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Assessing the Impacts of Stakeholders in Aquaculture Enterprise Development in the Western Cape, South Africa

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ABSTRACT

South African stakeholders, including the government, have made significant efforts to improve the enabling environment for aquaculture development. However, due to socio-economic pressures, the investment of public funding comes with expectations for job creation, transformation and empowerment. This study examined the effects of the current institutional framework, support systems and stakeholders on the development of the aquaculture sector in South Africa. The study was conducted on the west coast of the Western Cape, South Africa, focusing on the marine bivalve shellfish farming sub-sector in Saldanha Bay. A multiple-case study approach was employed. Semi-structured interviews were conducted with the owners or managers of ten aquaculture enterprises, and with nine representatives of role players who have experience in aquaculture, agriculture or enterprise development. The results indicated that over-regulation and complex application processes are still challenging, and a change in the lead department introduced uncertainty. The strong focus on socio-economic development was regarded as problematic. The study found that the enabling environment for aquaculture has greatly improved, but important challenges remain. The study recommends the establishment of an integrated aquaculture sector incubator programme to develop financially

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sustainable aquaculture enterprises and strengthen the role and mandate of an existing aquaculture industry organisation, such as Aquaculture South Africa.

Keywords: Aquaculture, Enterprise Development, Institutional Framework, Support Systems, Western Cape, South Africa.

1. INTRODUCTION

South Africa is one of the most unequal societies globally, with low economic growth, high poverty and high unemployment levels. The development and support of small businesses are an important tool for addressing these challenges. This is reflected in policy instruments such as the National Small Enterprise Act No. 102 of 1996, as amended, and the establishment of a Small Enterprise Development Agency (SEDA). In 2016, there were an estimated 2.2 million small enterprises in South Africa, supporting more than 8.5 million jobs and contributing 46% to the Gross Domestic Product (Department of Small Business Development [DSBD], 2017). However, it is known that small businesses in South Africa struggle to maintain sustainability and have a high business discontinuation rate (Herrington & Kew, 2018).

Aquaculture development could also contribute to addressing socio-economic challenges, such as economic growth, wealth creation, and job opportunities. Over the last few decades, several initiatives have been implemented to improve the environment for aquaculture growth. These include, but are not limited to, the Aquaculture Benchmarking Surveys in 2006 and 2009 (Botes, Thompson & Louw, 2006a; Britz, Lee & Botes, 2009), the National Aquaculture Strategic Framework (NASF) (DAFF, 2012), the National Aquaculture Policy Framework (NAPF) (DAFF, 2013b), and an aquaculture development programme called Operation Phakisa: Aquaculture Workstream (Operation Phakisa, 2014). In 2015, there were 189 freshwater and marine aquaculture farms in South Africa, with an annual production of 5,418 tonnes (valued at USD 52.3 million), and supporting 3,826 jobs (DAFF, 2017). By 2018, this had grown to 229 farms with an annual production of 6,365.8 tonnes (valued at USD 84.2 million), supporting about 6,500 jobs across the aquaculture value chain (DEFF, 2021).

Sector development initiatives have led to increases in private and public investment, the number of farms, production, and jobs in the aquaculture sector (DAFF, 2018). Investments were made into enterprises with a commercial focus, and into enterprises and projects with a

socio-economic focus, in various sub-sectors including mussels, trout, catfish, oyster and dusky cob (Brierley, 2003; Rouhani & Britz, 2004; Botes, Thompson & Louw, 2006b; DAFF, 2017; Hara, Njokweni & Semoli, 2017). Although some of these initiatives have been hailed as success stories, many have struggled to become self-sustainable (able to sustain its own operations from income from the sale of its goods and services, without continued external financial support). The relative success of commercially oriented aquaculture projects, as opposed to the problems experienced by projects with a socio-economic focus, is well-documented in the literature (Rouhani & Britz, 2004; Hara, Njokweni,. These examples illustrate that key stakeholders, especially the government, do not operate in a vacuum; their contexts and mandates have a significant impact on sector and enterprise development in specific ways.

Although the Department of Forestry, Fisheries and the Environment (DFFE) is the lead agency for aquaculture development, numerous inter-governmental stakeholders are also involved. The different mandates and motivations of other stakeholders could have both positive and negative impacts on the development of the sector and on aquaculture enterprises.

The study needed to address the question of how South Africa's current institutional framework and support systems for agribusiness or aquaculture development impact the sector and individual enterprises. It also needed to address the question of which role players are important to aquaculture enterprises, and how they impact the sustainable development and growth of the agribusiness/aquaculture sector. Through this investigation, the study aimed to provide insights that could guide future policies and strategies in the development of financially self-sustainable aquaculture enterprises.

2. CONCEPTUAL FRAMEWORK

An enabling environment for the sustainable growth of the aquaculture sector should comprise economic, legal, social and physical components to ensure 'fair access to resources, mechanisms for conflict resolution and access to information, credit and markets' (Shehadeh, 1999). Stakeholders are individuals or groups that hold an interest or stake in a resource, either directly (through exploitation of the resource) or indirectly (through managing or generating wealth or business from the resource) (Townsley, 1998). The Food and Agriculture Organisation of the United Nations (FAO) definition of an institutional framework for fishery

governance is "the set of principles, rules, conditions, agreements, processes, mechanisms and organisations used for the development and management of fisheries. Its functioning and outcome are influenced by the set of ideas, values, beliefs and assumptions under which the people concerned operate" (Manning, 2016). Commercial aquaculture is described as "the rearing of aquatic organisms with a profit motive, is done mainly by the private sector and does not need direct assistance from donor or government sources" (Percy & Hishamunda, 2001). In contrast, community-based aquaculture (CBA) is described as "situations whereby communities are empowered through skills, financial investment and the legal authority to practice aquaculture". The rationale for CBA is to "increase fish production for local consumption" (Hara, Njokweni & Semoli, 2017). The study distinguishes between commercial aquaculture ventures driven by profit motives and community-based or collective ventures with social objectives. The mussel farming industry provided a good case study, as it included examples of both commercial and community-based or collective aquaculture ventures.

3. RESEARCH METHODOLOGY

3.1. Study Area and Research Design

The study focused on the marine mussel aquaculture industry in South Africa. The study area was Saldanha Bay, on the west coast of South Africa, and included three bivalve shellfish (mussel and oyster) farming areas in Small Bay, Big Bay and Outer Bay (North), totalling 460 ha. The survey population included 27 aquaculture enterprises identified by the Bivalve Shellfish Farmers Association of South Africa (BSASA) and the Western Cape Provincial Department of Agriculture. The survey population also included role players in South Africa with responsibility or experience in aquaculture, agriculture or enterprise development. The role player categories included government departments responsible for aquaculture, aquaculture associations, universities and individuals with expertise in aquaculture farming and enterprise development.

A multiple-case study research design, as described by Yin (2009), was employed to develop a framework for collecting evidence. A case study approach was selected as it is a scientific research method in its own right and can generate context-dependent knowledge (Flyvbjerg, 2006; Yin, 2009; Remenyi *et al.*, 2010). The case study approach was selected as the most suitable for this study, as the research questions were mostly how/why questions, the study did not require control of behavioural events, and it focused on contemporary events. It also

provided the researcher with the opportunity to make comparisons, build a theory and propose generalisations about aquaculture agribusiness projects.

As described by Remenyi *et al*. (2010), the case study approach, in-depth surveys and focus groups were deemed suitable tactics for this study. In-depth surveys, including semi-structured interviews and focus groups, were selected as appropriate study tools to conduct interviews with farmers and other stakeholders, and to validate research conclusions. A qualitative approach was followed to conduct the research. The mussel farming industry provided a good case study, as it is the largest contributor to aquaculture production in South Africa (DAFF, 2017). Semi-structured interviews using survey questionnaires were conducted in 2020 with the owners or managers of ten bivalve shellfish farming enterprises, as well as with representatives of nine key stakeholders.

3.2. Sampling Procedure

Multiple case studies could be compared to multiple experiments. However, replication logic is used instead of sampling logic. Each case must be selected so that each case study either predicts similar results (a literal replication) or contrasting results for anticipatable reasons (a theoretical replication). If all individual case study findings align with predictions, the studies in aggregate would have provided sufficient support for the initial propositions related to the overall multiple-case study. However, if the individual case study results contradict the initial predictions, the propositions must be revised (Yin, 2009).

The study population for case studies included aquaculture agribusiness enterprises in the bivalve shellfish farming sub-sector in South Africa. All existing and new bivalve shellfish farming enterprises (27 in total) were approached through the Bivalve Shellfish Farmers Association of South Africa (BSASA), which is the relevant industry association, and the Western Cape Provincial Department of Agriculture. The sample included nine enterprises still in operation at the time, and one that had ceased operations. Selection was primarily based on the participants' willingness to participate in the study. Enterprises included a mix of commercial and community-based or cooperative initiatives.

A non-random, judgment sampling approach, as described in Willemse and Nyelisani (2015), was used to draw a sample from subsets of the role player population (government departments, implementing agents, and research institutions). This led to semi-structured interviews with

nine role player representatives. The role player sample selection was based on willingness to participate in the study and availability.

3.3. Data Analysis

In case study research, data analysis typically consists of examining, categorising, tabulating, testing, or recombining evidence to draw empirically based conclusions. For this study, relying on theoretical propositions was the preferred analytic strategy applied. A Thematic Data Analysis was used because the study followed a qualitative approach. Multiple-case study analysis consisted of two stages. Firstly, within-case analysis was conducted, where the qualitative data were analysed by identifying and copying responses from each transcription that were relevant to each of the questions asked during the interview. These responses were further analysed to create themes and sub-themes (or codes). MS Excel was used for the second stage of analysis (cross-case analysis), where grouping of themes and sub-themes, as well as summarising of codes, was completed. Results were used to generate radar charts.

4. RESULTS AND DISCUSSION

4.1. Key Stakeholders

Respondents identified ten key stakeholder groups (Table 1). For enterprise respondents, the three most important stakeholder groups were the government (100%), financial institutions (70%), and government-owned entities (60%). Role-player respondents listed the government (67%), industry support (44%), and financial institutions (44%) as the three most important stakeholder groups. Therefore, the government was recognised as the most important stakeholder group. The importance of government in creating an enabling environment for aquaculture development is recognised and described in the literature (Hishamunda, Ridler & Martone, 2014; Satia, 2017).

These stakeholder groups correspond with most of the groups identified in a legal guide for the development of the aquaculture sector in South Africa (DAFF, 2013a). Stakeholders with specific mandates for enterprise development, such as the Department of Small Business Development (DSBD), the Small Enterprise Development Agency (SEDA) and the Small Enterprise Finance Agency (SEFA), were not identified in the guide or by study respondents as key stakeholders. This indicated an insufficient focus on the development of aquaculture entrepreneurs and enterprises in South Africa.

TABLE 1: Key Stakeholder Groups and Associated Percentages

Key stakeholder groups	Number of respondents (n=10 Enterprises)	% Of enterprise responses	Number of respondents (n=9 Role players)	% Of role player responses
1. Government	10	100%	6	67%
2. Government-owned entities	6	60%	3	33%
3. Non-governmental organisations (NGOs)	1	10%	2	22%
4. Industry support and associations	5	50%	4	44%
5. Private public partnerships (PPPs)	4	40%	1	11%
6. Research institutions	2	20%	3	33%
7. Learning/ Training institutions	0	0%	2	22%
8. Funding/ Financial institutions	7	70%	4	44%
9. Industry sector	4	40%	3	33%
10. Markets	5	50%	1	11%

4.2. Impacts of Key Stakeholders

The main areas of impact of key stakeholders were categorised as the approach to enterprise development, community-based/cooperative ventures, different stakeholder mandates, and the enabling environment (Figure 1). Thirty percent (30%) of enterprise respondents and 56% of role-player respondents indicated that enterprise development is driven by the need to achieve socio-economic benefits rather than by market forces or commercial principles. The

importance of a commercial rather than socio-economic focus in aquaculture development projects is supported in the literature (Rouhani & Britz, 2004; Hara, Njokweni & Semoli, 2017). Fifty-six percent (56%) of role player respondents indicated that community-based or cooperative aquaculture venture projects do not work and are not self-sustainable. However, some indicated that these projects could be successful if they are managed correctly and have commercial rather than socio-economic motives.

There were mixed opinions about the change in lead agency for aquaculture from the Department of Agriculture, Forestry and Fisheries (DAFF) to the DFFE in 2019. This meant that aquaculture is now managed as a fishery instead of an agricultural activity, and it introduced uncertainty about governance and future development. The five-year review of Operation Phakisa recognised these concerns (DEFF, n.d.). Some enterprise respondents indicated that frameworks such as EIAs contributed to a supportive environment by allowing aquaculture activities to go ahead in an environmentally responsible manner. However, others felt that the environment was not supportive due to over-regulation, red tape, increased costs, and an excessive number of approved but unsustainable projects.

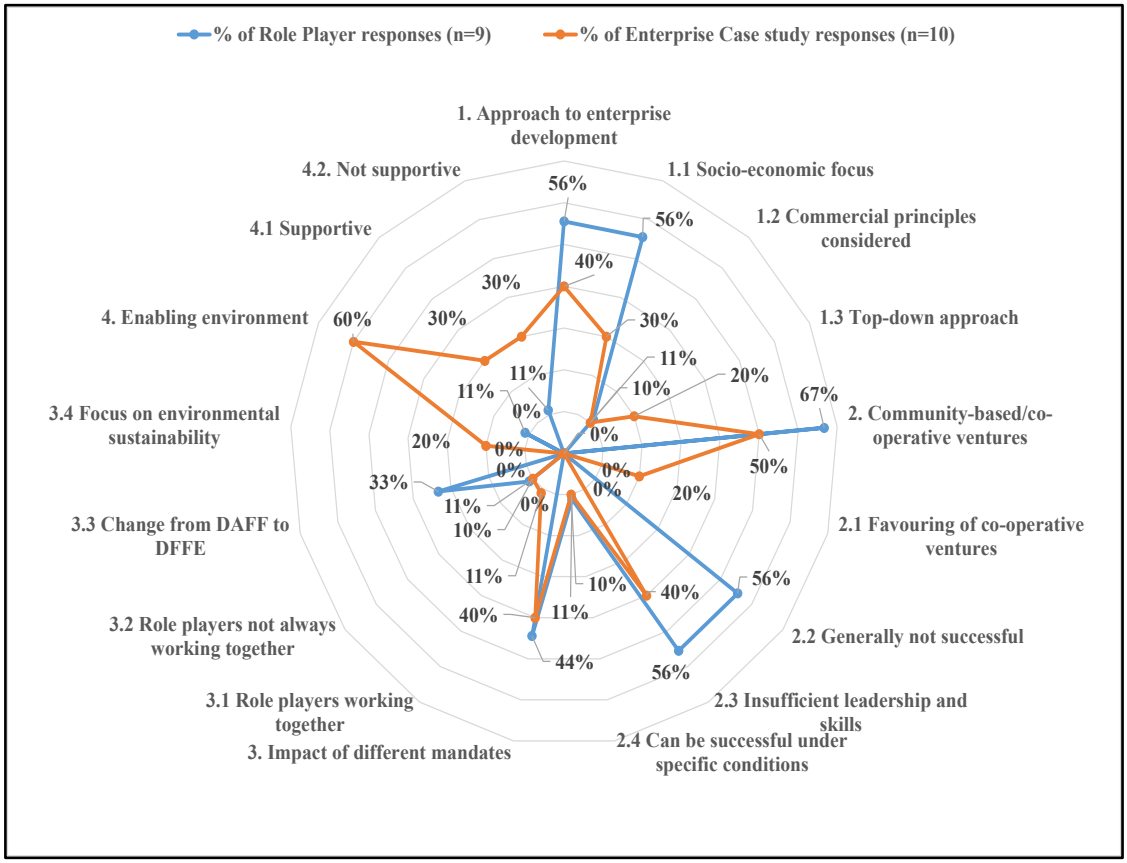

FIGURE 1: Role player and Enterprise Responses about Impacts of Key Stakeholders

4.3. Impacts of the Institutional Framework

Responses about the impacts of the institutional framework were categorised into the regulatory framework and complex application processes (Figure 2). Enterprise respondents felt most strongly about the impacts of environmental processes (60%), while role-player respondents were most concerned with aquaculture-specific legislation (56%). Enterprise concerns mainly were related to the Environmental Impact Assessment (EIA) recommendations for the Saldanha Bay Aquaculture Development Zone (ADZ), which limited total bivalve shellfish production to 10,000 tonnes per annum (TPA) for the first two years, and annual incremental increases by 5,000 TPA thereafter to a maximum of 27,600 TPA (DAFF, 2017). This limited farmers' ability to operate at full capacity. The problem of finding a balance between responsible regulation and optimal production levels is also experienced elsewhere, such as Norway's salmon aquaculture industry (Osmundsen, Almklov & Tveterås, 2017).

Most role-player respondents agreed on the need for aquaculture-specific legislation to guide the development of aquaculture. As part of Operation Phakisa, an Aquaculture Development Bill was drafted to promote the development of marine and freshwater aquaculture as a key agricultural activity. The Bill was withdrawn for rework in 2020 (DEFF, n.d.) and republished for comment in 2023. The responses support the literature that finds that aquaculture requires a specific legislative framework as a basis for long-term and sustainable growth (Young *et al.*, 2019). Over-regulation was a concern due to the high administrative burden and costs associated with seawater leases, compliance with permit applications and renewals, environmental monitoring and data collection, as well as food safety monitoring. This negatively impacted smaller companies.

For both respondent groups, complex and lengthy application processes (for rights, permits, leases and financial support) remain one of the most important constraints. This is despite the establishment of an Inter-departmental Authorisations Committee (IAC) aimed at simplifying application processes and reducing processing time (DEFF, n.d.; Operation Phakisa, 2014; DAFF, 2018). Enterprise respondents commented about insufficient communication regarding applications (40%) and insufficient communication between stakeholders (70%). This included the perceived inability of officials to understand the impacts of their decisions on industry, as well as confusion among applicants about what is required. Similar issues were experienced

elsewhere, for example, in Ireland, where dysfunctional licensing arrangements were a challenge to the development of the Irish oyster industry (Renwick, 2018).

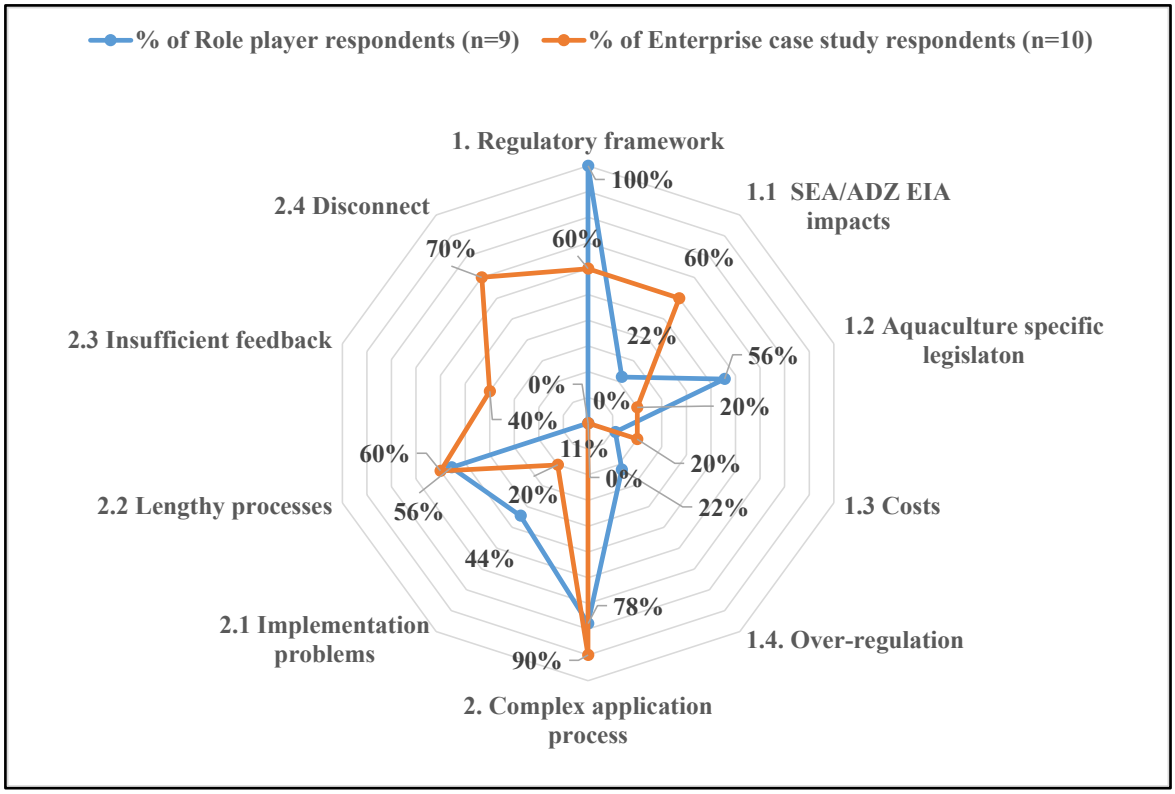

FIGURE 2: Role player and Enterprise Responses about the Institutional Framework

4.4. Impacts of Support Systems

Responses about the impacts of support systems for aquaculture enterprises were categorised into access, policies and programmes, and the education system and skills (Figure 2). Although 40% of enterprise respondents indicated that they had sufficient access to funding, water space, and technology, 30% mentioned that new aquaculture farmers were unaware of how to access the available support. Funding for aquaculture enterprises is available; however, funding conditions are challenging, especially for new entrants. These findings are supported by the literature, which highlights the importance of overcoming regulatory and financial constraints for the development of an aquaculture sector, as seen in the case of the oyster industry in Ireland (Renwick, 2018). Support systems were also perceived as being misaligned with different parts of the country or with the available environments, or as being too generic to support established enterprises. Responses about policies and programmes were categorised into insufficient consideration of industry, a communication gap between stakeholders, Operation Phakisa and market support. Enterprise respondents (70%) perceived that policymakers do not adequately

account for the realities of aquaculture limitations. Most role-player respondents (56%) were positive about the impacts of the Operation Phakisa (Aquaculture Programme); however, there was a concern that the goals related to job creation and economic development were overly ambitious. The local market demand for mussels is about 3,500 TPA. Therefore, the potential increase in bivalve shellfish production to more than 27,000 TPA would require additional market support. Operation Phakisa included the development of a Public Awareness and Marketing Strategy as well as an Aquaculture Development Bill. However, remaining challenges include the slow rollout of planned production and development of export markets (DAFF, 2019a, 2019b, 2020). During 2019, DFFE began developing an Oceans Economy Master Plan, which would build on and incorporate the lessons learnt from Operation Phakisa. Due to the COVID-19 pandemic, work on this Plan was halted and re-commenced in 2021.

