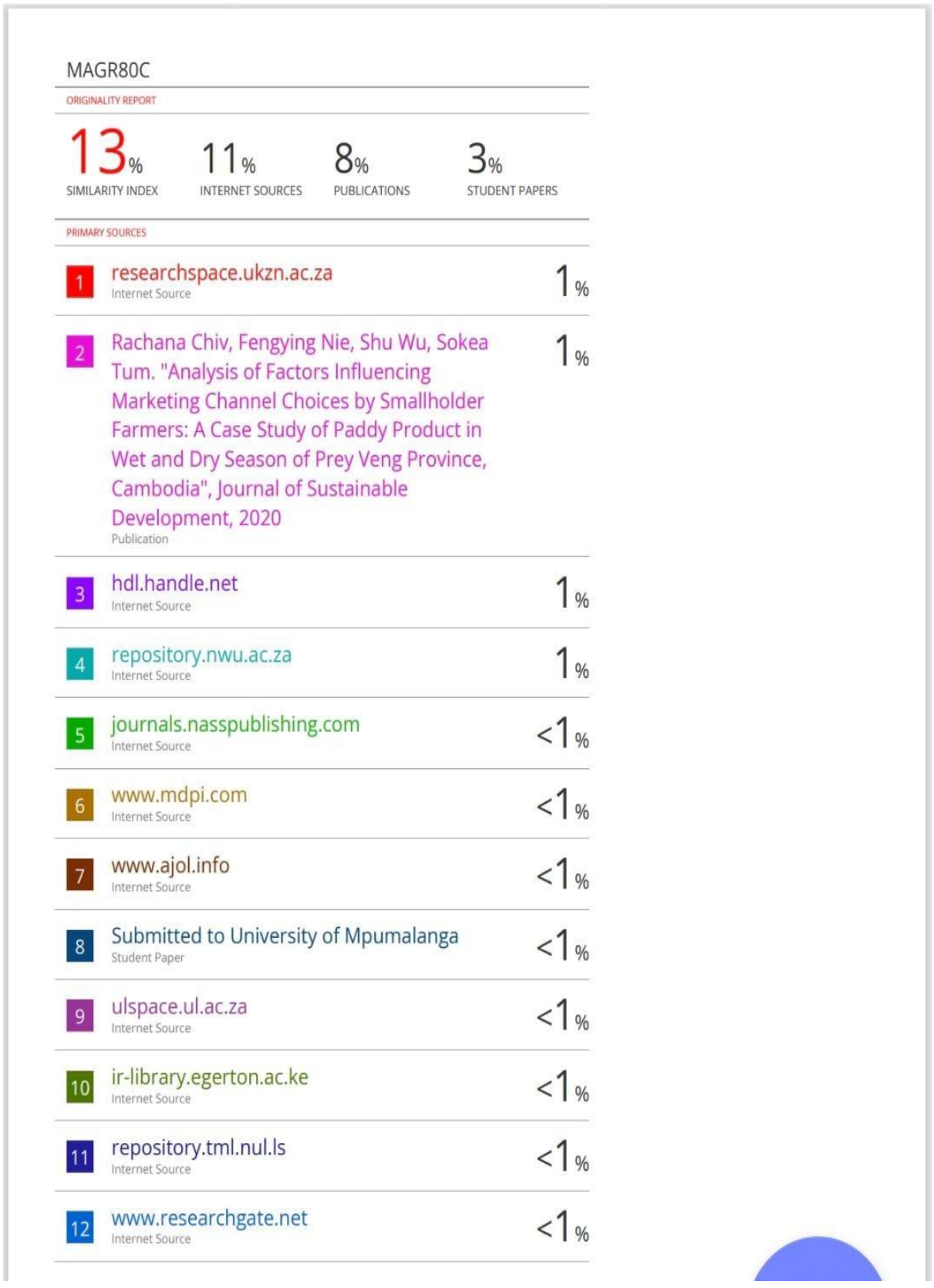
Figure 15: Researcher and a Farmer at Nhlazantshe

Figure 16: Researcher and a Farmer at Mooi Plaas

Figure 17: Researcher and a Farmer at Carolina

Figure 18: Researcher and a Farmer at eMpuluzi

Appendix 7: Turnitin Digital Receipt



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DETERMINANTS OF SMALLHOLDER MAIZE FARMERS' INNOVATIVE MARKET CHANNEL CHOICES: CHIEF ALBERT LUTHULI LOCAL MUNICIPALITY

RANDY THOLAKELE COSSA

20734672

orcid.org/ 0000-0001-5638-1496

A dissertation submitted in fulfilment of the requirements for the Master of Agriculture in Agricultural Extension and Rural Resource Management

Supervisor: Dr. Jotine Nduru

Co Supervisor: Dr Muzanai Mutara

School of Agricultural Sciences

Faculty of Agriculture and Natural Sciences

February 2025

UNIVERSITY OF MPUMALANGA

Appendix 8: Research Questionnaire

INFORMATION LEAFLET

Researcher: Randy Tholakele, Cossa (201734672)