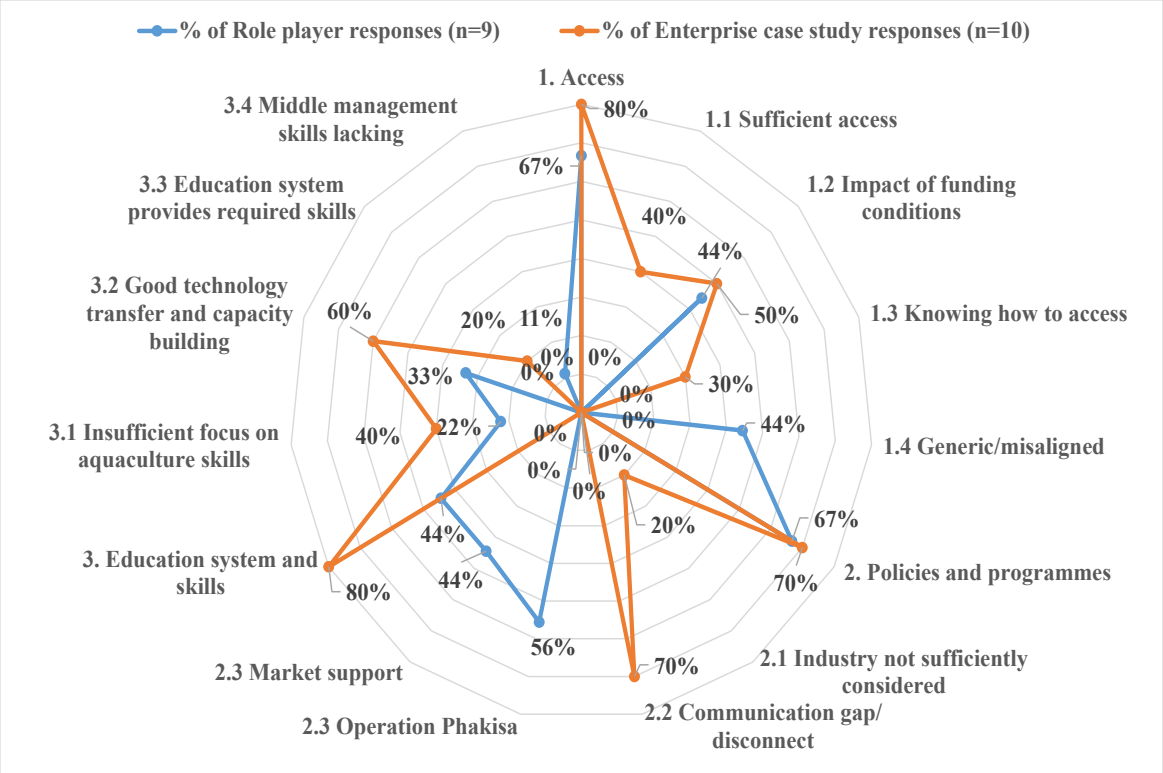

FIGURE 3: Role player and Enterprise Responses about Support Systems

While concerns were raised about aquaculture education and skills, 60% of enterprise respondents indicated that the required skills can be obtained through technology transfer, mentoring, online learning, and on-the-job training. Although "Aquaculture farmer" and "Aquaculture farm assistant" qualifications were developed and approved through Operation Phakisa (DAFF, 2018). Concerns about insufficient middle management are supported in the literature (Botes, Thompson & Louw, 2006a; Chrysalis, 2017).

The study found that key stakeholders have both positive and negative impacts on the aquaculture sector. The enabling environment for the sector has improved, but several key constraints and concerns remain. Positive impacts include efforts to improve the regulatory environment for aquaculture, a focus on environmental sustainability, the Operation Phakisa Programme, the market support programme, and skills improvement programmes. Remaining challenges include over-regulation, complex application processes, a strong focus on socio-economic need rather than commercial principles, the negative impacts of funding conditions, and a change in the lead department for aquaculture.

Industry associations do not receive support from government or other institutions and are dependent on membership fees. If fully funded, these associations could address many of the challenges and improve the sustainability of aquaculture enterprises and the industry. For example, the Bivalve Shellfish Farmers Association of South Africa (BSASA) received funding from the Foreign, Commonwealth and Development Office of the Government of the United Kingdom (FCDO) to investigate the potential of commercial kelp farming on the west coast of South Africa (BSASA, 2022). This led to further funding for a kelp farming feasibility study and kelp market and value chain analysis (BSASA, 2023). This highlights the potential of industry associations to fast-track the development of the aquaculture sector.

5. CONCLUSIONS AND RECOMMENDATIONS

The results of the study showed that the enabling environment for aquaculture sector development in South Africa has significantly improved over the last decade, particularly through interventions such as Operation Phakisa. However, challenges remain. While sector development initiatives led to increased investment, production expansion, and job creation, the development of aquaculture enterprises did not receive sufficient attention. Recommendations for interventions are therefore aimed at developing financially self-sustainable enterprises.

Aquaculture industry associations should be strengthened and resourced. If fully funded and supported, an industry organisation such as Aquaculture South Africa could launch an integrated project to pilot the recommendations from this study. This could include assistance with the development of a focused aquaculture Enterprise and Supplier Development (ESD)

strategy and an aquaculture sector incubator programme. It should include mentoring, coaching and capacity building through relationships with established commercial partners, the research community, financial partners, and other stakeholders. It should focus on a development path for new and established enterprises that would enable them to become financially self-sustainable, with the support of institutions such as DSBD and SEDA, in collaboration with private sector business incubators and accelerators.

Industry bodies could also assist with streamlining application processes through mechanisms such as an online application portal and a help desk to assist new entrants and guide applicants through the process. Additionally, they could facilitate improved coordination and communication between relevant stakeholders and enterprises. Lastly, the finalisation and implementation of the Oceans Economy Master Plan should serve as a platform for DFFE to enhance its visibility and increase confidence in its ability to address the aquaculture sector's challenges.

Addressing the challenges identified through this study could expand the positive impacts of the initiatives implemented to date, further improve the enabling environment for the sector and assist aquaculture enterprises in becoming financially self-sustainable.

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7. DISCLOSURE STATEMENT

The authors declare that they have no conflict of interest.

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Analysis of Stakeholders Influencing Smallholder Mango Production in Limpopo Province of South Africa

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ABSTRACT

The purpose of this study was to determine the influence of stakeholders on smallholder mango production in Limpopo Province, aiming to increase the effectiveness of this influence. Purposive sampling of the population of 374 smallholder mango producers with a plot size of ±4.7ha was used. Primary data was collected from the smallholder producers using a structured questionnaire designed to include selected variables on stakeholder interactions and influence. Key stakeholders included the Limpopo Department of Agriculture and Rural Development (LDARD), the South African Mango Growers Association (SAMGA), the Agricultural Research Council (ARC) and the National Agriculture Marketing Council (NAMC). The LDARD provided broad support, mainly farm management and marketing information (57%), SAMGA provided production (fertiliser application and spraying) information (86%), ARC provided research information (92%), while NAMC provided market information (59%). Interactions with the producers were mainly through LDARD meetings (11%) and visits (41%), SAMGA meetings (70%) and visits (23%), ARC meetings (12%) and emails (9%), and NAMC meetings (10%) and visits (11%). Lack of transformation and budgetary constraints were the main challenges limiting smallholder mango production. The study is crucial for efficient resource deployment and the maximisation of impact from

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development initiatives, especially in our country, which faces severe budgetary constraints and associated austerity measures.

Keywords: Smallholder Mango Producer, Mango Production, Stakeholder, LDARD, SAMGA, ARC, NAMC, Limpopo Province.

1. INTRODUCTION

The consumption of fresh fruits is increasing (Steinmetz & Potter, 1996), both locally and globally, and is expected to continue rising as consumers are willing to pay higher prices, especially for out-of-season fresh fruits. Agriculture is the key sector for economic development in most African countries and is highly reliant on production by smallholder farmers (Martey, Etwire, Wiredu & Dogbe, 2014). The statement by Martey *et al.* (2014) affirmed Engel and Salomon (1997), revealed that the agriculture sector is a primary source of income for the rural population and contributes to foreign exchange earnings for African economies. For instance, the agricultural sector contributed approximately 10 percent to South Africa's total export earnings in 2021, valued at $12.0 billion (ITA, USDC, n.d.).

The climate of South Africa encompasses both subtropical and Mediterranean climates, primarily influenced by large-scale seasonal atmospheric patterns, as well as the cool Atlantic Ocean and warm Indian Ocean (Daron, 2014). This diversity of climate favours the production of a wide range of agricultural products, including mango and other subtropical fruits. South Africa has a dual agricultural economy, characterised by both well-developed commercial farming and subsistence-based production in rural areas. In line with the assertion by Martey *et al.* (2014), agriculture is a significant economic activity in rural areas of South Africa.

Limpopo Province is one of South Africa's richest agricultural areas. The province is endowed with abundant agricultural resources, including rich soils and a favourable climate, and is one of the country's prime agricultural regions, noted for the production of various commodities, mostly subtropical (including mango) and citrus fruits, vegetables, and livestock. Approximately 2.7% of Limpopo's value-added Gross Domestic Product is derived from agriculture, with around 1.1% of the province's population employed in this sector.

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Farmers, especially smallholder farmers, face multiple challenges (Lawrence, Barr, & Haylor, 1999; Adekunle & Fatunbi, 2012). As was argued by Lawrence *et al.* (1999), the involvement of pertinent stakeholders in farming has the potential to address the multiple challenges faced by smallholder farmers. A multi-stakeholder approach is essential for mapping out the challenges and understanding, as well as articulating, appropriate options for farmers (Odhiambo, Nyangito, & Nzuma, 2004). Stakeholders, including the target group and partners (Zimmermann & Maennling, 2007), are influential in the implementation of farming activities. As affirmed by Nesamvuni and Tshikolomo (2014), there should be considerable interaction between farmers and various stakeholders, which include public organisations, private companies, and non-profit organisations.

Acknowledging the essence of stakeholder participation in farming, it was revealed that farming involves multiple stakeholders throughout the entire value chain, from production to the end (Karim, Rahman, Berawi, & Jaarpar, 2007). The statement by Karim *et al.* (2007) was supported by Dodds (2015), who indicated that since the 1990s, stakeholders have become an integral part of many organisations and that each of them (the stakeholders) brings vital capability, knowledge and skills, thereby building synergies to co-create something new and show impact.

Knowledge and understanding of stakeholders and their influence on farming requires a comprehensive stakeholder analysis. Analysis is essential for the effective stakeholder management process because it enables organisational teams to understand the stakeholder environment and develop appropriate engagement strategies (Mok & Shen, 2016). Different types of stakeholders may need different strategies (Nguyen, Chileshe, Rameezdeen, & Wood, 2020). A comprehensive stakeholder analysis aims to assess and understand the involvement of stakeholders in an organisation, determining their relevance (Tampio, Haapasalo, & Ali, 2022) and their influence on decision-making and organisational performance. As alluded to by Berlin, Bligard, and Chafi (2022), the importance of stakeholder analysis in gaining their perceptions and inputs, and ultimately ensuring their acceptance of future solutions, cannot be overemphasised.

This paper aims to provide pertinent information for enhancing the effectiveness of stakeholders influencing smallholder mango producers in the Limpopo Province of South Africa.

2. DEFINITION OF THE PROBLEM

There is an increasing expectation that projects should demonstrate clear impacts (Huzzard, 2021), and the same can be said for the smallholder mango projects in Limpopo Province. As stated by Huzzard (2021), many argue that impact can be leveraged by stakeholder engagement. Effective stakeholder engagement in the smallholder mango industry requires clear responses to key questions related to the stakeholders, which include: Who are the stakeholders? What are their roles in smallholder mango production? How do they interact with the mango producers? What is their contribution to the smallholder mango industry? What are their areas of leadership (if any)? What is their knowledge base? This paper addresses these questions based on a focused study on smallholder mango producers conducted in the Limpopo Province, South Africa.

3. RESEARCH METHODOLOGY

3.1. Study Area

The study was conducted in the Limpopo Province of South Africa, focusing on smallholder farmers who produce mangoes on communal lands, specifically in the Mopani and Vhembe Districts (Figure 1). As indicated by DALRRD (2020), most mango plantations in South Africa are located in Limpopo Province, with the majority concentrated in the Soutpansberg (Vhembe District) and the Letaba and Hoedspruit (Mopani District) areas.

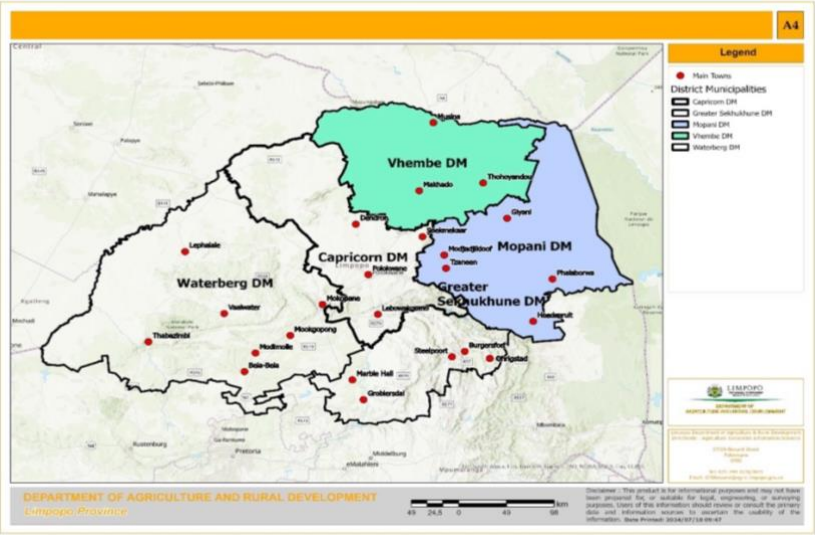

FIGURE 1: Map of Limpopo Province Showing the Location of Vhembe (Green) and Mopani (Blue) Districts that Constituted the Focus Area of the Study (Source: LDARD, 2024).

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As revealed by SAMGA (2023), mango plantings in the Limpopo Province covered an area of 4,277 ha, comprising 75 percent of the total plantings in South Africa. Plot sizes of smallholder mango producers were estimated at 4.7ha (Materechera & Scholes, 2021).

3.2. Sampling Procedures

The population for a study refers to the group about whom the researcher wants to conclude (Babbie & Mouton, 2010). As stated by Melville and Goddard (1996), a population is any group that is the subject of research interest. The study population consisted of 374 smallholder mango producers in Vhembe and Mopani Districts of Limpopo Province. According to Welman, Kruger, and Mitchell (2005), a sampling frame is a complete list of units of analysis, *where* each unit is mentioned only once. The units of analysis for the study were selected through purposive sampling, a sampling method in which researchers rely on their experience, ingenuity, and previous research findings to deliberately obtain units of analysis that are regarded as representative of the relevant population (Welman *et al.,* 2005). For this study, all 374 smallholder mango producers listed in the researcher's database were interviewed.

3.3. Data Collection

Primary data was collected for this study using a semi-structured questionnaire to interview individual smallholder mango producers. The questionnaire was designed to capture information relating to issues that included stakeholder identification, roles, types of interactions, level of importance and contributions made. The questionnaire primarily consisted of closed-ended questions that collected quantitative data. Before conducting a large-scale administration of the instrument, a pre-testing session was conducted to determine instrument validity. After validating the instrument, the researcher personally conducted interviews with 21 smallholder producers to gauge the exercise, and the remaining interviews were conducted by properly trained enumerators. Secondary data were collected through a literature review that focused on relevant books (or sections thereof), journal articles, reports, and reviews of other relevant documents.

3.4. Data Analysis

The data were analysed using the Statistical Package for the Social Sciences (SPSS), conducted by Quantemna Research Specialists. Findings were presented in the form of frequency tables and graphs that were discussed based on objective interpretations.

The research collected and analysed quantitative data and is referred to as a quantitative study (Hurmerinta-Peltomaki & Nummela, 2006; Leedy & Ormrod, 2010). A quantitative research approach involves the objective collection and evaluation of numerical information to interpret experiences and concepts (Kurten, Brimmel, Klein, & Hutter, 2022), in contrast to a qualitative research approach, which involves the subjective collection and evaluation of non-numerical data to understand ideas, perceptions, and events.

4. RESULTS AND DISCUSSION

4.1. Identification of Stakeholders in Smallholder Mango Production

Stakeholders, including target groups and partners, often play a significant role in the performance of the fruit industry. The establishment and implementation of any project requires active stakeholders to provide human and social capital (Zimmermann & Maennling, 2007). The first task in the stakeholder analysis was to identify the stakeholders themselves. The first step in identifying stakeholders was to develop a preliminary list of all potential stakeholders, a process that required some brainstorming (Morris & Biddache, 2012). According to Vos and Achterkamp (2006), identifying stakeholders could be regarded as drawing a line between parties involved and parties not involved.

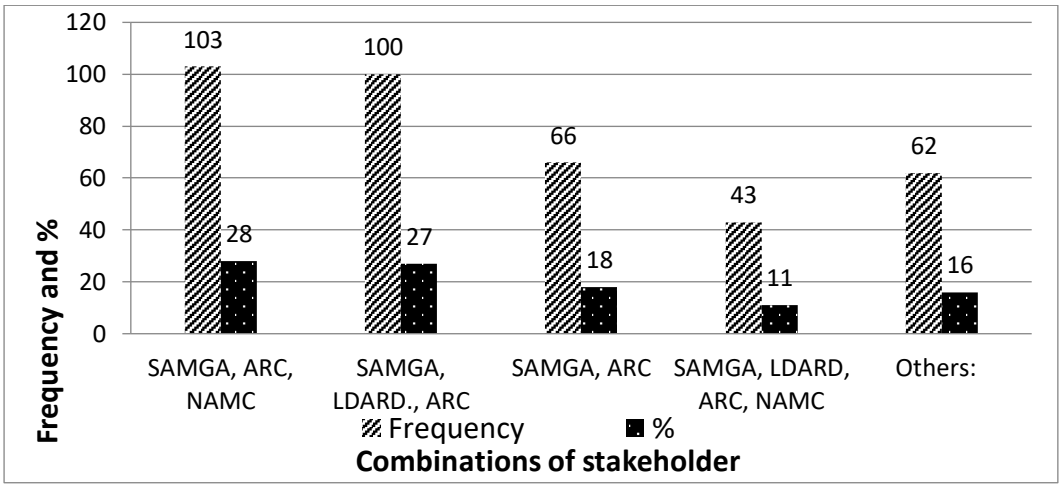

FIGURE 2: Stakeholders Identified by Smallholder Mango Producers in Limpopo Province

Stakeholder identification and categorisation are complex issues that can be analysed from multiple perspectives (Wegrzyn & Wojewnik-Filipkowska, 2022). The identification of stakeholders was based on perceptions of the smallholder mango producers. The process

included value chain analysis to consider all stakeholders involved in the mango value chain from production to consumption (Adekunle & Fatunbi, 2012; Stevens & Letty, 2014).

Combinations of names of stakeholders reportedly involved in smallholder mango production as perceived by the respondents were presented (Figure 2). Four stakeholders were considered important for the smallholder mango industry: the Limpopo Department of Agriculture and Rural Development (LDARD), the South African Mango Growers Association (SAMGA), the Agricultural Research Council (ARC), and the National Agricultural Marketing Council (NAMC).

Twenty-eight percent (28%) of the respondents regarded a combination of SAMGA, ARC, and NAMC as important stakeholders for the smallholder mango industry, while 27% opted for a combination of SAMGA, LDARD, and ARC. Eighteen percent (18%) of the respondents reported a combination of SAMGA and ARC as important stakeholders, while one in ten (11%) respondents felt that a combination of SAMGA, LDARD, ARC and NAMC was important stakeholders for their industry.

4.2. Stakeholder Roles

According to MacArthur (1997), the roles of stakeholders vary depending on the stakeholder's advocacy. Stakeholder engagement has grown into a widely used construct in business and society research (Kujala *et al*., 2022) and is important for understanding their (stakeholder) roles.

TABLE 1: Roles of Stakeholders Identified by Smallholder Mango Producers in Limpopo Province

Stakeholder	Role	Frequency	%
ARC	Provide information on research; conduct study groups	345	92
SAMGA	Provide recent information on fertilisation and spraying	320	86
NAMC	Provide market information and learning materials	223	59
LDARD	Provide information on marketing and on how to run a farm	215	57

All the respondents regarded stakeholders as having an important role in providing information. The importance of information was perhaps affirmed by Mittal and Mehar (2015), who suggested that empowering smallholder mango producers begins with access to information. Agricultural productivity and yield increase can be enhanced through the sharing of appropriate information (Opara, 2008) with smallholder mango producers.

Specifically, nine in ten (92%) of respondents reported that the ARC provided research information, 86% regarded SAMGA an important source of production (specifically fertiliser application and spraying) information, six in ten (59%) felt that NAMC provided market information with almost the same number (57%) of respondents associating LDARD with broad value chain support (farm management and marketing) information (Table 1).

4.3. Interactions Between Smallholder Mango Producers and Stakeholders in Limpopo Province

The types of interactions between smallholder mango producers and stakeholders, as well as the frequency of these interactions, are crucial for the successful production of mangoes by smallholder farmers.

TABLE 2: Interactions Between Smallholder Mango Producers and Stakeholders in Limpopo Province

Stakeholder	Type of interactions	Frequency of interactions	Frequency	%
LDARD	Meetings	Monthly	42	11
	Visits	Bi-monthly	152	41
SAMGA	Meetings	Bi-monthly	262	70
	Visits	Bi-monthly	85	23
ARC	Meetings	Bi-Monthly	46	12
	Emails	Bi-Monthly	35	9
NAMC	Meetings	Other	39	10
	Visits	Other	40	11

Except for the ARC, which interacted through meetings (12%) and emails (9%), the rest of the stakeholders interacted primarily through meetings and visits. LDARD held monthly meetings

(11%) and bi-monthly visits (41%), while SAMGA had bi-monthly meetings (70%) and bi-monthly visits (23%). NAMC had meetings at various frequencies (10%) and visits (11%). Generally, meetings and visits were common types of interactions, with the frequency ranging from monthly to bi-monthly (Table 2).

4.4. Stakeholder Contribution to the Smallholder Mango Industry

Stakeholder contributions to the smallholder mango industry can be valuable for producers to achieve success. Meaningful contributions should benefit one or more activities within the value chains of the smallholder mango industry.

TABLE 3: Stakeholder Contributions to Smallholder Mango Industry in the Limpopo Province

Stakeholder	Contribution	Frequency	%
ARC	Conduct study groups and training	333	89
LDARD	Daily visits	240	64
SAMGA	Conduct study groups	211	56
NAMC	Provide learning material	158	42

The stakeholders contributed to the smallholder mango industry in various ways (Table 3). The main contribution of the ARC was in conducting study groups and training (89% of respondents), which provided suitable platforms for sharing new research information and technologies. While SAMGA also conducted study groups (56%), likely for sharing production information, the NAMC was acknowledged for providing learning materials to smallholder mango producers (42%) related to their marketing mandate. The LDARD was noted for conducting daily visits to smallholder producers, which were likely aimed at addressing various issues within the mango value chain.

4.5. Stakeholder Area of Leadership in the Smallholder Mango Industry in Limpopo Province

The level of influence of stakeholders in the value chains of the smallholder mango industry is determined by their area of leadership. The main areas of stakeholder leadership in the smallholder mango industry in Limpopo Province are depicted in Table 4. The ARC and NAMC were perceived by 35% of smallholder mango producers to lead in research and

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marketing, respectively. Based on the prominent roles played by these stakeholder organisations in these areas, it would be expected that more respondents would have reported them as such.

TABLE 4: **Stakeholder Area of Leadership in the Smallholder Mango Industry in Limpopo Province**

Stakeholder	Area of leadership	Frequency	%
ARC	Research	131	35
NAMC	Marketing	131	35
SAMGA	Production	118	32
LDARD	Training	34	9

The relatively few respondents (35%) perceiving the ARC and NAMC as leaders in research and marketing, respectively, may be due to the stakeholder organisations being national entities with limited local footprints. The SAMGA was viewed by three in ten (32%) smallholder mango producers as leaders in production issues, while the LDARD was mentioned by only one in ten (9%) respondents as the leader in providing training.

4.6. Knowledge Base of Stakeholders in Smallholder Mango Production in Limpopo Province

In various interactions, it is expected that each stakeholder will contribute according to their knowledge base (Kennon, Howden, & Hartley, 2009). As opined by Kennon *et al.* (2009), stakeholders should possess knowledge of the sector in which they participate and should be consulted and involved in decision-making. According to Williams, Vo, Samset and Edkins (2019), consultation and involvement illustrate recognition of stakeholders. Understanding of the knowledge base of stakeholders in the smallholder mango industry in Limpopo Province was therefore deemed essential.

As indicated in Table 5, approximately nine in ten (91%) of the smallholder mango producers perceived the ARC to be the foundation for research knowledge; hence, the stakeholder organisation would be expected to be a strong leader in the mango industry in terms of research. The SAMGA was noted to be a knowledge base for study groups (48%) and information sharing (32%), while the NAMC remained associated with marketing knowledge (11%).

TABLE 5: **Knowledge Base of Stakeholders in Smallholder Mango Industry in Limpopo Province**

Stakeholder	Knowledge base	Frequency	%
ARC	Research	342	91
SAMGA	Knowledge of study groups	179	48
	Share information	118	32
NAMC	Marketing	40	11
LDARD	Provide skills in farming	6	2

The knowledge of LDARD remained less specific, with only 2% of respondents associating the stakeholder organisation with farming skills. This situation probably stems from the fact that the Department is broadly based in terms of knowledge, as it employs teams that cover most aspects of the mango fruit value chain (e.g., research, production, and agribusiness) at less specialised levels.

4.7. Challenges Experienced by Smallholder Mango Producers When Interacting with Stakeholders in Limpopo Province

It is essential to understand the challenges faced by smallholder mango producers when interacting with stakeholders, as these need to be addressed for improved smallholder mango production to be realised.

TABLE 6: Challenges Experienced by Smallholder Mango Producers Associated with Stakeholders in Limpopo Province

Stakeholder	Challenge	Frequency	%
SAMGA	Transformation	357	95
ARC	Budget	308	82
NAMC	Budget	135	56
LDARD	Quality of extension officers	36	10

The main challenge reported by smallholder mango producers that was associated with SAMGA was transformation (probably lack thereof), with 95% of the respondents having mentioned it. Budgetary constraints were a major challenge faced by mango producers

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associated with the ARC (82%) and NAMC (56%). Fewer respondents (10%) mentioned challenges associated with the LDARD, and these were primarily related to the quality of extension services (Table 6). The adverse effects of these challenges were likely exacerbated by the perceived lack of feedback from the stakeholders. As noted in the study, only one in five (20%) stakeholders were reported to have provided feedback, while the rest reportedly did not.

5. CONCLUSIONS AND RECOMMENDATIONS

The smallholder mango industry in Limpopo Province had numerous stakeholders that interacted with and influenced mango producers. The stakeholders identified as key to the success of smallholder mango production in the study area were: LDARD, SAMGA, ARC, and the NAMC. The main role of the ARC was research and study groups (92% of respondents), while that of SAMGA was production information, mainly focusing on fertiliser application and spraying (86%). NAMC was responsible for marketing information and learning materials (59%). The LDARD was less specialised and provided value chain support with a focus on farm management and marketing (57%). Meetings and visits occurred at various frequencies, dominating the types of interactions. Associated with stakeholder roles, their contributions were reported to include study groups (ARC-89%; SAMGA-56%), daily visits by LDARD (64%), and the provision of learning materials by SAMC (42%), likely for marketing information. The area of leadership was closely tied to the knowledge base, primarily encompassing research (ARC), marketing (NAMC), production issues (SAMGA), and comprehensive value chain support (LDARD).

The nature of support provided by each stakeholder was unique and could address different aspects of the mango value chain, thereby presenting an opportunity for a more effective mango industry if properly coordinated.

It is therefore recommended that strategies be developed to strengthen the contributions of each stakeholder to the smallholder mango industry. Such an achievement could be made by strengthening the coordination of support from stakeholders. The LDARD should lead such coordination and focus on bringing each stakeholder to the right point in the mango fruit production cycle to support the correct aspect of the value chain. Stakeholders should complement each other, rather than competing, and this is key to the efficient use of resources and addressing challenges such as budget constraints.

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Dialing into Agricultural Innovation Via Mobile Phones: Experiences of Smallholder Cocoa Farmers in Sekyere South, Ghana

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ABSTRACT

Over the last two centuries, traditional methodologies for disseminating technologies to farmers have undergone significant evolution, paving the way for technology-based approaches. The study, therefore, investigated the use of mobile phones by smallholder cocoa farmers to access agricultural information. A survey design was employed, and a sample of 244 farmers was selected using a multi-stage sampling technique. Stata version 17 was used to analyse the data. The use of mobile phones by farmers for accessing agricultural information is relatively low. The most commonly accessed agricultural information via mobile phones includes cocoa market prices (26.63%), planting techniques (24.2%) and access to credit (24.18%). Cocoa farmers generally disagreed with using mobile phones for agricultural information, with mean indices of 2.46 for production, 2.50 for varieties, 2.28 for marketing, and 2.40 for practices. The binary probit model revealed that age (5%), years of education (5%), access to credit (10%), and years of farming experience (5%) significantly influence the use of mobile phones to access agricultural information. The cost of mobile phones is a primary challenge that farmers face in accessing agricultural information. Addressing these challenges will be instrumental in promoting the

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effective use of mobile phones for extension delivery, ultimately benefiting cocoa farmers and contributing to the development of the agricultural sector.

Keywords: Access, Agricultural Information, Cocoa farmers, Mobile Phone.

1. INTRODUCTION

With the introduction of modern technology, farmers' information needs are growing rapidly. Thus, farmers often find that their traditional knowledge, experience, and trial-and-error approach to making decisions for day-to-day activities are ineffective in changing conditions (Emeana *et al*., 2020; Rahman *et al*., 2020). The high cost of face-to-face interaction, crumbling extension services, and poor market information have paved the way for the use of modern information and communication technology (ICT), such as mobile phones, in disseminating agricultural information to targeted farmers (Rahman *et al*., 2020). According to Meera *et al*. (2004) and Caron (2020), the advent of new patterns of agricultural development has transformed old ways of delivering important agricultural information to clients. Meera *et al*. (2024) noted that, as the world becomes increasingly dynamic and complex, extension agents must look ahead and align themselves to capitalise on opportunities and address the challenges that arise. Therefore, to enhance their service delivery, extension agents should think creatively by continuously updating and expanding their information needs (Tsan *et al*., 2019).

The field of information and communication technology (ICT) has demonstrated its transformative potential by providing several avenues for disseminating knowledge and information (Aldosari *et al*., 2021). ICTs have become a prevalent trend for extension services, advocating communication technologies as the future of agricultural extension and offering cost-effective alternatives to face-to-face approaches (Tsan *et al*., 2019; Caron, 2020). For developing countries such as Ghana, where limited access to current farming knowledge hinders the adoption of modern agricultural technologies, this holds immense significance (Aker & Ksoll, 2016; Feng *et al*., 2021).

In the realm of information, technology serves as an intermediary. The proliferation of technology across various domains of human life has created the potential for the rapid and unimpeded acquisition of vast amounts of knowledge that undergo continuous updates, enhancements, and

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revisions (Kumar, 2021). Similarly, the use of mobile phone services in the agricultural industry facilitates the dissemination of information about market conditions, weather patterns, transportation logistics, and agricultural methodologies (Krell *et al*., 2021). This enables farmers to establish communication channels with pertinent authorities and departments (Khan, 2022).

The extensive integration of mobile phones has profoundly permeated various aspects of human life, encompassing domains such as education, commerce, trade, and agriculture (Krell *et al*., 2021). Mobile phones have emerged as the predominant mode of communication among various ICTs, with approximately 62.9% of the global population active users of this technology, equivalent to a staggering 4.68 billion individuals (Aldosari *et al*., 2021). The remarkable proliferation of mobile phones has transformed operational practices (Kassem *et al*., 2021) across industries and created new professional opportunities (Kumar, 2021), especially in agriculture (Balogun *et al*., 2022; Birner *et al*., 2021). According to Yao *et al*. (2022) and Khan *et al*. (2022), the use of mobile phones has demonstrated efficiency in cost savings, improved bargaining power, reduced barriers to market participation, and facilitated farmers' travel to better-paying markets (Abdul-Rahaman & Abdulai, 2022). Krell *et al*. (2021) argued that mobile phones have the potential to transform the lives of many smallholder farmers in a short time and at a low cost.

Mobile phones have empowered farmers within the agricultural sector, enabling communication across various levels, from local interactions to administrative matters such as trade, information dissemination, and the procurement of agricultural inputs (Kassem *et al*., 2021). They have reduced travel expenses and enhanced productivity in remote, rural regions (Krell *et al*., 2021). Mobile phones have proliferated in marginalised farming communities due to their adaptability, cost-effectiveness, and user-friendly features (Aker & Ksoll, 2016). Due to the diverse range of communication channels they offer, mobile phones have provided farmers with a novel means of making provisional judgements. Mobile phones can provide farmers with access to weather information, market prices, farming advice, improved decision-making, and reduced vulnerability to market fluctuations (Krell *et al*., 2021).

Typically, providing farm advisory services using traditional extension approaches necessitates a substantial deployment of extension agents (Yao *et al*., 2022). However, Peng (2022) indicated

that the current number of extension agents falls short of meeting the information needs of agricultural communities. This insufficiency contributes significantly to the communication gap between farmers and extension agents (Rahmiati *et al*., 2022). Furthermore, interventions aimed at delivering agricultural information to farmers through mobile phones have presented farmers with straightforward access to information. According to Khan *et al*. (2022), there is contention that communication technologies hold the key to the future of agricultural extension, rendering the traditional face-to-face extension system economically unviable. This argument is based on the potential of cellular phones to replace the need for in-person extension services. Therefore, we can argue that mobile phones can meet most of the basic needs of agricultural communities by enabling two-way communication between farmers and service providers (Mbunda & Kapinga, 2021).

The existing literature extensively explores various aspects of mobile phone usage among farmers, emphasising its significance in communication, market access, and agricultural growth (Krell *et al*., 2021; Yao *et al*., 2022; Kassem *et al*., 2021; Mapiye *et al*., 2021; Mapiye *et al*., 2025; Abdul-Rahman & Abdulai, 2022; Neha *et al*., 2018). According to Khan *et al*. (2022), the widespread use of mobile phones among farmers has emerged as a vital tool for communication, reducing transportation costs, and enhancing access to markets and information. Furthermore, several researchers have focused their efforts on examining the impact of mobile phone usage among farmers on agricultural growth progress (Birner *et al*., 2021; Khan *et al*., 2022; Balogun *et al*., 2022; Haruna *et al*., 2018; Krell *et al*., 2021; Mehta, 2013). A growing body of research has also examined the utilisation of mobile phones by agricultural officers (Idrisa *et al*., 2013). Other studies by Li *et al*. (2020) and Mbunda and Kapinga (2021) suggest that mobile phones have had a positive and significant impact on improving and modernising the agricultural industry. Naveed and Hassan (2021), Kitole *et al*. (2023), Emeana *et al*. (2020), Rahman *et al*. (2020), and Aparo *et al*. (2022) have all investigated the constraints that farmers face when using mobile phones to access information. Despite the complexity of the factors influencing mobile phone adoption and use (Feng *et al*., 2021; Rahmiati *et al*., 2022; Nyagango *et al*., 2023; Lee *et al*., 2018; Mbunda & Kapinga, 2021; Ma *et al*., 2018), these factors have received little attention. This leaves a gap in understanding the dynamics of mobile phone usage for accessing agricultural information. This gap underscores the need for further research to better comprehend the complex relationships between socioeconomic characteristics and mobile phone usage patterns in cocoa farming.

The study, therefore, aims to examine how smallholder cocoa farmers integrate mobile phones into their agricultural practices for innovation. Specifically, the study intended to examine the nature of agricultural information farmers access via their mobile phones, assess their perceptions of the use of mobile phones for accessing agricultural information, determine the socioeconomic factors that influence farmers' use of mobile phones for accessing agricultural information, and identify the challenges faced by cocoa farmers in using mobile phones for accessing agricultural information.

This research makes a novel contribution by pioneering an exploration of technology adoption patterns among smallholder cocoa farmers, with a particular emphasis on the use of mobile phones to access critical agricultural information. Through a nuanced analysis of socio-demographic factors, including age, education level, access to credit, and years of farming experience, the research reveals the underlying determinants shaping technology adoption in these communities. Additionally, our study breaks new ground by conducting a comprehensive assessment of farmers' perceptions across diverse categories, including production, varieties, marketing, and agricultural practices. By uncovering both the perceived benefits and challenges associated with mobile phone usage in agriculture, we offer a nuanced understanding of the digital landscape in rural farming contexts. Importantly, by pinpointing specific obstacles hindering the effective use of mobile technology, the study equips policymakers and stakeholders with actionable insights to develop targeted interventions and initiatives that aim to increase agricultural productivity and support smallholder cocoa farmers in Ghana. Thus, this research represents a significant step forward in the discourse on ICT adoption in agriculture, paving the way for tailored solutions to address the unique challenges faced by cocoa farmers in this region.

2. METHODOLOGY

2.1. Study Area

The Sekyere South District (formerly Afigya Sekyere District) is one of the 261 Metropolitan, Municipal, and District Assemblies (MMDAs) in Ghana, and forms part of the 43 MMDAs in the Ashanti Region, with its administrative capital located in Agona. The Sekyere South District, located in the northeastern part of the Ashanti Region, is 37 kilometres from Kumasi, along the Kumasi-Mampong trunk road. The district has a total land area of 416.8 square kilometres,

representing approximately 1.7 percent of the region's total land size of 24,389 square kilometres. It shares common borders with Ejura Sekyedumase Municipal to the north, Mampong Municipal and Sekyere East district to the east, Kwabre East Municipal to the south, and Offinso Municipality to the west. The population of the district according to the 2021 Population and Housing Census stands at 120,076 (SSDA, 2024).

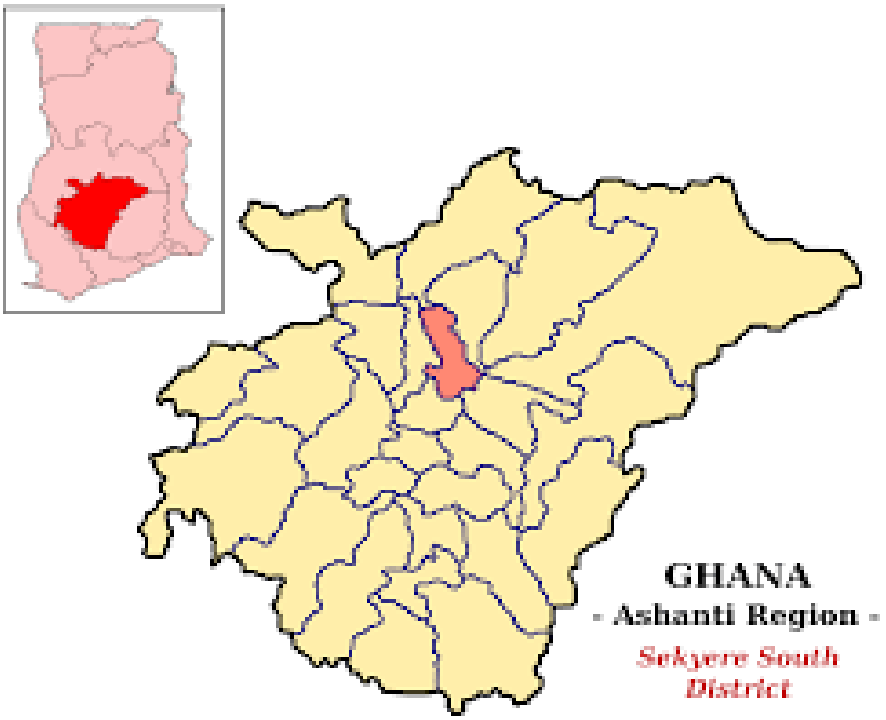

FIGURE 1: Map of Sekyere South District

2.2. Study Design

The study employed a cross-sectional research design. A cross-sectional research design is an approach where data is collected from a sample at a single point in time, offering a snapshot of their characteristics, behaviours, or attitudes without longitudinal tracking. Researchers select a representative sample and gather data through surveys, analysing it to identify patterns or relationships between variables. This design enables comparisons across different groups within the sample based on various factors, facilitating the exploration of associations or differences.

2.3. Study Population, Sample Size and Sampling Procedure

The study encompassed all cocoa farmers within the district, ensuring comprehensive coverage of the target population. The total population of registered cocoa farmers in the district from which the sampling frame was developed is 628. The sample size of 244 cocoa farmers was determined using Yamane's (1967) formula. This approach facilitated the selection of a representative subset of participants, allowing for meaningful insights into the perceptions, behaviours, and practices of cocoa farmers regarding the use of mobile phones for accessing agricultural information.

This study employed a multi-stage sampling approach, comprising several sequential steps, to ensure a representative selection of participants. Initially, the district was selected using a simple random sampling technique, where each district had an equal chance of being chosen. There are 15 cocoa districts in the Ashanti Region of Ghana. Subsequently, we selected four cocoa-growing communities (by ballot) out of approximately 20 (Jamasi, Wiamoase, Kona, and Boanim) using the same simple random sampling method, ensuring unbiased representation. Finally, we further sampled individual respondents from these selected communities using a simple random sampling procedure (balloting), giving each member of the community an equal chance of selection, thereby enhancing the overall representativeness of the study population. To develop the sampling frame, we obtained a comprehensive list of all registered cocoa farmers in each community. We then assigned a unique number to everyone in the sampling frame, thus assigning one (1) to 628. We wrote each unique identifier on a separate slip of paper, mixed them thoroughly, and drew the required number of slips. This multi-stage sampling approach aimed to systematically capture a diverse range of perspectives and experiences within the targeted population, facilitating robust analysis and interpretation of the research findings.

2.4. Research Instrument and Data Collection

Primary data collection was conducted through the administration of structured questionnaires designed to address the research objectives. The questionnaires were tailored to align closely with the specific aims of the study, ensuring that the data gathered could effectively address the research questions at hand. The questions posed in the questionnaires predominantly employed closed-ended formats to facilitate streamlined data collection and analysis. This included farmers' socio-demographic characteristics, access to mobile phones and usage patterns, types of agricultural information accessed (e.g., on production, improved varieties, marketing, and best practices), and

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the frequency and sources of such information. Additionally, data were collected on the perceived benefits, limitations, and challenges associated with using mobile phones for agricultural purposes. Respondents were also asked to rank barriers to mobile phone use, providing quantitative inputs for the analysis of constraints affecting mobile-based agricultural communication.

Researchers collected data directly from farmers while they were either at home or on their farms. This took a period of three weeks (March 2023). Two trained research assistants were engaged to assist with the data collection procedure. Questionnaires were designed in English but interpreted into the Akan language to aid quick understanding and response by the respondents. To enhance reliability, we implemented measures such as pilot testing with 20 respondents from Bepoase (within the Sekyere South District) to identify and address any ambiguities or issues with the questionnaire before full-scale data collection, thereby improving the reliability of the instruments. We ensured validity through aligning the research questions with the study objectives and using appropriate data collection instruments. We designed structured questionnaires to capture relevant variables and concepts related to the research objectives, thereby enhancing content validity.

2.5. Ethical Considerations

We implemented several measures to uphold ethical principles to the best of our ability. We provided participants with clear and comprehensive information about the study's purpose, their voluntary participation, and the use of their data. We obtained informed written consent from all participants before including them in the survey. There is no possibility of linking the data collected to specific individuals. We provided ample time for participants to provide their questionnaire responses, free from any form of pressure or coercion. We did not provide any financial incentives. We instructed participants to omit any uncomfortable questions and advised them to approach the questionnaire with careful consideration. Crucially, we did not include any inquiries or tasks that could result in bodily injury or induce psychological anguish, such as stress, anxiety, or depression, among the participants. Ultimately, we affirm that we are the authentic creators of this work. In light of these considerations, we present the findings of this study with transparency and integrity, acknowledging the limitations and expressing a commitment to upholding ethical principles in our research.

2.6. Data Analysis

We employed descriptive statistical methods, including frequency and percentage analysis, to examine farmers' responses regarding their demographics and access to information via mobile phones. By presenting farmers with a diverse array of agricultural information topics and asking them to indicate which ones they accessed through mobile phones, we aimed to capture a nuanced understanding of the specific types of information used by farmers in their decision-making processes (Aregaw *et al*., 2023).

To assess the perception of cocoa farmers regarding the use of mobile phones for accessing agricultural information, we employed a structured measurement approach using a five-point Likert scale. This scale, ranging from "strongly disagree" to "strongly agree," enabled farmers to express their level of agreement or disagreement with statements about the utility of mobile phone-based access to agricultural information. By offering a continuum of response options, from "strongly disagree" to "strongly agree," the Likert scale facilitated a nuanced understanding of farmers' attitudes and viewpoints regarding this technology-driven information dissemination paradigm. This methodological choice enabled us to capture the spectrum of opinions among cocoa farmers, providing valuable insights into their perceptions and preferences regarding the use of mobile phones for accessing agricultural information.