Supervisor:

Name: Dr. J.T. Ndoro

Telephone: 013 002 0166

E-mail address: Jorine.ndoro@ump.ac.za

Co-supervisor

Name: Dr. M Musara

Telephone: 013 002 0268

E-mail address: mazanai.musara@ump.ac.za

Dear Potential Research Participant,

I am, Randy Tholakele Cossa, a Master of Agriculture in Agricultural Extension and Rural Resource Management student at the University of Mpumalanga, in the School of Agricultural Sciences, Faculty Agriculture and Natural
Sciences. You are invited to participate in a research project titled: Determinants of Smallholder Maize Farmers Innovative Market Channel Choices: Chief Albert Luthuli Local Municipality.

The specific research objectives are:

1. To identify innovative market channels used by smallholder maize farmers using random utility maximisation model.
2. To evaluate the effects of agricultural extension services towards innovative market channel selection among smallholder maize farmers.
3. To explore constraints faced by smallholder maize farmers when accessing innovative market channels.

If you decide to take part in the study, you will be required to do the following:

- Sign this informed consent form.
- Completing the questionnaire, which will take approximately 25-40 minutes of your time.
- The questions are strictly for the purpose of this research study.
- Please note that your participation in answering this questionnaire is completely voluntary and you are allowed to withdraw any time should you wish to.
- Your name will not be recorded anywhere, and no one will be able to connect you to the answers you give.
- Pictures taken during data collection, will be attached to the dissertation report with no personal details of the participants.
- Your answers will be given a code number, or a pseudonym and you will be referred to in this way during data analysis and discussion of results in the research report.
- All responses will be summed together as a group with other respondents with no reference to individuals. This research is strictly for educational or academic purposes.

Your co-operation and participation in the study will be greatly appreciated. Please sign the informed consent below if you agree to participate in the study.

Kindly, answer each question honestly and accurately as your participation in this process is essential to the success of this study.

Yours faithfully

_____

Randy Tholakele Cossa

CONSENT FORM

1. I farmer_____agree to and am voluntarily taking part in this research project.
2. I understand that I have the right to withdraw from the study at any time and may choose no longer to participate without having to explain myself.
3. I am aware that the information I provide on the questionnaire is for educational / academic purposes.
4. I understand that my name will not be recorded.
5. I have been provided with, have read, the information leaflet regarding this research study.
6. I have had the opportunity to ask any questions related to this study and received satisfactory answers to my questions and any additional details I wanted.
7. I agree to answer the questions to the best of my ability.
8. I understand that I may refuse to answer any questions that I do not feel comfortable answering.
9. By signing this letter, I give free and informed consent to participate in this research study.

DATE	June 2024		
PARTICIPANT SIGNATURE			
RESEARCHER NAME	Randy Tholakele Cossa	RESEARCHER SIGNATURE	

This research is being conducted by Randy Tholakele Cossa.

Telephone: 078 045 5351	E-mail: 201734672@ump.ac.za

If there are any further questions about the research study or the questions itself, please contact the Supervisor (Dr J.T. Ndoro) at UMP. The Supervisor's contact details are as follows:

Supervisor	
Tel: 013 002 0166	Email: Jorine.ndoro@ump.ac.za

This research project has received ethical approval from the School of Agricultural Sciences Research Ethics Committee

SECTION A: DEMOGRAPHIC INFORMATION

No	QUESTIONS	OPTIONS								
1.	Gender	0= Female					1= Male			
2.	Age (years)	0= 18 – 35			1= 36 – 55		2= 56 and above			
3.	Marital status	0= Single			1= Married		2= Divorced		3= Widowed	
4	Highest educational exit level	0= No formal education	1=Primary level	2=Secondary level	3=ABET	4=Matriculated	5=Higher certificate	6=Diploma	7=Degree and above	8=Other (please specify)
5.	Farming experience (years)	0= Less than 5 years			1= 6 – 15 years		2= 16 – 20 years		3= 21 and above	
6.	Source of credit	0= None	1= Standard bank		2= Land Bank	3= ABSA	4= NYDA	5= MEGA	6= Other (please specify)	
7.	Cooperative membership	0= Yes			1= No		2= Name of Cooperative?			
8.	Land ownership	0= Communal			1= Leased		2= Land Reform		3= Own	
9.	Type of maize produced	0= White			1= Yellow		2= Both (White and Yellow)		3= Other (please specify)	
10.	Farm size (ha)	0= Less than 2			1= 3 to 10		2= 11 to 20		3= Above 21	
11.	Access to market channel information	0= Yes					1= No			
12.	Access to information on maize prices	0= Yes					1= No			