We employed the binary probit model to determine the socioeconomic factors influencing farmers' use of mobile phones to access agricultural information. We selected this model due to the dichotomous nature of the dependent variable, where a value of one (1) signified farmers who accessed agricultural information through mobile phones, and a value of zero (0) indicated those who did not. While useful for analysing binary outcome variables, the probit model has the limitation of assuming a normally distributed error term, which may not always align with real-world data distributions. Furthermore, interpreting the coefficients can be complex because they represent changes in the latent variable rather than direct changes in the outcome probability. It is also sensitive to outliers and influential data points, which can distort the estimation (Srimaneekarn *et al*., 2022). The technique allowed us to analyse the relationship between various socioeconomic factors and the likelihood of farmers using mobile phones to access agricultural information. The binary probit model helped determine the likelihood that farmers would use their phones to access

agricultural information, based on factors such as gender, age, marital status, farm size, education level, and other socioeconomic characteristics. This was achieved by comparing the binary outcome variable (whether farmers use or do not use phones to access agricultural information) to a set of predictor variables that identified those factors.

The study operationalised the dependent variable, which represents the use of mobile phones for accessing agricultural information, as a binary outcome, with a value of 1 indicating "yes" (use) and a value of 0 indicating "no" (not use). To determine the average usage pattern, the responses for each type of agricultural information accessed via mobile phones were aggregated, resulting in a cumulative score. We then averaged this cumulative score across all respondents to determine a mean cut-off point. We calculated the mean cut-off point in this case as the sum of the responses (e.g., 9 for "yes" and 0 for "no"), yielding a total of 9. We divided this total by 2 to arrive at a mean value of 4.5. We established a threshold based on this mean value, classifying responses below 4.5 as "not use" (0) and those above 4.5 as "use" (1). This re-categorisation enabled the grouping of respondents' mobile phone use into two categories, allowing for more in-depth research into the factors that affect usage patterns (Nyagango *et al*., 2023). We selected a range of predictor variables, including both continuous and discrete factors, to calculate the expected values of the outcome variable. Previous studies, such as Krell *et al*. (2021), Spencer *et al*. (2022), and Zheng and Ma (2023), influenced the selection of these variables.

The equation is represented as; $P_i = F(Z_i) = F(x+\beta X_i) = \frac{1}{1+e^{-Z_i}} = \frac{1}{1+e^{-(x+\beta X_i)}}$

where e represents the base of natural logarithms, Pi is the probability that an individual farmer would decide to use a mobile phone for accessing agricultural information (0-No, 1-Yes), given Xi, where Xi is the set of explanatory variables that influence the use of the mobile phones (Table 1), and β is the coefficients of the explanatory variables.

We identified the challenges faced by cocoa farmers by using mobile phones to access agricultural information using Kendall's coefficient of concordance. Kendall's Coefficient of Concordance is a statistical measure used to assess the level of agreement or concordance among multiple observers or raters when ranking or rating a set of items or variables. Farmers were asked to rank the identified challenges in order of severity, from one (1) (most severe) to nine (9) (least severe).

3. RESULTS AND DISCUSSION

3.1. Socio-Demographic Characteristics of Farmers

TABLE 1: Socio-Demographic Characteristics of Farmers

Variables	Measurement	A-prior Expectation	Frequency	Percent
Sex				
Female	Dummy: 1-Male, 0-Female	+/-	98	40.2
Male			146	59.8
Religion				
Christian	Dummy: 1-Christian, 0-Others	+/-	223	91.4
Muslim			21	8.6
Marital status				
Married	Dummy: 1-Married, 0-Others	+/-	172	70.5
Divorced	(Divorced, single, widowed)		17	7.0
Single			20	8.2
Widowed			35	14.3
Age				
20-30	Continuous: years	+	10	4.1
31-40			25	10.2
41-50			41	16.8
51 above			168	68.9
Level of education				
Junior High School	Continuous: years	+	103	42.2
None			82	33.6
Primary			46	18.9
Senior High School			8	3.3
Tertiary			5	2.0
Land ownership type				
Family land		+/-	112	45.9

Hired	Dummy: 1-Own, 0-Others		12	4.9
Leased land	(Family, hired, lease)		6	2.5
Own			114	46.7
Farm size				
0.5-2	Continuous: acres	+/-	22	9.0
3-5			100	41.0
5-10			91	37.3
Above 11			31	12.7
Access to credit				
No	Dummy: 1-Yes, 0-No	+/-	235	96.3
Yes			9	3.7
Years of Farming				
1-3	Continuous: years	+/-	16	6.6
4-6			18	7.4
7-10			50	20.5
Above 11			160	65.6
Household size				
1-3	Continuous: number of persons	+/-	49	20.1
4-6	living in a house		120	49.2
7-10			61	25.0
Above 10			14	5.7
Membership of cooperative				
No	Dummy: 1-Yes, 0-No	+/-	12	4.9
Yes			232	95.1
Ownership of mobile phone				
No	Dummy: 1-Yes, 0-No	+/-	39	16.0
Yes			205	84.0

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In Table 1, approximately 59.8% of the respondents were males, indicating a predominance of male farmers among the respondents. This gender distribution highlights the male-dominated nature of the cocoa farming communities within the study area (Alao *et al*., 2020). The majority (68.9%) of respondents were aged 51 and above, indicating that older individuals primarily engage in cocoa farming, which may impact the adoption of new agricultural practices and technologies (Adebayo *et al*., 2021). The religious composition of the respondents revealed that an overwhelming majority (91.4%) identified as Christians, while 8.6% identified as Muslims. Marital status revealed that a significant portion (70.5%) of the cocoa farmers were married. This high percentage of married farmers indicates that these individuals may have significant family responsibilities, which could affect their ability to allocate resources and time to their farming activities (Pierotti *et al*., 2022).

The respondents' education levels varied, with approximately 42.2% having completed junior high school. This relatively low level of education may influence their ability to access and use agricultural information and innovations. Most (46.7%) of the farmers owned their farming lands, providing them with more control over their farming practices and potential investments in land improvements. In terms of farm size, most (41%) of the sampled farmers owned between three (3) and five (5) acres of land. This relatively small farm size could limit economies of scale and the potential for mechanisation. Access to credit was severely limited, with 96.3% of farmers reporting that they had no credit. This lack of financial resources can hinder their ability to invest in the necessary inputs and technologies to improve productivity (Alao *et al*., 2020).

The data also indicated that most respondents (65%) had been farming for more than 11 years, demonstrating a high level of experience in cocoa farming. However, long-term farming without adequate access to modern techniques and resources might not lead to significant productivity improvements (Sabasi *et al*., 2021). The respondents' household size revealed that about 49.2% had between four (4) and six (6) members. Larger households may have both positive and negative effects on farming, providing more labour but also increasing consumption needs (Pierotti *et al*., 2022). The majority (95.1%) of respondents were members of agricultural groups. Membership in these groups can facilitate access to shared resources, information, and support networks, potentially enhancing farming practices and outcomes. Additionally, 84.0% of the farmers owned

mobile phones, which could be a crucial tool for accessing agricultural information, market prices, communication with other farmers, and extension services (Jones *et al*., 2023).

3.2. Types of Agricultural Information Farmers Access through Mobile Phone

TABLE 2: Types of Agricultural Information Farmers Access through Mobile Phones (n=244)

Variables	Access through a mobile phone
New improved varieties	22.5
Weather information	20.9
New farming methods and practices	23.0
Diseases and pest control	22.1
Fertiliser application	22.1
Planting techniques	24.2
Government input subsidies	20.9
Cocoa market prices	26.63
Access to credit	24.18

Table 2 shows farmers in Sekyere South District who use mobile phones to access a variety of agricultural information. This indicates that a substantial percentage of farmers are not utilising their mobile phones to access essential agricultural information. Recent research suggests that although farmers have a high rate of mobile phone ownership, they do not extensively use it for agricultural purposes. Although more than 90% of farmers in Pakistan possess mobile phones, a significant number of them fail to efficiently utilise these devices for accessing agricultural information (Khan *et al*., 2012; Chhachhar *et al*., 2016).

Only 22.5% of respondents reported having access to information about new, improved varieties of cocoa. This suggests a potential gap in knowledge dissemination in this area, given the less frequent use of mobile phones as a source of information on new crop varieties. Only 20.9% of the respondents reported having access to weather information, while 79.1% reported lacking this information. Similarly, Aparo *et al*. (2022) and Chhachhar and Memon (2019) asserted that farmers have limited access to weather information.

About 23.0% of respondents have access to information on new farming methods and practices. This indicates that although a quarter of farmers use mobile phones to learn about modern farming techniques, the majority still lack this information, suggesting a need for increased outreach and education (Nyaplue, 2015). About 22.1% of respondents reported having access to information on diseases and pest control, while 77.9% reported not having access to this information through the phone. Rahmiati *et al*. (2022) demonstrated that in India, farmers tend to prefer seeking guidance from government agents overusing their mobile phones.

Similar to pest control, 22.1% of respondents have access to information on fertiliser applications. Only 24.2% of respondents have access to information on planting techniques. Approximately 20.9% of respondents reported having access to information on government input subsidies via their phone. Government subsidies can have a significant impact on farmers' operational costs, and the low access rate suggests a need for improved communication about available subsidies (Voica, 2022; Thapa *et al*., 2023).

Information on cocoa market prices is the most accessed category, with 26.63% of respondents reporting availability. This reflects a critical market information gap, which is essential for making informed economic decisions regarding cocoa sales. Knowing market prices helps them make strategic decisions about when to sell, and access to credit is essential for investing in their farms. The use of mobiles for these purposes underscores their role in economically empowering farmers. The increased use of market information also signifies its efficacy in agricultural practices (Tang *et al*., 2015). Only 24.18% of respondents reported having access to credit-related information. Credit is critical for financing agricultural inputs and operations, and the significant majority lack access, indicating a need for more effective credit information dissemination.

3.3. Perception of Cocoa Farmers Towards Mobile Phone Usage for Accessing Agricultural Information

TABLE 3: Perception of Cocoa Farmers Towards Mobile Phone Usage for Accessing Agricultural Information (n=244)

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree	Mean	Std. Dev.

	F (%)	F (%)	F (%)	F (%)	F (%)		
Production (Mean Index=2.46)							
Availability of cocoa farm implements.	113 (46.3)	58 (23.8)	6 (2.5)	16 (6.6)	51 (20.9)	2.31	1.593
Increasing my yield.	74 (30.3)	81 (33.2)	20 (8.2)	24 (9.8)	45 (18.4)	2.52	1.472
Improvement in the nutrient status of my soil.	75 (30.7)	76 (31.1)	22 (9.0)	24 (9.8)	47 (19.3)	2.55	1.490
Varieties (Mean Index=2.50)							
Information on new varieties of seeds.	80 (32.8)	77 (31.6)	18 (7.4)	24 (9.8)	45 (18.4)	2.49	1.489
Information on good varieties of cocoa beans seedlings.	76 (31.1)	85 (34.8)	14 (5.7)	20 (8.2)	49 (20.1)	2.51	1.500
Marketing (Mean Index=2.28)							
Packaging of my produce.	130 (53.3)	39 (16.0)	4 (1.6)	20 (8.2)	51 (20.9)	2.27	1.641
Contact potential buyers.	125 (51.2)	48 (19.7)	12 (4.9)	22 (9.0)	37 (15.2)	2.17	1.505
Prices of cocoa commodities.	107 (43.9)	50 (20.5)	18 (7.4)	20 (8.2)	49 (20.1)	2.40	1.580
Agricultural Practices (Mean Index=2.40)							
Control diseases and pest on my cocoa farm.	83 (34.0)	74 (30.3)	18 (7.4)	20 (8.2)	49 (20.1)	2.51	1.540

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Information on irrigation system.	145 (59.4)	33 (13.5)	10 (4.1)	18 (7.4)	38 (15.6)	2.06	1.528
Information on fertiliser application.	71 (29.1)	85 (34.8)	18 (7.4)	24 (9.8)	46 (18.9)	2.54	1.471
Information about pruning.	79 (32.4)	81 (33.2)	16 (6.6)	20 (8.2)	46 (18.9)	2.47	1.489

NB: Strongly disagree=1.00-1.49; Disagree=1.50-2.49; Neutral=2.50-3.49; Agree=3.50-4.49; Strongly agree=4.49-5.00

Table 3 provides insights into the perceptions of cocoa farmers across various categories: production, varieties, marketing, and agricultural practices. The mean index for the production category (2.46) indicates disagreement among cocoa farmers about the usefulness of mobile phones in obtaining information about production practices. This implies that most cocoa farmers do not perceive mobile phones as particularly useful tools for accessing information related to their production. Farmers may have limited access to relevant production information via mobile phones, either due to technological barriers such as poor network coverage or limited internet connectivity, or a lack of tailored content available through mobile platforms (Nyaplue, 2015; Erlangga *et al*., 2023). Additionally, farmers' preferences for traditional sources of agricultural knowledge, such as extension services or face-to-face interactions with agricultural experts, may influence their perceptions of the utility of mobile phones for production-related information (Jones *et al*., 2023). Furthermore, the discrepancy in perceived usefulness could stem from varying levels of familiarity or comfort with mobile technology among cocoa farmers. Those who are less adept at using mobile phones or who have limited exposure to digital tools may be less inclined to view them as effective means of accessing production information compared to those who are more technologically savvy (Abdulai *et al*., 2023).

The slightly higher mean index for the varieties category (2.50) indicates a relatively neutral perception among cocoa farmers about the usefulness of mobile phones in accessing information about new and improved varieties. This neutral perception could stem from the fact that farmers perceive mobile phones as potentially useful for accessing information on new cocoa varieties.

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However, they may also harbour doubts or uncertainties about the reliability or comprehensiveness of such information when delivered through digital channels. Additionally, farmers' experiences with mobile-based agricultural extension services or the quality of content available through mobile platforms may vary, leading to mixed perceptions among respondents (Abdul-Rahman & Abdulai, 2022).

The mean index of 2.28 in the marketing category, which is slightly lower than the scores in the previous categories, suggests that cocoa farmers disagreed regarding the usefulness of mobile phones for marketing purposes. Farmers may perceive limitations in the ability of mobile phones to effectively support their marketing efforts. This could include concerns about the reliability of mobile networks, access to relevant market information, or the ability to engage in direct marketing activities using digital platforms (Nyagango *et al*., 2023). This could stem from challenges or barriers they face in using mobile phones for marketing purposes (Lee *et al*., 2018). These may include limited access to mobile-based marketing platforms or services, inadequate training or technical support for leveraging mobile technology in marketing strategies, or a lack of awareness about the potential benefits of digital marketing tools (Idrisa *et al*., 2013).

The category of agricultural practices, with a mean index of 2.40, indicates that cocoa farmers disagreed on the effectiveness of mobile phones in providing information about agricultural practices. Although farmers may recognise the potential benefits of using mobile phones to access agricultural information, they may also harbour doubts about the reliability or accuracy of the information available through mobile channels, particularly in comparison to traditional extension services or expert advice (Nyaplue, 2015).

3.4. Socioeconomic Factors that Influence Cocoa Farmers' Use of Mobile Phones for Accessing Agricultural Information

TABLE 4: Socioeconomic Factors that Influence Cocoa Farmers' Use of Mobile Phones for Agricultural Information

Variables	Co-efficient (Std. Error)	Marginal effects
Sex	-0.0366	0.964
	(0.500)	(0.482)

Marital status	-1.312	0.269
	(0.861)	(0.232)
Age	1.502	4.491
	-3.265**	0.0382**
Years of education	0.698**	2.010**
	(0.290)	(0.584)
Farm size	0.222	1.249
	(0.256)	(0.32)
Access to credit	1.278*	3.591*
	(0.741)	(2.661)
Years of farming	0.822**	2.274**
	(0.399)	(0.908)
Religion	-0.606	0.546
	(0.554)	(0.302)
Household size	0.331	1.393
	(0.242)	(0.337)
FBO Membership	0.412	1.51
	(0.984)	(1.486)
Phone Ownership	0.194	1.215
	(0.627)	(0.761)
Constant	-5.486**	0.00414**
Number of obs. = 239; LR chi^2 (17) = 67.49; Prob > chi^2 = 0.000; Pseudo R^2 = 0.239		

NB: *** p<0.01, ** p<0.05, * p<0.1

Table 4 presents the various factors that contribute to the use of mobile phones for accessing agricultural information. We found statistical significance in the following factors: age, years of education, access to credit, and years of farming. The significant and negative correlation with mobile phone usage at a 5% significance level indicates that younger cocoa farmers are more inclined to use mobile phones for accessing agricultural information. This finding aligns with Nyagango *et al*.'s (2023) research, which also revealed a positive association between age and the

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use of mobile phones for agricultural marketing information among farmers. Specifically, the study highlighted that younger farmers exhibit a greater propensity for such use compared to their older counterparts.

The significant and positive association between education and mobile phone usage at a 5% significance level suggests that cocoa farmers with more years of formal education are more inclined to use mobile phones for accessing agricultural information. The level of education of smallholder farmers serves as a crucial socio-demographic factor influencing their use of mobile phones for accessing agricultural information. This finding aligns with the research of Krell *et al*. (2021) and Khan *et al*. (2022), which identified a significant link between individuals' educational attainment and their use of mobile phones for obtaining agricultural marketing information. Rahman *et al*. (2020) observed that farmers with limited literacy skills were less likely to employ mobile phones to access agricultural marketing information.

The significant and positive relationship between access to credit and mobile phone usage, at a 10% significance level, indicates that cocoa farmers with access to credit are more likely to use mobile phones for agricultural information. Access to credit can facilitate the acquisition of mobile phones or subscriptions to access agricultural data, thus enhancing their use of mobile phones for accessing agricultural information. Moreover, the positive and significant relationship between years of farming experience and mobile phone usage at a 5% significance level suggests that cocoa farmers with more experience in cocoa farming are more likely to use mobile phones to access agricultural information. This observation is consistent with the notion that older individuals are typically the primary users of mobile phones for agricultural information (Krell *et al*., 2021). According to Aldosari *et al*. (2019), farmers with extensive farming experience may be hesitant to adopt mobile phone technologies for accessing agricultural information.

The coefficient for years of farming, which is 0.822, suggests a positive relationship between the duration of farming experience and the likelihood of using mobile phones for accessing agricultural information among cocoa farmers. This implies that as farmers gain more experience in cocoa cultivation over time, they are increasingly inclined to use mobile phones as tools for obtaining relevant agricultural information. This finding aligns with the notion that farmers with

longer tenure in the profession may develop a deeper understanding of the importance of being informed about evolving agricultural practices, market trends, and pest management strategies to optimise their productivity and profitability. As they accumulate practical knowledge and encounter various challenges and opportunities in their farming endeavours, experienced farmers may recognise the value of leveraging mobile technology as a convenient and accessible means of accessing timely and relevant agricultural information (Aldosari *et al*., 2019).

3.5. Challenges Faced by Cocoa Farmers in the Use of Mobile Phones for Accessing Information

TABLE 5: Challenges Faced by Cocoa Farmers in the Use of Mobile Phones for Accessing Information (n=244)

Challenges in using a mobile phone	Mean	Ranking
Cost of a mobile phone	2.16	1st
Cost of mobile data	3.08	2nd
Incomplete information	4.31	3rd
Unreliable mobile network	4.50	4th
Language barrier	4.57	5th
Digital literacy level	4.73	6th
Breaking up of sound	5.64	7th
Weak signal strength	7.46	8th
Frequent service interruptions	8.54	9th
N=244; Kendall's W[a]=0.530; Chi-Square=1034.458; df=8; Asymp. Sig.=0.00		

The application of Kendall's W coefficient (0.53) and chi-square statistics confirms a moderate level of consensus among respondents regarding the ranked challenges associated with mobile phone use in agriculture (Table 5). This level of agreement enhances the credibility of the rankings and underscores the importance of the identified issues within the context of agricultural communication.

Foremost among these challenges is the cost of mobile phones, which was ranked as the primary barrier. This highlights the financial burden of acquiring and maintaining a mobile device, which

remains a significant obstacle for many farmers (Erlangga *et al*., 2023). The cost of mobile data follows as the second major concern, reflecting the recurring expense of data packages. Even after obtaining a mobile phone, the affordability of data continues to limit farmers' ability to access information effectively (Wyche & Steinfield, 2016).

Incomplete information ranks third, highlighting the inadequacy of relevant, timely, and comprehensive agricultural content available on mobile platforms. This limits the usefulness of mobile phones as tools for informed decision-making and productivity enhancement (Erlangga *et al*., 2023). Addressing this may involve tailoring content to farmers' needs, integrating extension services into digital platforms, and ensuring the timely dissemination of locally relevant information. The fourth-ranked challenge, unreliable network coverage, highlights infrastructural limitations that hinder consistent communication. This calls for investment in mobile infrastructure—such as expanding coverage and enhancing reliability—to improve connectivity, especially in rural and remote areas (Mittal & Mehar, 2016).

The language barrier, ranking fifth, underscores the need for agricultural information to be delivered in local languages to facilitate effective communication and inclusivity. Closely following are concerns about digital literacy, breaking up of sound, and weak signal strength, which reveal usability and technological barriers that affect the effectiveness of mobile communication tools. Lastly, frequent service interruptions point to broader issues of network stability and service reliability in rural Ghana. These findings collectively emphasise the need for holistic interventions that combine technological, infrastructural, and educational strategies to enhance the role of mobile phones in agricultural development (Idrisa *et al*., 2013).

4. CONCLUSION

Despite the widespread availability and use of mobile phones for various activities, their usage among cocoa farmers for accessing cocoa market prices and credit-related information is relatively low, implying that mobile phones are not yet a critical tool for economic decision-making in cocoa farming, suggesting a reactive rather than proactive approach to farm management. The low usage of mobile phones for accessing agricultural information highlights a significant gap in knowledge transfer and the adoption of innovative farming techniques. Cocoa farmers' perceptions of the

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usefulness of mobile phones for accessing agricultural information vary widely, with many holding neutral views or disagreeing. Socio-demographic factors such as age, education level, access to credit, and years of farming experience significantly influence the likelihood of cocoa farmers using mobile phones to access agricultural information. Several key challenges hinder the effective use of mobile phones among cocoa farmers, including the cost of mobile phones and data, incomplete or unreliable information, poor mobile network coverage, language barriers, and issues related to digital literacy.

Based on the study's conclusions, we offer the following recommendations: The Ghana Cocoa Board could develop policies and initiatives to improve cocoa farmers' access to affordable mobile phones and data packages. There could be partnerships established between government agencies, telecommunications companies, and agricultural extension services to expand mobile network coverage in rural areas and ensure reliable connectivity for farmers. The launch of agricultural information campaigns that specifically target farmers, emphasising the advantages of mobile phone use for accessing valuable information, could be helpful. Technology organisations can also create user-friendly mobile applications and services tailored to the specific agricultural needs of farmers. These should include features for accessing information on crop varieties, weather forecasts, pest control, and other relevant topics. Content provided through mobile phones must be in local languages to overcome language barriers and make the information more accessible and understandable for all farmers.

We suggest two key areas for further study: conducting longitudinal studies to track changes in mobile phone usage over time among cocoa farmers, which will help identify trends, long-term impacts, and the sustainability of mobile phone adoption for agricultural purposes. Secondly, investigate the direct impact of mobile phone usage on agricultural productivity, income, and the livelihoods of farmers.

The reliance on self-reported data, as a limitation, can introduce bias, as respondents might overestimate or underestimate their mobile phone usage or other behaviours. The scope of mobile phone usage is limited. We did not explore in detail other potentially beneficial uses of mobile phones. The findings, as a cross-sectional study, provide a snapshot in time and do not account for

changes in mobile phone usage or other variables that may occur over time. The study did not fully account for external factors that could influence mobile phone usage, such as government policies, the presence of agricultural extension services, or the availability of mobile phone training programmes.

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A Systematic Review of Constraints Associated with the Beef Value Chain in the Southern African Development Community (SADC)

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ABSTRACT

More than 30 years after the formation of the AU, intra-African trade remains relatively low in magnitude. Africa aims to increase inter-and intra-African trade through the African Continental Free Trade Area (AFCFTA). To realise this, Africa must boost production, especially agricultural production, which has remained stubbornly low. This study aimed to identify some of the factors contributing to this issue in the red meat and live animals value chain, which is a priority value chain for the SADC. In the SADC, beef is the dominant product, so it was selected as the focus of this study. A systematic review was used to identify factors that constrain beef production. Boolean search strings were used to identify relevant literature from databases. Inclusion-exclusion criteria were based on abstract content. Since some of the literature was dated, focus group discussions, value chain analysis workshops, and a validation workshop were used to confirm the constraints. Market-related constraints, namely: lack of market information, market segmentation, cost of compliance; Production-related constraints, namely: disease prevalence, lack of technology adoption, hygiene issues; Structural constraints, namely: infrastructure gaps, governance issues, and lack of integration; and Social constraints, namely: gender imbalance, were identified. Addressing these constraints will enable the SADC to increase both inter- and intra-SADC beef trade.

Keywords: Africa, AFCFTA, Beef, Systematic Review, Constraints, Value Chain, Validation.

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1. INTRODUCTION

The pursuit of both African regional and continental political and economic integration agendas has led to the formation of numerous institutions. Following the Abuja Treaty of 1994, African efforts for integration culminated in the formation of the African Union (AU) in 2002 (Magoke & Öke, 2023; de Melo & Solleder, 2025). It has been more than 30 years since the African Union (AU) was formed, but intra-African trade remains stubbornly low (de Melo & Solleder, 2025). Intra-SADC agricultural exports of vegetable and animal products were valued at USD 2,871 million in 2019. This represented 6.2% of total intra-SADC exports. Intra-SADC agricultural imports were valued at USD 2,498 million, accounting for 7.1% of total intra-SADC imports (SADC, 2021). Since agriculture is the mainstay of this region, these figures need to improve.

Sixteen or so regional economic communities (RECs) have been formed, of which the AU recognises eight. Although the chronology and objectives of the formation of RECs differ, according to Magoke and Öke (2023, p. 6), RECs "… are considered as essential vehicles or 'building blocks' towards achieving continental integration." Pursuant to the economic integration objectives, the African Continental Free Trade Area (AfCFTA) was established in 2018, among other objectives, to create a single market for goods and services, which is expected to boost trade between African countries (Magoke & Öke, 2023). To boost this trade, Africa needs to increase its production.

There are specialised organisations that focus on supporting the enhancement of production to assist in achieving the AfCFTA objectives. For instance, the African Union-Interafrican Bureau for Animal Resources (AU-IBAR), a specialised technical office of the African Union Commission's Department of Agriculture, Rural Development, Blue Economy, and Sustainable Environment, leads the development of animal resources in Africa. It works at the continental and regional levels in collaboration with RECs and African Union (AU) Member States (MSs). Its mandate is to coordinate and support the sustainable development and utilisation of animal resources to enhance nutrition and food security in the AU MSs.

It is this mandate that led AU-IBAR to collaborate with the European Union as development partners in initiating the Sustainable Development of Livestock for Livelihoods in Africa (Live2Africa) Project, which focuses on implementing the continental components of the Livestock Development Strategy for Africa (LiDeSA 2015-2035) (AU-IBAR, 2015). The

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project is grounded in the Malabo Declaration targets, the Sustainable Development Goals, and the African Union Agenda 2063. It builds systemic capacity in livestock and, therefore, the study of constraints limiting production is of paramount importance.

Worldwide food production must meet global food demand. A 50-70% increase in food productivity is needed to feed the projected 9 billion people by 2050 (UN, 2019). Livestock provides 13% of total calories and about 26% of protein for humans. Estimates also indicate that, because of economic growth, urbanisation, and changes in consumption patterns in developing countries, demand for livestock products is likely to more than double in the next 20 years (Louw *et al.,* 2018). Given the anticipated growth in demand for livestock products, SADC would like to increase intra-SADC trade in livestock and livestock products. The SADC would also like to increase its share of inter-regional trade by actively participating in the AfCFTA. To achieve this objective, the SADC intends to strategically position itself as a net exporter of livestock and livestock products.

To understand the aspirations of different African regions, AU-IBAR facilitated a continental prioritisation workshop in 2018. The workshop focused on identifying all the regional value chains, and an in-depth SWOT analysis was undertaken. This process highlighted some of the weaknesses and potential opportunities for delivering the desired transformation. Given its aspirations, the SADC has selected the red meat and live animal value chains as its priority. With the appropriate actions, the strategic position of being a net exporter of livestock and livestock products can be achieved, as there is room for expansion. For instance, Cook (2024) indicates that of the 50 top world beef-producing countries, South Africa, Tanzania, and Zimbabwe are the only SADC countries included.

The most extensively studied of the red meat value chains in the SADC region is the beef value chain. This is evidence of the prominent position that beef holds in the diets of the SADC region. The beef value chain is also important because it offers attractive market opportunities locally (within countries), regionally (in the SADC) and internationally (World Bank, 2011). For instance, in 2019, intra-SADC beef exports totaled USD 207 million, and intra-SADC beef imports were USD 153 million (SADC, 2021). To improve the SADC trade balance in beef, it is essential to review the constraints faced along the beef value chain in the SADC region, as identified in the existing literature, and combine these with a SWOT analysis to formulate a way forward for developing the beef value chain.

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2. METHODOLOGY

2.1. Theoretical Framework

Porter's value chain theory undergoes the study. Porter classified value chain activities into primary activities and support activities. Primary activities create the product while support activities play a supporting role (Rahman *et al.,* 2021). We apply Porter's framework to identify constraints along the SADC beef value chain.

2.2. Systematic Review

The systematic review process was followed in this study. Academic and grey literature were systematically identified from electronic databases and the websites of relevant organisations. The electronic databases searched included Web of Science, Scopus, Google Scholar, AGRICOLA, ScienceDirect, SciELO, and SpringerLink, among others. A general Boolean search string, 'Constraints' AND 'livestock' AND 'production' AND 'value chain' AND 'Southern Africa', was initially used and then narrowed down to SADC by following up references identified in the initial articles. Some grey literature was found in the form of work papers and project reports from different organisations**.** Open-access full-text articles were identified and retrieved through search engines like Google Chrome and Mozilla Firefox. ResearchGate services, which offer direct full-text requests from authors, were also utilised.

The electronic databases to which Stellenbosch University and the University of Pretoria subscribed were used to retrieve relevant articles that were not available on free access. The advantage of these sources is that a single search accesses multiple databases. Inclusion-exclusion criteria were based on whether abstracts made direct or indirect reference to constraints along the beef value chain. Literature from the last 25 years has been evaluated on this basis. Intensive searches were then conducted to identify relevant literature published within the last 10 years. Where dated empirical evidence was superseded by evidence from the last 10 years, the most recent article was cited. A substantial amount of dated literature was superseded in this manner and was, therefore, not cited. Dated literature that was not superseded was used, but the findings were qualitatively triangulated and validated.

2.3. Triangulation and Validation

Qualitative methods were used to triangulate and validate the findings from the literature review. Focus group discussions (FGDs) were conducted with key informants from four SADC

countries: Namibia, Mozambique, Eswatini, and Madagascar. Countries were purposively selected based on the researcher's ease of access. In each country, AU-IBAR has a focal person who coordinates its activities. The focal people in the selected countries were asked to purposively select 9 to 12 participants knowledgeable about the beef value chain in their country to participate in FGDs. Group size was guided by the recommendations of Neuman (2006), Collins *et al.* (2007), and Creswell (2009). Four FGDs, one in each of the selected countries, were held online using the Zoom platform.

Workshops to perform value chain analyses were held in four SADC countries: Tanzania, Malawi, Namibia, and Eswatini. Twelve to fifteen participants were purposively selected based on their involvement in administration or production along the beef value chain. During the workshops, the beef value chains in each country were analysed and mapped. Factors affecting different nodes of the beef value chain were discussed and compared with those identified in the literature. Thus, constraints affecting the beef value chain were concurrently triangulated and validated.

Finally, a validation workshop, which representatives from the 16 SADC MSs attended, was held in Arusha, Tanzania, from 20th to 22nd June 2022. At the workshop, among other agenda items, the constraints identified through the systematic review, FDGs, and the value chain analysis workshops were validated. Where dated references were used, it was essential to verify that the constraints remained relevant as identified.

3. RESULTS

3.1. Review of Beef Value Chain Constraints in the SAD Region

The identified constraints were grouped into four categories: production-related constraints, structural constraints, market-related constraints, and social gaps.

3.1.1. Production-Related Constraints

3.1.1.1. Disease and Disease Management

Animal disease control and general management are poor in most SADC countries (Wilson, 2018; Madzingira & Simasiku, 2020). Only 29 percent of cattle in Tanzania receive regular vaccinations. The control of internal helminth parasites and the protection of animals from ticks and tick-borne diseases is hardly practiced. Partly because of poor disease control, animals die. The death rates in calves may be as high as 70% of those infected by East Coast Fever (ECF),

a disease that can be reduced to less than 30% by dipping only. The reproductive rates in cattle are 50% or less, with heifers typically calving for the first time at 4 years of age and then producing a calf every 2 years. The growth rates are low. This greatly reduces overall output. Off takes could reach 12% but they are more likely to be around 10%. The meat resulting from the poor health of animals is of very poor quality. The bleak picture of animal health painted by Wilson (2018) is not limited to Tanzania. Many SADC countries experience this cycle. Bennett *et al.* (2019) point out that the lack of resources for basic disease and parasite management is a constraint for the beef value chain in Zimbabwe. Foot-and-mouth disease (FMD) affects exports from Zimbabwe to countries free from FMD. In Zimbabwe, tick-borne diseases are attributed to insufficient dipping. Babesiosis, Anaplasmosis, Heartwater, and Theileriosis cause 55-65% of cattle mortalities. Lubungu *et al*. (2015) mention that in Zambia, outbreaks of diseases such as FMD, Contagious Bovine Pleuropneumonia (CBPP), corrido, and anthrax negatively affect the inter-provincial trade of live animals, thus limiting market options, especially for smallholders who end up selling at low prices in local markets. Basic, cheaply constructed infrastructure, such as cattle crushes, can deliver the necessary treatments to animals and also improve access to dipping (Vernooij *et al*., 2016). Disease control and the provision of necessary infrastructure are areas where PPPs could perform well. Governments could provide infrastructure, while the provision of veterinary medicines could be privatised. In Madagascar, Andriamparany *et al.* (2023) note that training in livestock disease management can enhance the performance of the livestock value chain.

3.1.1.2. Lack of Technology Adoption

The lack of technology adoption is a prominent constraint on the beef value chain. Smallholders do not adopt simple technologies that have a high impact on productivity. In Tanzania, calf growth, currently estimated at 300 g/day, could be easily increased to 400 g/day with supplementation, resulting in a 33 percent increase in productivity. The calving interval could also be decreased by the same margin through strategic supplementation. Vaccination/dipping for the effective control of East Coast Fever and anthelmintic treatment can result in a productivity improvement of more than 200%, whereas a combination of disease control and strategic supplementation could increase annual off-take by 20 percent (Wilson, 2018). The SADC region can enhance the performance of the beef value chain by adopting simple technologies. The World Bank (2011) notes that investment in such technologies pays for itself many times over.

3.1.1.3. Lack of Hygiene

The supply of quality hygienic beef is a challenge in most rural areas in Africa. In some countries, such as Tanzania, it's a challenge throughout the entire beef value chain. The livestock resource base in Tanzania is huge. For instance, the cattle herd is estimated to be about 28.5 million. However, irrespective of its potential to contribute to Tanzania's economic development, the sector is underutilised (Kamugisha *et al*., 2019). Like in many sub-Saharan countries, the Tanzanian traditional beef production sector is underdeveloped and faces challenges in observing the hygienic conditions required to supply quality beef. In fact, in Tanzania, this is such a constraint that quality hygienic beef is supplied to "niche" markets where consumers are prepared to pay a premium for the improvement in hygiene and beef quality.

The practices in the traditional beef sector pose a health risk to consumers. The occurrence of the *Campylobacter species* has been recorded in the traditional value chain in Tanzania. The *Campylobacter species* is transmitted to humans when contaminated meat is consumed (Mahundi *et al*., 2011; Ntanga *et al*., 2014; Kashoma *et al*., 2016). In a study in Tanzania, it was estimated that in one municipality, contaminated beef in the traditional sector accounted for more than 15% of roasted and just under 35% of stewed beef consumed (Mahundi *et al.,* 2011). These studies concluded that improving the quality of beef is a key aspect in reducing the health risk to consumers of beef. This conclusion might apply to many SADC countries where hygienic conditions for beef need to be improved.

3.1.2. Structural Constraints

3.1.2.1. Infrastructure Gaps

In some SADC countries, there is poor and/or inadequate infrastructure (Vernooij *et al*., 2016), including marketing infrastructure and road networks (UNIDO, 2012; Lubungu *et al*., 2015). In the cases of poor infrastructure, the marketing of live animals could benefit from the construction of physical open-air markets. These could be strategically constructed near dipping tanks to utilise the available infrastructure (World Bank, 2011). This is also an area where PPPs could be established, with the government providing facilities for water supply, fencing, and sanitation, while the management is left to private companies. A crucial condition is that such open-air markets should be able to provide adequate information (World Bank, 2011) to mitigate the problems associated with information asymmetry. In Madagascar,

Andriamparany *et al*. (2023) concluded that investments in transportation and marketing infrastructure could support the development of the local livestock sector and improve the local supply of animal-source food in the SAVA region.

3.1.2.2. Governance and the Cost of Compliance

According to Fabre *et al.* (2021), governance comprises formal and informal rules that are applied at various stages of the value chain. Analysing governance mechanisms along the value chain and their social relations can reveal the major negative and/or positive drivers of the value chain. Generally, governance is associated with the costs of compliance for stakeholders along the value chain. Chamboko and Erasmus (2014) report on the costs of compliance that are incurred along the beef value chain in Zimbabwe. There is a rural district levy, which varies between $5 and $40 per animal sold. Some rural district councils require buyers of cattle to purchase a license for $250 per quarter to be allowed to buy animals in the district. Cattle buyers are also required to register with the Agricultural Marketing Authority at a fee of $150 per annum. Moving cattle requires a permit, which costs $10, and a police anti-stock theft clearance, which is supposed to be free but for which the police charge an unofficial facilitation fee of $5. Producers who want to sell animals must provide transportation for veterinary and police officers to and from the farm. Farmers set aside two days to obtain the necessary permits and police clearance. For farmers, these set-aside days come at a very high opportunity cost. Under the harmonised model By-Law, the total cost of regulatory compliance in the Zimbabwean beef value chain is $110 and $112 per animal sold in the small- and large-scale beef value chains, respectively. Under this scenario, producers will incur losses of $7 per head sold ($0.04/kg dressed weight) and $17 ($0.09/kg dressed weight) in the small- and large-scale value chains, respectively. Levies can be used to benefit the beef value chain. Scoones *et al.* (2010) provide an example of such an approach from Namibia, which can be replicated in the SADC.

3.1.2.3. Lack of Integration (Horizontal and Vertical)

Across the globe, smallholder farmers lack access to essential resources, including finance, extension services, market information, and quality control (Mapiye *et al*., 2020; Mapiye, 2022). They also lack the organisation that can support them in addressing these constraints and profitably integrating into their product value chains. To alleviate this constraint, the development of farmer organisations and associations within the SADC can be achieved

through horizontal integration. Empirical evidence suggests that producer organisations can be utilised to enhance value chains (Widadiea *et al*., 2021). Examples of successful horizontal integration can be found in Zimbabwe, where the Zimbabwe Farmers Union is a powerful actor in most agri-value chains, and the government utilises cooperatives to organise smallholder agricultural producers, including cattle producers (Bennett *et al*., 2019). Vertical integration can also occur along the red meat and live animals value chain (Bennett *et al.,* 2019). Zimbabwean abattoirs are reportedly very active in vertical integration and can serve as case studies for improving the performance of the beef value chain in the SADC.

3.1.3. Market-Related Constraints

3.1.3.1. Information Gaps and Price Discovery Challenges

Access to market information along the beef value chain is minimal, especially for smallholders (Mapiye *et al.,* 2020). Lack of information is not only a problem for smallholders. It affects most value chains in Africa, where even the number of stakeholders along the value chain is unknown. Regarding the Tanzanian red meat value chain, Wilson (2018, p. 1) wrote, "The chain is fragmented, unorganised, uncontrolled (despite being over-regulated) and uncoordinated. It is dominated by large numbers of smallholder stock owners, an unknown but undoubtedly immense number of middlemen who operate across every link and a similarly unknown number of small processors and butchers who put products on the market for the consumer, but who mainly lack the technical and financial ability to run it efficiently and profitably." The constraints faced by smallholder traders in Zimbabwe, as reported by Dube *et al*. (2017), include competition from the large-scale formal sector, high purchase prices and transportation costs, limited trader skills and access to information, and poor market information**.** A lack of information on standards, grades, and prices increases transaction costs for most market intermediaries and smallholder livestock producers. This limits their market participation (Key *et al.,* 2000; Costales *et al.,* 2006).

In many African countries, livestock market information systems are not in place. Where they do exist, they generally perform poorly, do not provide sufficient and timely information, and lack transparency. Information transparency fosters confidence development between actors and plays a crucial role in reducing information asymmetry, thereby improving price discovery mechanisms, especially for under-resourced value chain stakeholders (Fabre *et al*., 2021). A lack of information means that value chain actors, especially smallholder producers and small-

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scale operators, operate under conditions of asymmetric price information, thereby weakening their negotiating position when dealing with larger stakeholders who can collect more information. Gabre-Madhin (2009), Lubungu *et al.* (2015), Bennett *et al.* (2019), Ogundeji and Maré (2019) and Mapiye *et al.* (2020) report on asymmetric information, which leads to inefficient price discovery systems. Inefficient price discovery not only affects marketing decisions but also impacts production (World Bank, 2011; Government of South Africa, 2019). Andriamparany *et al*. (2023) report that in Madagascar, a lack of market information, as well as issues with timeliness and transparency in market information, reduces livestock market performance.

3.1.3.2. Lack of Niche Markets, Markets and Market Segmentation

In the SADC, there is scope for the development of all types of markets, including niche markets. Robust animal traceability systems can promote access to (niche) export markets. When traceability systems fail, it can lead to the temporary or permanent blocking of export markets, as seen in Botswana in 2011 (van Engelen *et al*., 2013). A lack of animal traceability severely limits the development of inclusive value chains for red meat and live animals in the SADC, as well as their access to niche markets. Pasture beef production, which can increase export market access, can be done in an environmentally sustainable way. Some farmers in South Africa are employing regenerative agriculture management practices to produce beef cattle (Coetzee, 2025; Farmer Angus, 2025). Consumers are willing to pay a premium for pasture-raised beef (Stampa *et al*., 2020). Commercial farmers can achieve the desired pasture attributes through adjustments in management. However, for smallholder farmers whose production systems are already low-input systems (Marandure *et al*., 2020), certification for organic and/or pasture production might not require many management adjustments.

Marandure *et al*. (2016) also investigated the willingness of traders and consumers to support the development of a natural pasture-fed beef brand (NPB) by smallholder cattle producers in South Africa, yielding positive results. However, in order to develop this potential, government support is necessary. The Farm Assured Namibian Meat (FAN Meat) scheme, which markets free-range, hormone-free beef with guaranteed animal welfare and veterinary standards, is a good example of an initiative that can be leveraged to capitalise on this potential (Scoones *et al*., 2010). Organically raised and branded beef (Labuschagne *et al*., 2010; Marandure *et al*., 2016) can also be used to penetrate both local and international markets (van Engelen *et al*.,

2013). Kunene-Ngubane *et al*. (2018) concluded that South Africa has the potential to produce pasture-raised organic meat, including from communal farmers. The best opportunity for South Africa to capture a portion of the global market is not through competing with countries that export large volumes, but rather by competing with countries like the Netherlands, which export low volumes of higher-quality beef (Beefmaster Group, 2021), and by targeting niche markets.

Some market segmentation is practised within the SADC countries. For instance, Lubungu *et al*. (2015) and Sikamwaya and Guiyu (2020) describe the Zambian beef market as segmented between choice beef, which is primarily produced by commercial farmers through feedlots, and standard beef, which is mainly produced by smallholder livestock farmers using a low-intensity production system. In 2015, the standard beef market accounted for 80% of total beef demand. Lubungu *et al.* (2015) mention that there is higher price volatility in the standard beef market. The segmentation, therefore, is more of a hindrance to the development of smallholder livestock producers in Zambia. The Government of South Africa (2019) notes that low market intelligence along the beef value chain can also hinder development. This is an area where PPPs could be developed to address the issue of low market intelligence alongside the beef value chain in the SADC, especially for smallholders.

3.1.3.3. The Beef Carcass Classification System

In some SADC countries, one of the contentious aspects along the beef value chain is the carcass classification system. In Zimbabwe (Bennett *et al*., 2019) and South Africa (Mapiye, 2017), government development strategies are leading to the introduction of indigenous breeds that are leaner but smaller than exotic breeds. The carcass grading systems in Zimbabwe and South Africa favour exotic, large breeds that produce meat for high-value export markets, which are slaughtered at a younger age than those from smallholders (Strydom *et al*., 2015; Chingala *et al*., 2017). The carcass classification systems undervalue animals from smallholder farmers, who, ironically, are being encouraged by governments to participate more in the beef value chain.

The genetic resources of indigenous animal breeds, especially cattle, are crucial to the value chain of red meat and live animals, as they provide livelihoods for rural societies (Ramsay *et al*., 1998) and enable them to meet socio-cultural, economic, and nutritional requirements (Zulu, 2009). The inclusion of smallholders in the development of the red meat value chain

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largely depends on revising the beef carcass classification systems to more inclusive ones. Some serious questions need to be asked about the classification of beef carcasses. For instance, when meat is deboned, does it matter to the end market user which size carcass frame it came from, or does quality then depend on other parameters that are independent of carcass size? The existing literature suggests that the carcass classification system needs to be revisited and reformed to reflect current regional government efforts and consumption preferences (Chingala *et al*., 2017). Vermeulen *et al.* (2020) note that many consumers, particularly those from marginalised groups, struggle to understand the current beef classification system. Therefore, a user-friendly, inclusive beef classification system is long overdue.