13.	Main source of information (maize prices and market channels)	0= Agricultural extension agents		1= Word of mouth (farmer to farmer)		2= Social media groups		3=Other (please specify)
14.	Type of farming	0= Rainfed				1= Irrigated		
15.	Hired farming implements and machinery.	0= None	1= Hand-held tools (e.g. hoes)	2= Planter	3= Tractor	4= Harrow	5=Tined cultivators	6=Boom sprayer
		7= Ripper	8= Tiller	9= Plough	10= Combine harvester	11= Corn sheller	12= Thresher	13= Other (please specify)
16.	Implements and machinery you own	0= None	1= Hand-held tools (e.g. hoes)	2= Planter	3= Tractor	4= Harrow	5=Tined cultivators	6=Boom sprayer
		7= Ripper	8= Tiller	9= Plough	10= Combine harvester	11= Corn sheller	12= Thresher	13= Other (Please specify)
17.	Type of storage facility	0= None		1= Grain mud huts		2= Metallic silo		3= Other (please specify)
18.	Distance to the market centre (Km)	0= Less than 40km		1= 41 to 80km		2= 81 to 120km		3= Above 121km
19.	Vehicle ownership	0= None		1= Bakkie		2= Car		3= Other (Pease specify)
20.	Mode of transport to the market	0= Own		1= Individual hire		2= Collective hire		4= Public transport

SECTION B: INNOVATIVE MARKET CHANNELS USED BY SMALLHOLDER MAIZE FARMERS

NO	QUESTIONS	OPTIONS			
1.	Which innovative market channel(s) are u currently using to sell your maize produce	0= Contract	1= Collective	2= E-commerce	3= Other (Please specify)
Based on your selection in the first question, please choose the specific sub-type that you mostly use as your primary method:					
2.	If you chose '**Contract'** please specify the type, you are using.	0= Short-term	1= Medium-term	2= Long-term	
3.	If you chose '**Collective'** please specify the type, you are using.	0= Cooperative	1= Farmer associations	2= Farmer groups	
4.	If you chose '**E-commerce'** please specify the type, you are using.	0= Social media	1= Phone calls	2= Other (please specify)	

SECTION C: EFFECTS OF AGRICULTURAL EXTENSION SERVICES (AES) TOWARDS INNOVATIVE MARKET CHANNEL CHOICES

NO.	QUESTIONS	OPTIONS		
	1. Access of extension services			
1.1	Do you receive AES	0= Yes		1= No
	2. Changes in yield and income			
Please provide detailed information regarding your maize farming activities for the years 2021 and 2023 in the sections provided.				
Years		**0= Cultivated area (ha)**	**1=Produced yield (tons)**	**2=Sales (tons)**
2.1	2021			
2.2.	2023			

SECTION D: CONSTRAINTS FACED BY SMALLHOLDERMAIZE FARMERS WHEN ACCESSING INNOVATIVE MARKET CHANNELS

NO.	STATEMENTS	OPTIONS				
		0= Strongly disagree	1=Disagree	2=Neutral	3=Agree	4=Strongly agree
1. Financial Constraints						
1.1	It is costly to transport farm produce to the desired market-centre					
1.2	Unavailability of financial institutions influence farmers' ability to access different market channels					
1.3	It is expensive to obtain relevant market information using online platforms					
1.4	It is costly to buy packaging materials (sacks) to properly package maize produce					
1.5	Limited access to grants, donations and supports influences farmers' participation in maize marketing					

2. Physical Constraints						
2.1	The tarmac road has potholes, making it difficult for farmers to use when transporting maize produce					
2.2	Farmers' find it difficult to use the gravel road during rainy days which influences the driving of farm machinery and vehicles causing delays in farming operations and deliveries.					
2.3	Inadequate storage facilities result into farmers' maize produce spoilage					
2.4.	Limited access to production resources (e.g. farm machinery, implements and tools) hinder farmers' ability to enhance maize productivity					
3. Natural Constraints						
3.1	Unreliable water supply for irrigation influences farmers' productivity					
3.2	Insufficient arable land restricts farmers' options for expanding maize farms					

3.3	Unfavourable weather conditions affect farmers' maize production resulting into low yield					
4. Social Constraints						
4.1	I receive poor support for resolving conflicts related to water rights					
4.2	There are conflicts within our farmer groups/ cooperatives					
4.3	I receive inadequate training on maize production					
4.4.	I receive insufficient training on maize marketing which influences my choice of innovative market channel					
4.5	I receive inadequate relevant market information influencing my decision to select profitable markets					
Human constraints						
5.1.	I receive insufficient extension service assistance/ support					
4.2.	I receive inadequate technical assistance for compliance with market entry regulations					

4.3.	Lack of formal education influences farmers' decision for maize marketing					
4.4.	Insufficient network infrastructure hinders farmers' ability to use online platforms for marketing maize					
4.5.	Insufficient marketing skill(s) limit farmers' ability to effectively choose innovative market channels for selling maize.					

THANK YOU FOR YOUR TIME!!