3.1.4. Social Gaps

3.1.4.1. Lack of Gender Balance

Gender is an issue that needs to be addressed in most African countries. More inclusive gender participation could improve the performance of the red meat and live animals value chain. Even in matrilineal societies, such as the Tonga of the Southern Province of Zambia, where women can own cattle independently of their husbands, women are rarely able to sell animals without obtaining permission from their husbands or brothers. Lubungu *et al.* (2015) showed that in these communities, approximately 80% of male household heads are the primary decision-makers regarding whether an animal should be kept or sold. This is, in part, because women are believed to be holding the animals for their children's future use. In Zambia, Mafimisebi *et al.* (2015) found that along the beef value chain in the Southern Province, 97.5 per cent of those who practised cattle rearing were males, all the abattoirs were run by males, 75 percent of processors and retailers were also males, and that 55 percent of beef consumers were male. These statistics demonstrate the need for more gender-inclusive strategies along the beef value chain in the SADC region (Devaux *et al*., 2018).

4. OTHER CONSTRAINTS

The constraints identified in the literature were validated as being current and still negatively impacting the beef value chain specifically and the red meat value chain in general. Additionally, six other constraints were identified through the FGDs and value chain analysis workshops. These constraints are discussed below.

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4.1. Production-Related Constraints

4.1.1. Livestock Theft

Theft of livestock was identified as negatively affecting the beef value chain, especially the breeding programmes. It was mentioned that animal traceability programmes can be used to address this constraint.

4.1.2. Lack of Effective National Beef Breeding Systems

Participants mentioned the lack of effective national beef breeding systems in many SADC countries. Participants from Eswatini mentioned that livestock in the Swazi Nation Land (SNL) has been improved through the national breeding programme, and currently, 80% of exported meat is from SNL.

4.1.3. Lack of Government-Led Drought Management Strategy

It was suggested that a drought management strategy led by the government be developed, as during a drought, farmers lose both feeder and breeding stock and struggle to recover. It was suggested that, since drought affects many SADC countries to varying extents, the possibility of developing regional feed reserves should be explored. Local materials, such as sugar cane tops in Lesotho (Eswatini) and molasses in Mozambique, could be used as feed.

4.1.4. Lack of Water Storage and Conservation

Lack of water storage and conservation were mentioned as aspects that constrain the value chain for red meat and live animals in general, and specifically the beef value chain. This aspect could be included in the drought management strategy. This was mentioned as an area where PPPs could be developed.

4.1.5. Poor State of the Smallholder Livestock Sector

Participants mentioned that, although many governments claim to be committed to livestock commercialisation among smallholder livestock farmers, the poor state of the smallholder sector in many SADC countries constrains the development of this sector. Participants mentioned that in Mozambique, the smallholder sector accounts for 85% of the cattle and 96% of the small ruminants, and public support should be commensurate with these statistics.

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4.2. Lack of a Common Vision

Finally, participants noted that stakeholders in the beef value chain of SADC countries lacked a shared vision for the development of the red meat value chain in general and the beef value chain in particular. The concern was that, both within countries and in the SADC region, the beef value chain stakeholders are operating in silos. In some countries, for instance, Namibia's Meat Board is attempting to develop a common vision for the red meat value chain to which everyone is expected to subscribe, thereby alleviating this constraint. Participants mentioned that it is essential for the SADC to develop a regional beef value chain vision that guides its development within the SADC. Depending on which specific aspect of the value chain is of interest, this constraint can be classified under one of the four constraint categories: namely, production-related, structural, market-related, or social-related constraints.

5. CONCLUSION

Through the systematic literature review, ten constraints were identified along the SADC beef value chain. These were classified into production-related, structural, market-related, and social constraints. For production-related constraints, small investments in affordable supplementation can alleviate some of the constraints. For structural constraints, basic infrastructure, such as dipping, can be cost-effectively addressed. Among the market-related constraints, the beef classification system presents a significant challenge. However, adjustments that lead to the inclusion of smaller-framed animals need to be considered. This is strongly supported by the fact that smallholders, who largely produce small-framed animals, often struggle to understand the objectives of the current beef classification system. The suggested changes align with the economic transformation programs of most African countries, which aim to develop more inclusive economies. In line with the inclusive approach, some countries have alleviated market-related constraints by leveraging the almost organic smallholder production systems and unlocking export markets in countries such as Norway and Sweden. Concerted government support in the SADC can help countries capitalise on these markets. Within the economic transformation programmes of many countries, gender balance is one aspect that is emphasised. Gender inclusive beef value chains need to be developed in the SADC.

The additional constraints identified by the qualitative methods were mostly production related. Animal theft, inadequate drought management, insufficient water conservation, and the poor

state of animals in the smallholder sector all reduce the impact of animal breeding programmes. Lack of transparency in breeding programmes is also an aspect that needs to be addressed to improve the performance of the beef value chain, in particular, and the red meat and live animals value chain in general. The region could also benefit from a coordinated approach to improving the performance of the beef value chain through a shared development vision.

Some limitations of the study are worth noting. First, the constraints were not prioritised. Priorities could not be developed based on the systematic review, and, given the possibility that the priority rankings of constraints could differ among SADC countries, prioritisation was not attempted during the qualitative approaches. It is recommended that, before addressing the constraints, each country should rank them in order of priority. Prioritisation should be based on the extent of the effect of each constraint within the SADC countries. Therefore, it is recommended that studies be conducted to establish the frequency of occurrence and the associated economic impact of each constraint in each SADC country.

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7. DISCLOSURE STATEMENT

The authors report there are no competing interests to declare.

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Examining Key Factors and Supportive Interventions Influencing Smallholder Livestock Farming Performance in Umvoti Local Municipality

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ABSTRACT

This study examined the key factors influencing agricultural performance and the supportive interventions employed by the government for smallholder livestock farmers in Umvoti Local Municipality, KwaZulu-Natal, South Africa. A mixed-methods approach was employed, involving the administration of questionnaires to 300 smallholder livestock farmers, focus group discussions, and key informant interviews. The study found that farming skillset, climate variability, and agricultural resource availability were the most critical factors affecting agricultural performance. The majority of farmers were male, had secondary education, and practised free-range grazing on communal land. Access to production inputs and markets was limited, with most farmers relying on local informal markets. Government support interventions included farmer assistance programs, veterinary services, extension services, and value-adding training, but their accessibility and effectiveness varied. The study recommends a multi-pronged approach to improve smallholder livestock farming, including increasing access to production inputs and markets, strengthening farmer support programs, and promoting sustainable agricultural practices. The findings of this study contribute to an understanding of the challenges faced by smallholder farmers and provide a foundation for designing effective support mechanisms that align with their needs and circumstances. Since the target population was smallholder farmers, the information obtained was limited and not generalisable to commercial farmers. Addressing these factors through targeted interventions, capacity building, climate adaptation strategies, and improved resource accessibility is crucial

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for enhancing the productivity and livelihoods of smallholder livestock farmers in Umvoti Local Municipality.

Keywords: Agricultural Performance, Smallholder Livestock Farmers, Interventions, Umvoti Local Municipality.

1. INTRODUCTION

The South African rural economy is largely dependent on smallholder farming for sustaining livelihoods and food security (Oluwatayo, 2019). Smallholder agriculture is the dominant sector within the broader agricultural landscape, comprising over 2 million smallholder farmers compared to approximately 35,000 commercial farmers (Carelson *et al*., 2021). This sector has been a longstanding practice in South Africa (SA), particularly among rural households (Hlatshwayo *et al*., 2021). The 2022 census report revealed that KwaZulu-Natal and the Eastern Cape provinces accounted for the same proportion of smallholder livestock farming, at 25.8%, compared to other provinces (Stats SA, 2022). This highlights the importance of smallholder farming in national agricultural production and food security, particularly in resource-limited settings where it is often the primary source of sustenance and income (Hazell, 2020).

The South African government has implemented several initiatives to recognise the significance of smallholder agriculture (Carelson *et al*., 2021). These include infrastructure development, input subsidies, and agricultural extension services provided by the government (Zantsi *et al*., 2021). Local programs focused on market access, resource pooling, and knowledge sharing are examples of community initiatives that also have an impact (Kaponda & Chiwaridzo, 2024). Although the goals of these programs are to increase farmers' knowledge, lower production costs, and open up markets, those efficacies vary, calling for more focused and situation-specific strategies (Sango, 2022). This variance has exposed the smallholder livestock farmers in the Umvoti local municipality to a continuous build-up of challenges that discourage their agricultural performance. Therefore, this study aims to examine the key factors influencing the agricultural performance of smallholder livestock farmers in Umvoti Local Municipality and identify supportive interventions that can enhance their productivity, profitability, and overall well-being.

The objectives of this study are to identify key factors influencing the agricultural performance of smallholder livestock farmers and to explore the strategies and interventions employed to

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support their productivity. This evidence can inform the implementation of development programs and investment strategies that can effectively address the needs of smallholder farmers and promote sustainable agricultural development. Without a clear understanding of the challenges faced by smallholder farmers in this study area, they may miss growth opportunities, and the effectiveness of existing support mechanisms and interventions may be compromised, resulting in misdirected or ineffective efforts that waste valuable resources.

2. THEORETICAL FRAMEWORK

The theoretical framework underpinning this study is grounded in the Sustainable Livelihoods Framework (SLF), which provides a comprehensive lens for analysing the multifaceted factors influencing the agricultural performance of smallholder farmers and the efficacy of interventions designed to support them (Natarajan *et al*., 2022). This framework is complemented by aspects of the Diffusion of Innovations Theory (DOI), which explains the adoption and impact of agricultural interventions (Anon., 2018). Together, these theories offer a robust foundation for addressing the study's aim of contributing evidence-based insights to guide smallholder farmer development and enhance food security in the Umvoti Local Municipality.

2.1. Sustainable Livelihoods Framework (SLF)

The SLF, developed by the Department for International Development (DFID), offers a comprehensive approach to understanding rural livelihoods by examining the interplay between five core asset categories: human, natural, financial, physical, and social capital (Natarajan *et al*., 2022). These assets form the foundation of smallholder farmers' livelihoods and determine their capacity to engage in productive agricultural practices (Seetha, 2024).

For this study, the SLF serves as a lens to address the first specific objective: to determine the factors affecting the agricultural performance of smallholder livestock farmers in Umvoti Local Municipality. The key elements of the SLF that are particularly relevant include human capital, natural capital, financial capital, physical capital, and social capital (Seetha, 2024). Analysing these dimensions provides insights into the constraints and opportunities faced by smallholder farmers in their agricultural performance (Natarajan *et al*., 2022). This framework also highlights the vulnerabilities posed by external shocks, such as climate change or market fluctuations, and how these influence livelihood strategies (Natarajan *et al*., 2022).

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2.2. Diffusion of Innovations Theory (DOI)

The DOI, proposed by Everett Rogers, focuses on how new ideas, practices, or technologies are communicated and adopted within a social system (García-Avilés, 2023). This theory is particularly relevant to the second specific objective: to explore the interventions employed by various stakeholders, including the Department of Agriculture and Rural Development, local municipalities, and other government entities, that support smallholder farmers in Umvoti Local Municipality, with the aim of enhancing the agricultural performance of smallholder livestock farmers.

According to the DOI, the adoption of innovations follows a process influenced by several factors:

(i) **Relative Advantage**: The perceived benefits of an intervention compared to existing practices (El Malouf & Bahemia, 2023). For instance, farmers are more likely to adopt interventions that clearly enhance livestock productivity or reduce costs (Rizzo *et al*., 2024).

(ii) **Compatibility**: The alignment of the intervention with farmers' existing values, experiences, and needs (El Malouf & Bahemia, 2023). Interventions that are culturally and contextually appropriate are more likely to be adopted (Marsiglia & Booth, 2015).

(iii) **Complexity**: The ease or difficulty of understanding and implementing the intervention (El Malouf & Bahemia, 2023). Simpler and more user-friendly solutions tend to be adopted more readily.

(iv) **Trialability**: The ability to experiment with the intervention on a small scale before full adoption (El Malouf & Bahemia, 2023). Pilot programs or demonstrations can build confidence among farmers (Alexopoulos *et al*., 2021).

(v) **Observability**: The visibility of positive outcomes from the intervention (El Malouf & Bahemia, 2023). Successful case studies or peer testimonies can encourage widespread adoption (Alexopoulos *et al*., 2021).

By applying the DOI, this study will evaluate the design, delivery, and effectiveness of agricultural support interventions, including extension services, training programs, and access

to financial or technical resources. The theory will also shed light on barriers to adoption and how these can be addressed to improve the uptake and sustainability of interventions.

2.3. Integration of Theories

The integration of the SLF and DOI provides a synergistic framework for this study. While the SLF emphasises the resources and contextual factors that influence agricultural performance, the DOI focuses on the process and dynamics of intervention adoption (Natarajan *et al*., 2022; El Malouf & Bahemia, 2023). Together, these frameworks enable a comprehensive analysis of both the internal and external factors shaping smallholder farming outcomes (Khan *et al*., 2022). This theoretical foundation supports the study's aim of contributing evidence-based insights for targeted interventions and inclusive rural development. By linking the determinants of agricultural performance with the mechanisms of effective intervention implementation, the study will offer actionable recommendations to enhance food security and the livelihoods of smallholder livestock farmers in Umvoti Local Municipality.

3. EMPIRICAL LITERATURE REVIEW

This study empirically investigated the key factors influencing agricultural performance and the effectiveness of supportive interventions for smallholder livestock farmers in South Africa. Utilising a mixed-methods approach with data from smallholder farmers, focus groups, and key informant interviews, the farming skillset, climate variability, and agricultural resource availability are critical determinants of their performance (Oluwatayo, 2019). Furthermore, most farmers are males who primarily practice free-range grazing on communal land, with significant limitations in accessing production inputs and broader markets (Barajas *et al*., 2024). While government interventions, including farmer assistance, veterinary services, and extension services, along with value-adding training, are in place, their accessibility and efficacy have been found to be inconsistent (Amaglobeli *et al*., 2024). Therefore, the recommendations include a multi-pronged approach to enhance smallholder livestock farming through improved access to inputs and markets, strengthened support programs, and the promotion of sustainable practices (Cheteni & Mokhele, 2019).

4. MATERIALS AND METHODS

4.1. Study Site

The study site, Umvoti Local Municipality, is situated in the KwaZulu-Natal province of South Africa and is administratively identified as KZN245 (Umvoti Municipality, 2020). The municipality consists of 14 wards, as illustrated in Figure 1; hence, this study targeted all the wards. However, areas such as Ntunjambili and Kranskop, located in Ward 5 (Figure 1), have portions that fall under Umvoti Local Municipality, and other portions fall under Ilembe District (Umvoti Municipality, 2020). All 14 wards participated, with 22 participants from wards 1, 6, 8, 11, and 12, and 14 participants from wards 2, 3, 4, 5, 7, 9, 10, and 13. There were 21 participants in total. The municipality spans both urban and rural areas, providing a diverse backdrop for understanding agricultural practices and interventions (Umvoti Municipality, 2020). As a region with significant agricultural potential, offering opportunities for growth and improvement in local food security, it serves as a critical case study for exploring the determinants of smallholder agricultural performance and the effectiveness of targeted interventions (Umvoti Municipality, 2020). Umvoti is characterised by a mix of urban hubs, such as Greytown, and vast rural areas that support a predominantly agrarian population (Umvoti Municipality, 2020). Its geography includes fertile valleys and rolling hills, which are integral to the agricultural livelihoods of its residents (Umvoti Municipality, 2020). Livestock farming, a cornerstone of agricultural activity in the municipality, plays a vital role in local food systems and economic sustainability by providing household income (Umvoti Municipality, 2020).

The municipality has identified Local Economic Development (LED) as a priority, with a particular emphasis on enhancing agricultural performance to address food security and promote rural development (Umvoti Local Municipality, 2023). The rural population, largely dependent on smallholder farming, faces challenges such as limited access to infrastructure, markets and extension services (Umvoti Local Municipality, 2023). The socioeconomic profile of Umvoti reflects high levels of unemployment and poverty, particularly in rural areas, where smallholder farmers often lack the resources and knowledge to improve agricultural productivity (Stats SA, 2022). The choice of Umvoti Local Municipality as the study site aligns with the overarching aim of contributing evidence-based insights to enhance local food security and promote inclusive rural development. The findings from this site can serve as a model for other municipalities facing similar socioeconomic and agricultural challenges.

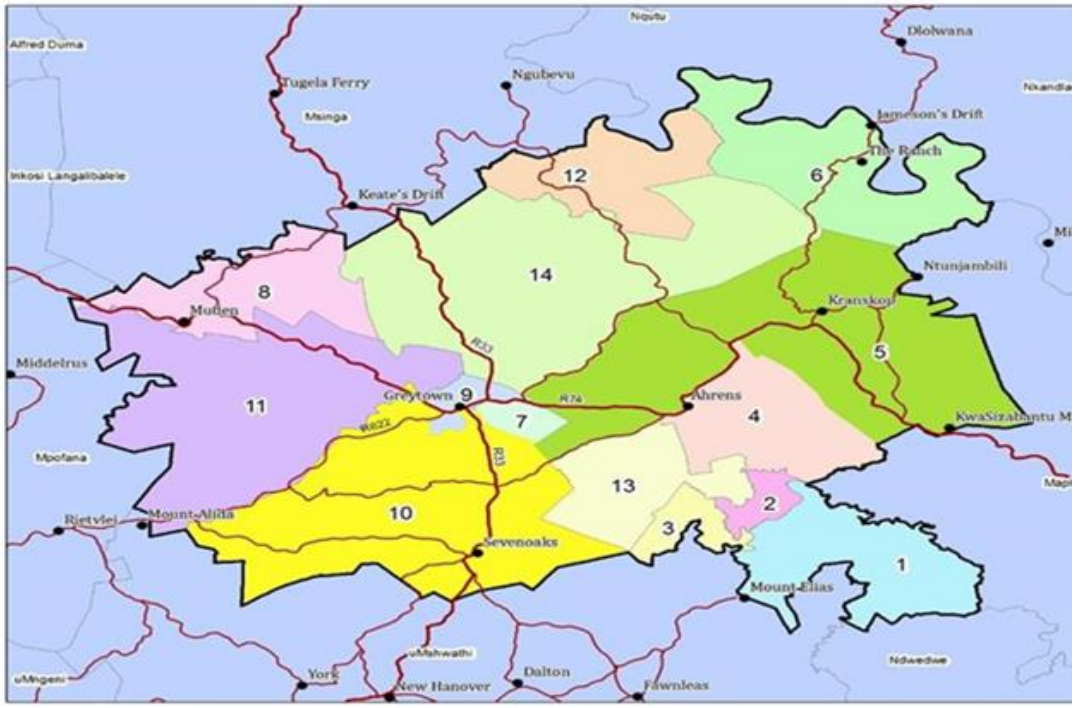

FIGURE 1: The Map of the Umvoti Local Municipality (Source: Umvoti Municipality, 2020).

4.2. Research Design

This research employed a mixed-methods design to examine the key factors influencing agricultural performance and explore the supportive interventions for smallholder livestock farmers in Umvoti Local Municipality. This approach enabled a comprehensive understanding of the complex dynamics at play by integrating both qualitative and quantitative data, thereby mitigating the potential biases inherent in either quantitative or qualitative approaches individually (Susanto *et al*., 2024).

For objective 1, which looked at key factors affecting the agricultural performance of smallholder livestock farmers, the quantitative methods, specifically the descriptive statistical analysis of questionnaires, were ideal for identifying and measuring the key factors influencing the performance across the sample of 300 smallholder livestock farmers in Umvoti local municipality (Susanto *et al*., 2024). The qualitative methods, including thematic analysis of focus group discussions and key informant interviews, were also employed to ensure that the research findings are grounded in the realities of smallholder livestock farmers in Umvoti Local Municipality (Tenny *et al*., 2022).

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For objective 2, which looked at the supportive interventions employed by the government to support smallholder livestock farmers in Umvoti local municipality, the qualitative methods, such as the thematic analysis of the key informant interviews and focus group discussions, were used to obtain insights into the experiences, challenges, and needs related to existing and potential support interventions (Susanto *et al*., 2024).

4.3. Study Population Sampling Procedure

The study focused on smallholder livestock farmers residing in the rural areas of Umvoti Local Municipality, KwaZulu-Natal, South Africa. This population is characterised by significant socioeconomic, geographic, and demographic diversity, providing valuable insights into the factors that influence agricultural performance and food security (Umvoti Municipality, 2020). The socioeconomic profile of the study population reveals high levels of unemployment and poverty, with farmers primarily relying on livestock farming, particularly cattle, goats, and poultry for household consumption and income generation (Umvoti Local Municipality, 2024). Geographically, farmers are distributed across the municipality's rural expanse, with many residing in remote areas lacking adequate infrastructure, such as roads, electrification, and water access (Umvoti Local Municipality, 2023). These disparities influence farming practices and restrict access to essential support services (Touch *et al*., 2024).

A simple random sampling technique was used to select 300 smallholder livestock farmers from a population of 1,800. This information was obtained from the database of smallholder livestock farmers maintained by the Department of Agriculture and Rural Development's Umvoti local office. The target population of smallholder livestock farmers encompasses both small stock, including goats, sheep, and pigs, as well as large stock, such as cattle and poultry. The simple random sampling technique ensured that every farmer had an equal chance of being included in the study, thereby minimising selection bias and enhancing the generalizability of the findings to the broader population (Noor *et al*., 2022). The sample size of 300 was deemed appropriate based on Cochran's formula (Noor *et al*., 2022). This formula suggested that for a population of 1800, a sample size of 300 achieves a 95% confidence level with a 5% margin of error, ensuring the representativeness of the sample and the generalisability of the findings to the broader population of smallholder livestock farmers in the Umvoti local office (Sugden, 2000).

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4.4. Data Collection

Data collection employed a mixed-methods approach. Initially, quantitative data were obtained through a structured questionnaire administered to a sample of 300 participants. The data were collected in 2024 over a three-month period, from August to October. This provided a preliminary understanding of the smallholder livestock farmers within the Umvoti local municipality. Subsequently, a purposive sampling technique was utilised to select participants for qualitative data collection through focus group discussions (Stratton, 2024). Each focus group, consisting of 8-10 participants, facilitated an in-depth exploration of farmers' experiences, knowledge, and challenges related to agricultural production. A total of 33 focus group discussions were conducted, with 2 to 3 per ward. For wards close to one another, the third focus group discussion included a portion of participants from each ward to meet the limit of 8 to 10 participants.

To complement the focus group findings and provide a multifaceted perspective, semi-structured interviews were conducted with key informants involved in service provision to smallholder livestock farmers (DeJonckheere & Vaughn, 2019). This triangulation of data sources, incorporating both farmer and stakeholder perspectives, enabled a more robust analysis of the factors influencing agricultural performance (Susanto *et al*., 2024). Furthermore, the focus group discussions, moderated by a neutral facilitator, were designed to foster open communication and active participation (DeJonckheere & Vaughn, 2019).

4.5. Data Analysis

Objective 1, focused on identifying key factors influencing the agricultural performance of smallholder livestock farmers in Umvoti Local Municipality, was addressed through mixed-methods analysis. Quantitative data from questionnaires were analysed using descriptive and inferential statistics via SPSS to summarise trends and identify significant relationships (Ali, 2021). Techniques such as correlation analysis, regression analysis, and t-tests were employed to investigate the impact of factors like resource access, market access, and farmer demographics on agricultural performance (Smith, 2015). Qualitative data from interviews and focus group discussions underwent thematic analysis to uncover patterns and themes, providing deeper insights into these influencing factors (Sovacool *et al*., 2023). This integration of methods enabled a comprehensive investigation of agricultural performance (Smith, 2015).

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For Objective 2, which explored strategies and interventions supporting farmer productivity, qualitative methods were employed. Data collection involved in-depth interviews with key informants and focus group discussions with smallholder farmers, capturing nuanced perspectives on available support systems (Susanto *et al*., 2024). The qualitative data, analysed using NVivo software, underwent systematic coding and thematic analysis. Recurring concepts were identified, organised, and grouped into themes, thereby enhancing the rigour and transparency of the findings (Bazeley, 2007). This process ensured the results reflected participants' experiences and insights into farmer support strategies (Bazeley, 2007).

5. RESULTS AND DISCUSSIONS

5.1. Socioeconomic Demographics of Participants

5.1.1. Gender Distribution

The gender distribution in Table 1 indicates a predominance of male smallholder livestock farmers, with males constituting 73.3% and females making up the minimum of 26.7%. This disparity suggests, like many other regions around the world, that males within the Umvoti local municipality are more engaged in agricultural activities (Medagbe *et al*., 2020). Elias *et al*. (2024) found that this is because women are often invisible in decision-making processes, lacking control over livestock assets and land. These findings also align with Maziya *et al*. (2020), who concluded that although poverty is common among smallholder livestock farmers in South Africa, it is more pronounced in households headed by women. While Aboah *et al*. (2024) found that male dominance in livestock production is greater than female due to the physically demanding nature of livestock handling activities. Understanding gender roles is therefore essential in developing targeted interventions that enhance productivity and ensure equitable access to resources (Medagbe *et al*., 2020).

5.1.2. Educational Level

Education levels among the smallholder livestock farmers varied, with the majority having completed secondary school (30.7%) or primary school (17.0%). A notable proportion (11.0%) had attained higher education, while a small fraction (9.7%) lacked formal education. Similarly, Bese *et al*. (2021) also reported low education levels among smallholder farmers in the Eastern Cape, South Africa. Mwamfupe (2019) and Hlalele (2014) explained that this is due to the limited opportunities for higher education in rural areas, where smallholder farmers reside, resulting in a low proportion of farmers with higher education. Education is a critical

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factor in adopting modern farming techniques and improving productivity (Touch *et al*., 2024). Therefore, initiatives aimed at enhancing educational opportunities in rural areas could have a significant impact on agricultural performance and, subsequently, household food security (Touch *et al*., 2024).

5.1.3. Age Distribution of Farmers

Table 1 reveals a significant age gap in the farming community, with senior farmers constituting the largest proportion at 60%. Middle-aged farmers accounted for 31.7%, while young farmers represented only 8.3%. According to Touch *et al*. (2024), this could be due to the rural-urban migration of youth in search of employment and educational opportunities, leaving elders behind. Dokubo *et al*. (2023) concluded that this trend could have implications for the future of agriculture, as the knowledge and experience of senior farmers may not be adequately transferred to younger generations. Additionally, the ageing farmer population may pose challenges in terms of labour availability and the long-term sustainability of the farm (Tong *et al*., 2024).

5.1.4. Land Ownership

The data reveals that a significant majority (75.3%) of respondents do not own land they use for farming, while only 24.7% have land ownership. This lack of land ownership among most smallholder livestock farmers could be a major constraint to their agricultural performance, as land ownership often determines the ability to invest in and improve agricultural productivity (Mdoda & Gidi, 2023). According to Pravalie *et al*. (2021) and several other reports, Africa accounts for over 60% of the world's available arable land; however, smallholder farmers in Africa often struggle to secure sufficient and suitable land to grow crops and raise livestock. Boss and Meinzen-Dick (2020) reported that this is due to the predominant land tenure arrangements, where land was collectively held by families; hence, no form of security was provided to users, especially women and youth. For example, in most regions of Africa, only a small fraction of land rights, which is limited to 1-2%, is held by women, and this also depends on the marital status of a woman (Boss & Meinzen-Dick, 2020).

5.1.5. Type of Land Ownership

The findings revealed that the majority (67%) use communal land, followed by freehold (23.3%), PTO (8.3%), and lease (1.3%). According to Rootman *et al*. (2015), this is due to the

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legacy of apartheid, low livestock sales, and the potential of smallholder livestock systems for rural development in South Africa. Communal land ownership, therefore, has implications for agricultural productivity, as it may restrict individual investment and innovation due to shared rights and responsibilities (Barajas *et al*., 2024). The allocation of communally owned land is only done by the traditional authority. Conversely, freehold and leasehold types provide more security and incentives for investment (Timmins *et al*., 2022). The dominance of communal land ownership suggested that collective approaches and community-based interventions could be more effective in enhancing agricultural performance.

5.1.6. Livestock Management Practices

The majority of farmers (74.7%) used free-range grazing, which allows livestock to roam freely on natural pastures, due to lower input costs and a reliance on natural resources. Intensive farming, which involves controlled environments with supplementary feeding, is practised by 20.7% of farmers. Pasture-based and stall-fed systems were less common, accounting for 1.7% and 3%, respectively. Due to several factors such as limited financial resources and lack of livestock production expertise, the majority of smallholder farmers from the rural areas practise free-range grazing because it requires less capital investment and livestock can forage for natural feed, eliminating the need for expensive supplements (Nkonki *et al*., 2018; Mbatha, 2021). However, these farmers are often limited in accessing high-quality forage, which then reduces their ability to compete in mainstream beef markets, resulting in low farm income (Nyambali *et al*., 2022).

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TABLE 1: **Socio-Demographic Characteristics of Smallholder Livestock Farmers in Umvoti Local**

Variable	Frequency	Percent
Gender		
Male	220	73.3
Female	80	26.7
Educational Level		
No formal education	29	9.7
Primary school	51	17.0
Secondary school	92	30.7
Vocational training	95	3.7
Higher education	33	11.0
Age Distribution		
Young farmer	25	8.3
Middle-aged farmer	95	31.7
Senior farmer	180	60
Years of Experience		
Beginner	7	2.3
Intermediate	92	30.7
Advanced	201	67
Land Ownership		
Yes	74	24.7
No	26	75.3
Type of Land Ownership		
Freehold	70	23.3
Communal	201	67
PTO	25	8.3
Lease	4	1.3
Livestock Management Practices		
Pasture Based	5	1.7
Stall-Fed	9	3.0
Free Range	224	74.7
Intensive Farming	62	20.7
Access to Production Inputs		
Easily Accessible	16	5.3
Moderately Accessible	103	34.3
Not Accessible	181	60.3
Ease of Access to Financial Resources		
Easy	4	1.3
Moderate	34	11.3
Difficult	262	87.3
Source of Water for Farming		
Rainfed	80	26.7
River/ Stream	185	61.7
Borehole/well	12	4.0
Other	23	7.7
Market Access		
Local Market	295	98.3
Regional market	5	1.7
Total	300	100

TABLE 2: Types of Livestock Raised by Smallholder Livestock Farmers in Umvoti Local

Variable Type of Livestock	Frequency	Percent
Cattle and goat	183	61
Sheep and goat	31	10
piggery	20	7
poultry	66	22
Total	300	100

5.1.7. Access to Production Inputs

The data revealed a significant challenge faced by smallholder livestock farmers in accessing essential production inputs. Over 60% of farmers reported that these inputs are not accessible to them, while only a small fraction (5.3%) had easy access to them. According to Nyambali *et al*. (2022), De Almeida *et al*. (2021), and several other studies, the lack of access to crucial inputs, such as feed, veterinary medicines, and breeding stock, may severely hinder productivity and profitability for smallholder livestock farmers. Sithirith *et al*. (2024) found that in Cambodia, the inaccessibility of production inputs is due to a lack of purchasing power, and the high costs of production inputs are one of the key factors that trap smallholder farmers' households in a cycle of debt, leaving them food insecure. This suggests the need for improved supportive policies to enhance the availability and affordability of these inputs for smallholder farmers (De Almeida *et al*., 2021).

5.1.8. Source of Water for Farming

The data revealed that the primary source of water for smallholder livestock farmers in the Umvoti local municipality is rivers and streams, accounting for 61.7% of respondents. The reliance on surface water sources can make these farmers vulnerable to seasonal variations in water availability, particularly during dry periods (Piemontese *et al*., 2024). Hawkins *et al*. (2022) found that resource-poor farmers, whose feed availability relies on rain, are mostly those who struggle to purchase supplements during the dry season. As a result, they are most likely to struggle to manage the herd effectively during the dry season, which reduces the reproductive capacity of livestock (Piemontese *et al*., 2024).

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5.1.9. Market Access

The study suggested that the vast majority (98.3%) of smallholder livestock farmers primarily rely on local markets to sell their livestock and livestock products. This suggests that their operations are largely localised and may face limitations in accessing wider markets and potentially higher prices (Mbatha, 2021). While some farmers (1.7%) do sell to regional markets, this suggests a limited capacity to expand their market reach and diversify their income sources. This reliance on local markets could make these farmers vulnerable to price fluctuations, changes in local demand, and limited market information (Touch *et al*., 2024). Balehegn *et al*. (2021) found that marketing is one of the issues most seriously impeding livestock development in Africa. According to Cheteni & Mokhele (2019), smallholder farmers continue to participate in livestock markets due to the remoteness of livestock producers from main urban market centres and poor road infrastructure, which results in high transport costs.

5.1.10. Type of Livestock

Based on Table 2, the dominant livestock combination is "Cattle and goat," representing 61% of farmers, suggesting a strong preference for these animals, likely due to their economic importance for sales and cultural value. Poultry is the second most common, at 22%, indicating its role in providing income and food security, likely due to its quicker turnover, as they take about 5 weeks to be ready for sale. Conversely, "Sheep and goat" (10%) and "piggery" (7%) are less prevalent, possibly due to factors such as specific environmental requirements, market demand, or higher initial investment/management complexities (Hawkins *et al*., 2022). These distributions highlight a focus on cattle and goats, suggesting that factors such as access to grazing land, water resources, and markets for these specific livestock types are crucial for the overall agricultural performance of smallholder farmers in the Umvoti local municipality (Touch *et al*., 2024).

5.2. Factors Affecting Smallholder Farmers' Agricultural Performance

The thematic analysis identified three key factors influencing the agricultural performance of smallholder livestock farmers in the Umvoti Local Municipality: farming skillset, climate variability, and access to agricultural resources (Figure 2). These factors, interlinked and multifaceted, contribute significantly to shaping productivity and livelihoods in this context.

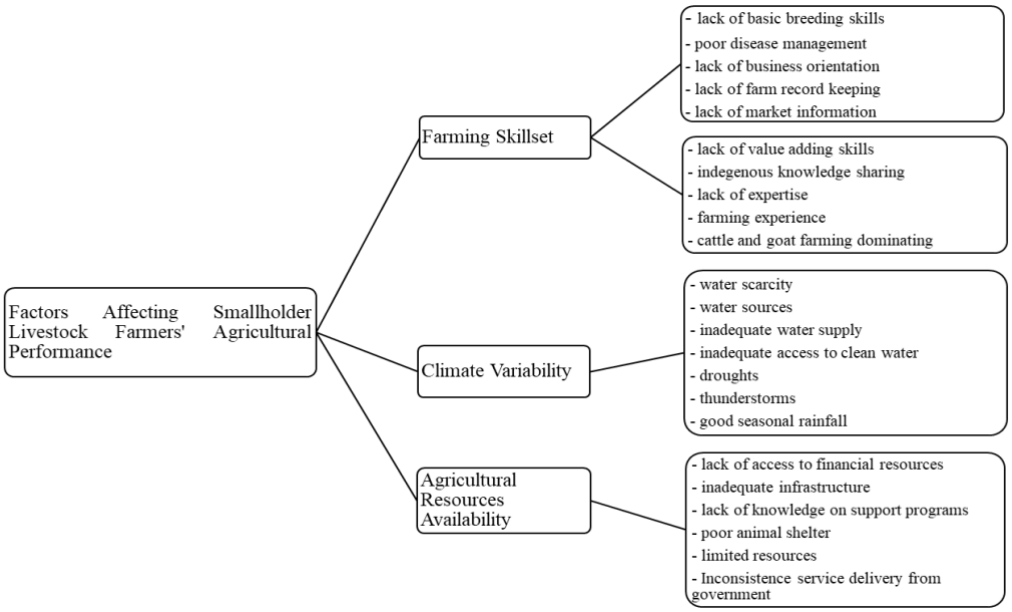

FIGURE 2: **The Key Themes Highlighting Factors Affecting Smallholder Farmers' Agricultural Performance in Umvoti Local Municipality**

5.2.1. Farming Skillset

A critical challenge for smallholder livestock farmers in Umvoti is the lack of essential farming skills, which impedes productivity and the ability to adapt to changing agricultural demands. Deficiencies in basic breeding skills, disease management, and farm record-keeping were evident, alongside a lack of business orientation and market information. These gaps limit farmers' ability to enhance livestock health, optimise production processes, and engage effectively with markets (Bese *et al*., 2021). Additionally, the dominance of cattle and goat farming, which is often reliant on indigenous knowledge and traditional practices, highlights a need for modernised value-adding skills and technical expertise. These findings align with previous studies that emphasise the importance of capacity building and education in enhancing agricultural performance among smallholder farmers (Jones *et al*., 2020).

5.2.2. Climate Variability

Climate variability emerged as a significant factor affecting agricultural performance. Farmers reported challenges related to water scarcity, inadequate water supply infrastructure, and limited access to clean water. Recurring droughts, thunderstorms, and other climatic events exacerbate these issues, disrupting farming operations and livestock productivity. However, respondents also noted instances of favourable seasonal rainfall, which underscores the

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complex and inconsistent impacts of climate on agriculture. Such findings are consistent with broader research, which highlights the vulnerability of smallholder farmers to climate variability and underscores the need for adaptive strategies (Zenda *et al*., 2024). Effective water resource management and climate-resilient practices are crucial for mitigating these challenges and ensuring sustainable agricultural production (Zenda *et al*., 2024).

5.2.3. Agricultural Resource Availability

The availability and accessibility of agricultural resources represent another crucial determinant of performance. Farmers reported inadequate infrastructure, including poor roads and animal shelters, limited financial resources, and a lack of knowledge regarding government support programs. Furthermore, inconsistencies in service delivery by government institutions were highlighted, which often undermined the effectiveness of agricultural interventions. These constraints align with studies that emphasise the importance of access to resources and institutional support in enhancing smallholder agricultural outcomes (Susanto *et al*., 2024). Addressing these barriers through improved infrastructure, financial support, and streamlined extension services is critical to empowering farmers and boosting productivity (Susanto *et al*., 2024). The findings underscore the interplay of farming skill sets, climate variability, and resource availability in shaping the agricultural performance of smallholder livestock farmers in Umvoti. Addressing these factors through targeted interventions, including capacity building, climate adaptation strategies, and improved access to resources, is crucial for enhancing productivity and livelihoods (Myeni & Moeletsi, 2020).

5.3. Support Interventions

Figure 3 illustrates the key government support interventions that emerged from the focus group discussions and key informant interviews. The interventions that were discussed encompassed broader support networks beyond disease management. The thematic analysis identified several government support interventions aimed at enhancing the productivity and resilience of smallholder livestock farmers in the Umvoti Local Municipality. These strategies encompass veterinary services, disease management training, farmer support programmes, and value-adding initiatives, among others. Their effectiveness in addressing key challenges faced by smallholder farmers offers insights into potential improvements for targeted support (Myeni & Moeletsi, 2020).

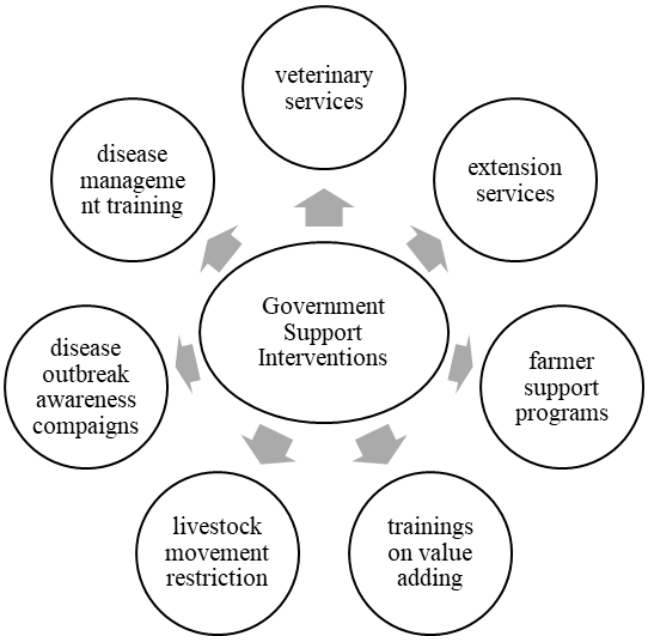

FIGURE 3: **The Government Support Interventions for Smallholder Livestock Farmers in Umvoti**

5.3.1. Veterinary Services and Disease Management

Veterinary services emerged as a cornerstone of government interventions, offering critical support for livestock health. These services are complemented by disease management training and awareness campaigns designed to equip farmers with the knowledge to identify, prevent, and address livestock diseases. Disease outbreaks can devastate smallholder livelihoods by reducing livestock productivity and increasing mortality rates (Zawadi, 2024). The integration of awareness campaigns with veterinary services promotes a proactive approach, enabling farmers to effectively mitigate risks (Maina *et al*., 2023). These findings align with the literature that emphasises the role of veterinary interventions in improving livestock health and safeguarding food security (Sarma, 2024).

5.3.2. Extension Services and Farmer Support Programmes

Extension services offer farmers access to technical expertise and practical knowledge, thereby facilitating the adoption of improved farming practices (Raji, 2024). These services bridge the gap between smallholder farmers and innovation, enabling them to enhance productivity through modernised techniques (Raji, 2024). Similarly, farmer support programs provide a structured framework for accessing resources, including subsidised inputs and financial

assistance (Amaglobeli *et al*., 2024). However, the effectiveness of these programs often hinges on consistent delivery and accessibility, with respondents highlighting occasional gaps in service provision. Studies have consistently shown that extension services play a pivotal role in supporting smallholders by addressing technical constraints and fostering sustainable agricultural practices (Moyo & Salawu, 2018).

5.3.3. Value-Adding Initiatives and Capacity Building

Training on value addition represents a significant effort to enhance the economic viability of smallholder farming (Tselaesele *et al*., 2018). These initiatives aim to equip farmers with skills to diversify their income streams through the processing, branding, and marketing of livestock products (Tselaesele *et al*., 2018). Such interventions empower farmers to move beyond smallholder farming and engage with broader markets, thereby improving profitability (Malembe, 2021). Capacity-building initiatives also include workshops designed to enhance technical expertise and business acumen, ensuring that farmers are equipped to navigate complex agricultural systems (Tselaesele *et al*., 2018). Previous research has underscored the importance of value addition in strengthening rural economies and improving farmer resilience (Malembe, 2021).

5.3.4. Regulatory Measures for Disease Control

Livestock movement restrictions are implemented as a regulatory measure to curb the spread of diseases (Tildesley *et al*., 2019). While these restrictions are crucial during outbreaks, they can also inadvertently limit market access, posing challenges for smallholder farmers who rely on livestock sales (Knight-Jones *et al*., 2017). Balancing disease control with market access remains a critical consideration for policymakers and practitioners (Knight-Jones *et al*., 2017). Effective implementation of such measures requires collaboration between government agencies and farmers to ensure compliance without compromising livelihoods (Tildesley *et al*., 2019).

5.3.5. Challenges and Opportunities in Intervention Delivery

The thematic analysis revealed inconsistencies in the delivery and accessibility of government interventions. While many programs are well-intentioned, their impact is often diluted by logistical challenges, limited outreach, and inadequate follow-up mechanisms (Touch *et al*., 2024). Enhancing the efficiency of intervention delivery requires addressing systemic barriers

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and fostering participatory approaches that incorporate farmer feedback (Touch *et al*., 2024). Research emphasises that inclusive and context-specific interventions are more likely to yield sustainable outcomes for smallholder farmers (Nyoni *et al*., 2024).

The analysis highlights the multifaceted nature of government support interventions in addressing the challenges faced by smallholder livestock farmers. While veterinary services, capacity-building initiatives, and regulatory measures contribute positively, gaps in service delivery underscore the need for enhanced coordination and outreach (Maposa, et al., 2023). By refining these interventions and ensuring their alignment with the needs of farmers, policymakers can significantly enhance the productivity, resilience, and sustainability of smallholder farming systems (Maposa *et al*., 2023). This discussion contributes to a deeper understanding of the interplay between support mechanisms and smallholder agricultural performance, providing a foundation for evidence-based policy recommendations.

6. CONCLUSION AND RECOMMENDATIONS

This study examined the key factors influencing agricultural performance and supportive interventions for smallholder livestock farmers in the Umvoti Local Municipality, KwaZulu-Natal, South Africa. The study employed a mixed-methods approach, collecting data from 300 smallholder livestock farmers through questionnaires, focus group discussions, and key informant interviews. The findings revealed that farming skillset, climate variability, and agricultural resource availability were the most important factors affecting agricultural performance. The majority of farmers were men, had a secondary education, and practised free-range grazing on communal land. Access to production inputs and markets was limited, with most farmers relying on local markets. Government support interventions included farmer assistance programs, veterinary services, extension services, and value-added training, but their access and effectiveness varied. The study recommended a multi-pronged approach to improve smallholder livestock farming, including increasing access to production inputs and markets, strengthening farmer support programs, and promoting sustainable agricultural practices.

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This study received no external funding.

9. DATA AVAILABILITY STATEMENT

The corresponding author will provide the datasets used and/or analysed upon reasonable request.

10. DECLARATION

The authors declared that they have no conflict of interest.

11. AUTHOR CONTRIBUTIONS

Data collection, analysis, and discussion of the empirical results for the above-listed publication manuscript were conducted in their entirety by S.A.M. with the advice and guidance of K.D.N. All tables and figures were produced by S.A.M. unless otherwise referenced in the respective sections and publications.

12. APPROVAL STATEMENT/ETHICS STATEMENT

This study was approved by the Humanities and Social Sciences Research Ethics Committee (HSSREC); the protocol reference number is HSSREC/00007202/2024. All participants provided informed consent before participating in the study.

13. INFORMED CONSENT STATEMENT

Participants were informed about the purpose of the study through the written consent form, which outlined their rights to withdraw from the study at any time and the confidentiality of their responses. They were also informed about the potential risks and benefits of participating in the study, and therefore, they signed the form to give their consent.

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Factors Influencing Profitability of Land Reform Farm Enterprises in the KwaZulu-Natal Province of South Africa

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ABSTRACT

Various factors influence the profitability of enterprises owned by land reform farmers. This study aimed to identify the factors influencing the profitability of land reform farm enterprises in KwaZulu-Natal. Data were collected from 262 land reform farmers in KwaZulu-Natal through a structured questionnaire. Using the linear odds model, the study established that production input costs, extension advisory services, training received, household size, labour man-days, and marketing costs have a statistically significant influence on the profitability of land reform farms in KwaZulu-Natal. Household size and marketing costs have a negative effect, whereas production input costs, extension advisory services, training received from government and stakeholders, and labour man-days have a positive effect on profitability. Other variables were not statistically significant. The study concluded that comparing marginal costs and marginal returns to inform farm investment decisions, as well as the provision of extension advisory services and training by government and stakeholders, are indispensable instruments that drive profitability. Utilising family labour to mitigate the impact of household size, reducing marketing costs, and enhancing labour efficiency increases profitability. The study proposes a policy overhaul on training and extension services, prioritising the Key Result Areas (KRAs) for small-scale farmers and land reform farm enterprises.

Keywords: Profitability, Enterprise, Investment, Returns, Land Reform.

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1. INTRODUCTION

The land reform programme in South Africa is considered the cornerstone in changing the land ownership patterns inherited through the unjust apartheid regime in the country. Land reform is defined as a government programme empowered through legislation that aims to redistribute ownership, claims, and rights to existing farmland in order to benefit impoverished and historically disadvantaged persons and communities by raising their absolute and relative status, power, and income (Lipton, 2009). It mainly results in laws that are enacted to increase the poor's rights to land, thereby reducing poverty (Lipton, 2009; Manenzhe *et al*., 2016). Generally, everyday literature refers to the actions inspired by such legislation as land reform or land reform activities.

In South Africa, the land reform programme was initiated by the government as a post-colonial strategy to correct the wrongs committed during the apartheid era, which led to land being taken from millions of Black people (Phasha & Moyo, 2020). The primary target of land reform initiatives is to help formerly marginalised groups live better lives, not just by placing them on agricultural land, but also by offering them support services (Terblanche, 2011). Ochieng (2020) suggests that land reform has multiple meanings. Some define it as a shift in the agricultural system or the entire range of actions required or preferred to enhance the system or relationships between individuals regarding their land rights (Ochieng, 2020). Lipton (2009) argues that land reform programmes are intended and likely to directly redistribute ownership of, claims on, or rights to current farmland, benefiting people with low incomes.

Land reform encompasses one or more of its three main tiers, namely land redistribution, land restitution, and land tenure reform. Recent literature includes the fourth tier, which is the land administration reform (Netshipale *et al*., 2017; Hull *et al*., 2019; Davies *et al*., 2020). This study focused on land redistribution and restitution, targeting farmers who benefited during acquisition and post-acquisition support for agricultural production. Land transferred for non-agricultural purposes is not included in this study. With the exception of the restitution sub-programme, which is a standing rights-based land transfer process, the South African government has been implementing changes in the redistribution space through the introduction of various sub-programmes as conduits for the programme's implementation. Mphahlele (2023) reckons that most of these sub-programmes were introduced between 1995 and 2010. These sub-programmes are Settlement for Land Acquisition Grant (SLAG), Farm Equity Share Scheme (FES), Land

Redistribution for Agricultural Development (LRAD) and Proactive Land Acquisition Strategy (PLAS).

The Settlement for Land Acquisition Grant (SLAG) was introduced to acquire land primarily for the settlement of people with an income of less than R1500 per month (Claassens, 2017). The people in the SLAG sub-programme were settled in groups through Communal Property Associations (CPAs) and were expected to farm collectively (Binswanger-Mkhize, 2014). The Farm Equity Share Scheme (FES) was introduced, aiming to enable farmers to acquire shares in existing agribusinesses (Mphahlele, 2023). In 2001, Land Redistribution for Agricultural Development (LRAD) was introduced to acquire land for agricultural production (Claassens, 2017; Mphahlele, 2023). In 2006, the Proactive Land Acquisition Strategy (PLAS) was introduced as a mechanism to sustain land acquisition for redistribution purposes (Claassens, 2017; Hall & Kepe, 2017; Mphahlele, 2023). All of these sub-programmes, except PLAS, have since been discontinued due to their failure to meet their objectives (Kirsten *et al*., 2016; Claassens, 2017; Mphahlele, 2023). The continuous enactment of legislation to redefine reform directions is a common practice in countries; hence, it cannot be an isolated case in South Africa (Besley & Burgess, 2000). Hence, South Africa has also been making constant attempts to enact and change laws to address the challenges of land reform, including the sustainability and profitability of the farms.

According to Xaba and Masuku (2013), the profitability of agricultural enterprises is influenced by the selling price, quantity of fertiliser, and distance to the market. The allocation of resources also affects both productivity and profitability (Libago, 2017). The farmers are price takers on both the input cost and the income generated from the produce. This then squeezes the farmer on both sides of the operation (Xaba & Masuku, 2013). Farming remains a lucrative business venture for many due to its ability to generate huge wealth if properly managed, as well as significant losses when the odds are not favourable. When undertaken on a very small scale, Mdoda *et al*. (2022) state that an agricultural business can be started with minimal capital requirements, particularly where land and water are readily available (Mdoda *et al*., 2022). However, Mdoda *et al*. (2022) further caution that South Africa is a water-stressed country, and this has a direct negative impact on farming, its productivity, and profitability.

Notably, the profitability of agricultural enterprises owned by land reform farmers has come under sharp scrutiny. Economically, agriculture remains one of the most fundamental sectors for development in most African developing countries (Phiri *et al*., 2023). It is considered one of the

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key drivers of the economy, as the country's food security mainly depends on this sector. Where agriculture and land allocation are neglected, acute poverty and inequality are evident (Davies *et al*., 2020). This results in the failure of systems and means of production. In South Africa, Kirsten *et al*. (2016) argue that the failure of land reform farms is evident on social platforms, but there is no empirical evidence to document the reasons for it. Hence, this study aims to consider the factors influencing the profitability of land reform farmers in KwaZulu-Natal (KZN).

2. DEFINITION OF PROBLEM

As already mentioned, land reform in South Africa is a necessity for changing the land ownership patterns and remains central to driving the economy, ensuring sustained food security and reducing rural poverty and inequality. In South Africa, land reform has been characterised by various sub-programmes with several objectives, which have been phased out or modified over the past many years since the programme was introduced and supported through legislation. While land reform objectives involve changing land ownership patterns, many proponents and beneficiaries of land reform associate the acquisition of land with poverty alleviation (see also Ntsiapane et al., 2023 on smallholder wool farmers), quality of life, or livelihood issues, rather than with commercial farming (Kirsten *et al*., 2016).

Since the formation of the Economic Freedom Fighters (EFF), a left-leaning and militant political party in 2013, the South African land issue has been fiercely debated both inside and outside of government (Xaba & Akinola, 2023). Such vociferous engagements have led to two state-led initiatives to evaluate the status quo of land in South Africa: the High-level Panel on the Assessment of Key Legislation and Acceleration for Change, led by former President Kgalema Motlanthe in 2017, and the Presidential Advisory Panel Report on Land Reform and Agriculture in 2019. This highlights the point of political and social dissatisfaction with the slow pace of land reform.

From 2011, the purchase of land by the state (through PLAS) and allocation to leasehold by beneficiaries has become the entirety of the land redistribution sub-programme (Hall & Kepe, 2017). However, Hall and Kepe (2017) argue that while policy improvements are welcome to improve the programme, there are growing trends of elite capture that warrant urgent attention. Evidence from various studies suggest that the land redistribution as a sub-programme has not been at the speed that is intended to deliver the promise of equitable access to land; secondly, the land reform projects are failing to deliver on the promises of sustainable agricultural projects for production, income

generation, food production, employment, food security, poverty alleviation and rural development (Kirsten *et al*., 2016; Davies *et al*., 2020). Binswanger-Mkhize (2014) notes some islands of success in the horticulture space, although they exist in an environment marked by partial or complete failure, with the number of beneficiaries and the size of the land area transferred being very low. The literature on land reform indicates that most land reform projects have failed, with only about 50% of rural land reform projects yielding some benefits to beneficiaries, although these benefits are often quite small (Cousins, 2016; Akinola & Kaseeram, 2021). Akinola and Kaseeram (2021) perceive the general weaknesses of many land reform projects as being the lack of attention to continuities between pre- and post-transfer livelihoods strategies.

The study on auditing land redistribution projects by North West University highlighted project failures that emanate from inappropriate planning and contextual failures (Kirsten & Machethe, 2005; Claassens, 2017). The key findings of that study were that out of all the land reform projects in the North West province, one third of them were surrounded by conflict which resulted to members losing interest; 55% of projects did not have the necessary requisite implements for production; 27% had inadequate implements while more than 25% of their projects had not produced anything since taking ownership of their land (Kirsten & Machethe, 2005). Davies *et al*. (2020) confirm that giving beneficiaries land without the means to work it is a recipe for failure. This is further confirmed by Khapayi and Celliers (2016), who state that the unavailability of farming implements, such as tractors and machinery, also limits the farmer's productivity. Khapayi and Celliers (2016) confirm that the majority of the farmers use the little money they have to hire these implements when needed. The implements of those who had them were old and of poor quality (Khapayi & Celliers, 2016). These key findings by Kirsten and Machethe (2005), Khapayi and Celliers (2016), and Claassens (2017) suggest an urgent policy trajectory that will point to corrective measures to ensure that future implementations of land reform circumvent such failures. Claassens (2017) argues that the study's findings draw attention to the quality and appropriateness of the type of business plans that formed the basis for project approval. As Kirsten *et al*. (2016) posit, while the South African government has introduced a comprehensive land reform programme to address skewed land ownership patterns, the reality is that many of these land reform projects have failed to reach the level of commercial viability.

Xaba and Roodt (2018) emphasise that what is important in land reform is not just the acquisition of land, but also the provision of a smooth transfer of land ownership, as well as the provision of

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post-acquisition support services. Kirsten *et al*. (2016) confirm that infrastructure, such as roads, water, and electricity, is essential as part of the support, in addition to land transfer. Kirsten *et al*. (2016) further argue that, although the rate of failure of land reform projects in South Africa is widely reported in the media and on various public platforms, empirical studies systematically evaluating the status of these land reform projects are very limited. Determining the salience of each contributing factor in the high failure rates is necessary to design remedies that enable better-performing programs (Binswanger-Mkhize, 2014). As Davies *et al*. (2020) state, if our interest is in successful land reform, we should be interested in the factors that contribute to its successful implementation.

3. THE CONCEPT OF PROFITABILITY

Broadly considered, the concept of profitability measures the difference between revenue and costs (Chavhunduka, 2016). Although many techniques exist for profit appraisal, the Return on Investment (ROI) is a popular appraisal technique due to its significance in measuring profitability (Wakibia *et al*., 2011). To consider profitability using ROI, it may also be necessary to consider enterprise value and profit margin. An enterprise is a complex, highly integrated system comprising processes, organisations, information, and supporting technologies, with multifaceted interdependencies and interrelationships across their boundaries (Nightingale, 2002). It is a defined scope of economic organisation or activity that returns value to participants through their interaction and contribution (Allen *et al*., 2001).

When it comes to profit, it is generally measured as gross operating surplus (Kilpatrick, 1996). Returns and margins are two terms commonly used to refer to profit (Obasi *et al*., 2016). The gross operating surplus can be expressed as revenue less expenses, but before loan interest is subtracted (Kilpatrick, 1996; Obasi *et al*., 2016; Chavhunduka, 2016). Phiri *et al*. (2023) express ROI as the difference between total sales, also referred to as gross income (GI), and total variable costs. This represents the ratio or balance between the company's gross profit and the level of sales achieved during the same period (Mahdi & Khaddafi, 2020). Mahdi and Khaddafi (2020) note that sales prices have a strong influence on the gross profit margin. The purpose of measuring the gross profit margin is to determine the amount of gross profit that can be obtained from each unit of the product's sale value (Mahdi & Khaddafi, 2020). Finally, the ROI provides a measure of performance of any investment and represents the enterprise's ultimate objective for shareholders (Zamfir *et al*., 2016). ROI reveals how much a particular business makes from the usage of capital (Wakibia *et al*., 2011;

Babatunde *et al*., 2023). While all other instruments can be useful in measuring profitability, ROI remains one of the most commonly used instruments (Zamfir *et al*., 2016). This study identifies factors that have a significant influence (both positive and negative) on enterprise profitability. The study aimed to analyse the impact of key variables on profitability in land reform farm enterprises.

4. RESEARCH METHODOLOGY

In this section, the main process and steps followed to address the study's primary objective are detailed. Section 4.1 This section discusses the conceptual framework for the study. Section 4.2 outlines the empirical approach. Section 4.3 examines the variables and model selection. Section 4.4 describes the methods of data collection. Finally, Section 4.5 presents the data analysis for the study.

4.1. Conceptual Framework

The conceptual framework for factors affecting profitability, as shown in Figure 1, identifies four key characteristics that impact business profitability. The main characteristics are individual [***IC***], household [***HC***], business [***BC***] and financial capital [***FC***] (Tundui & Tundui, 2018). The predictors that influence profitability mainly emanate from these four characteristics. This study confirms that every factor influencing the profitability of a farm business can be traced back to these four characteristics, as displayed in FIGURE 1.

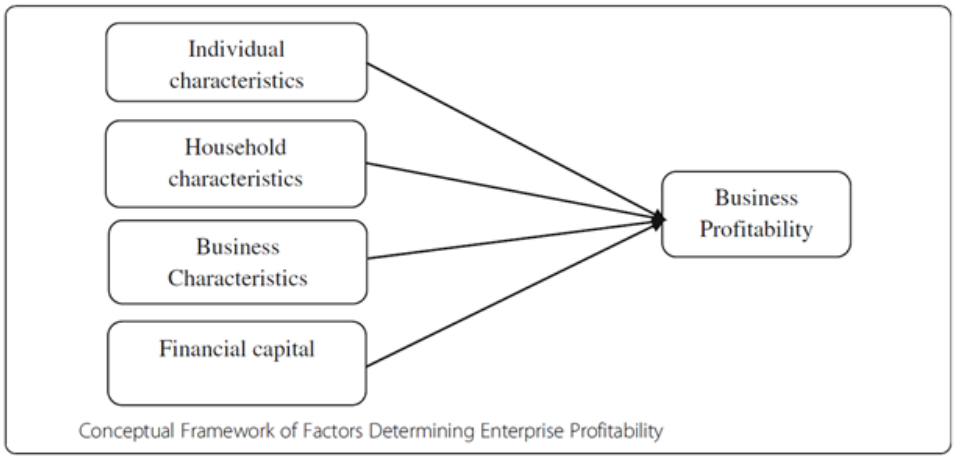

FIGURE 1: Conceptual Framework for Factors Determining Enterprises' Profitability (Source: Tundui & Tundui, 2018)

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In business, the practice of diversification is crucial for increasing streams of business revenue, thereby enhancing profit [BC]. This also helps reduce hunger and improve other indicators of physical well-being (Rahman & Connor, 2022). Boyce *et al*. (2005) argue that increased variety in product lines may lead to increased income from sales; however, such increased variety may induce some new level of business complexity [BC] and stricter management requirements [IC] (Boyce *et al*., 2005). As a result, while mixed farming is attractive due to the higher income generated from a variety of crops and livestock, Kingwell (2011) argues that mixed farming systems are difficult to manage and require a high level of skill [IC]. Also, decision-making for a mixed farm is a challenging and complex process (Kingwell, 2011). Browne *et al*. (2013) argue that the decision a farmer takes regarding which crops [BC] to cultivate and where, the technology to use, as well as short- and long-term management decisions [IC] will determine the level of profitability for the farm in the near future.

The choice of the mark*et al*so influences the magnitude of profit realised by the farmer [BC] (Xaba & Masuku, 2013; Libago, 2017). Libago (2017) confirms that the gains in profit are often influenced by the market utilised [BC] by the farmer, as prices differ according to type and distance to market. Libago (2017) opine that the National Fresh Produce Markets (NFPM) remain the main channel through which farmers market their vegetable and fruit produce. However, through these channels, the farmers are taken advantage of throughout the transactions since they are unable to negotiate pricing and have weak credit ties [BC] with buyers (Xaba & Masuku, 2013). As a result, many farmers become price takers, as they are indebted to buyers, which reduces their bargaining power and, in turn, reduces their profits (Xaba & Masuku, 2013). When it comes to adopting new and improved production techniques, farmers' level of education [IC] is key (Libago, 2017).

Nyam *et al*. (2022) agree that education [IC] and household size [HC] influence the profitability of farmers. In this regard, a low level of technology adoption and a lack of record-keeping have been associated with a low level of education (Libago, 2017). Bowman & Zilberman (2013) concur that farmers' attitudes [IC], the availability of resources [HC], and their education and knowledge [IC] are particularly crucial in driving profitability. Bowman and Zilberman (2013) further opine that farmers may be risk-averse when it comes to changing crop choices or implementing new agricultural practices [FC]. The decision to maintain lower profits may be due to an inability to fully comprehend the potential results that change can yield.

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Other factors influencing profitability are the quantity and timing of rainfall [BC], which have a direct impact on the profitability of dryland farming (Browne *et al*., 2013). This is because changes in rainfall affect soil moisture content, pasture, and crop growth, which in turn impact crop yields and livestock production volumes (Browne *et al*., 2013). The price changes [BC] in the factors of production also have significant implications for the farm's profit. The fluctuations take place in both local and international markets (Browne *et al*., 2013). Undoubtedly, the increase in costs of inputs [BC] has a direct impact on the final price paid by the consumer. Such changes and increases initially affect farm-level economics, then spread throughout the entire system (Pannell *et al*., 2014). Farm-level economics [BC] is driven by key factors such as labour, capital, risks, and uncertainties, as well as time-related factors such as interest rates (Pannell *et al*., 2014).

According to Xaba and Masuku (2013), the profitability of vegetable farmers is also dependent on access to credit, selling price, fertiliser quantity [FC] and gender of the farmer [IC]. Xaba and Masuku (2013) concur with Libago (2017) that distance to the market [BC] is a key factor, as farmers pay higher costs for markets located at a greater distance. Xaba and Masuku (2013) further argue that if farmers can reduce transportation costs [BC] and provide commodities or services at a reduced opportunity cost, then market involvement becomes more profitable.

With respect to access to credit, Browne *et al*. (2013) emphasise that start-up finance is an indispensable tool necessary for commercialisation. Hence, credit [FC] is considered a crucial factor in enhancing the farm profitability of agricultural production for resource-poor smallholder farmers (Oyedele *et al*., 2009). Credit enables farmers to afford farm assets as a start-up, generating profit more quickly than they would without access to credit (Xaba & Masuku, 2013). In a study of the profitability of agricultural enterprises by Izekor and Olumese (2010), the lack of adequate capital for investment [FC] was considered the most critical challenge faced by the farmers. Bowman and Zilberman (2013) view that the farmer's choice of crops, farming practices, and desire to invest in new crops or technologies will depend on the farmer's income, resource base, and capacity to obtain credit [FC]. Each of the factors mentioned above is operationalised as a variable that influences the farm's profitability.

4.2. Empirical Approach to the Study

This section outlines the methodology followed in the regression model. Following other studies, Kumbhakar (1994), Adesina and Djato (1997), Kolawole (2006), Izekor and Olumese (2010), Xaba

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and Masuku (2013) and Libago (2017), the factors that affect the profitability of enterprises as mentioned in section 4.1 were listed and operationalised into variables under TABLE 1.

These variables were further described for notation in the Linear Odds Model. Control variables, such as the farmer's age, gender, and marital status, were included last so that the model prioritises key variables (SmartAfrique, 2020). Dummy variables were recoded to give a mathematical effect to the model. However, Kelley and Bolin (2013) argue that if the analysis is to be successful, not every potential variable that could affect the dependent variable can be included. Hence, some variables that cannot be measured or would have a negligible effect on the model are excluded (Kelley & Bolin, 2013).

4.3. Linear Odds Model to Estimate Profitability

4.3.1. The Variables in the Study

Pienaar and Traub (2015) concur with Kelley and Bolin (2013) that selected variables should have significant discriminating power, which will improve individual performance on the model. They should have a clear relationship to the characteristics that the research is interested in. TABLE 1 provides a list and description of the variables regressed in the model.

TABLE 1: Variables in Linear Odds Model

Variable Name	**Variable Description**	**Notation & Expected sign**	
Dependent Variable (Y)			
Return on Investment (Y_i)	Return on investment in ZAR, expressed as a percentage (ROI%), transformed to a Logit function.	Y_i (LROI)	(+)
Independent Variables (X)			
Land area utilised (X_1)	Size of the farm area in hectares, continuous variable.	Land_utilized_Ha	(+)
Farming experience (X_2)	Farming experience of the farmer in years, continuous variable.	Mangt_Experience	(+)
Education (X_3)	Farmer's level of education in years, continuous variable.	Education_years	(+)
Advisory days (X_4)	Number of days of extension advisory service received per annum, continuous variable.	Advisory_days	(+)

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Training days (X_5)	Number of days of training received, continuous variable.	Training_days	(+)
Household size (X_6)	Number of persons dependent on farming income, continuous variable.	Household size#	(-)
Labour man-days (X_7)	Labour input in man-days, continuous variable.	Labour_days	(+)
Age (X_8)	Age of the farmer in years, continuous variable.	Age	(-)
Total grant received (X_9)	Total grant funding received in ZAR, continuous variable.	Total_grant	(+)
Chemicals & fuel (X_{10})	Chemicals and fuel costs in ZAR, continuous variable.	Chem+FuelZAR	(-)
Number in entity (X_{11})	Number of persons associated with the legal entity, a continuous variable.	Entity_No#	(-)
Total farm size (X_{12})	Size of the farm in hectares, continuous variable.	Land_size_Ha	(+)
Production inputs cost (X_{13})	Total costs of production inputs in ZAR, continuous variable.	Prod_costs	(-)
Marketing costs (X_{14})	Marketing costs in ZAR, continuous variable.	Marketing_costs	(-)

4.3.2. Model Specification

As already mentioned in Section 3, the Return on Investment (ROI) is widely accepted as a valid method for evaluating investment opportunities against one another or the general performance of any investment (Cloete & Spies, 2013; Zamfir *et al*., 2016). The ROI is instrumental in showing the final production results (De-Pablos-Heredero *et al*., 2018).

The factors influencing the profitability of land reform farm enterprises were analysed using the linear odds model. When analysing data on competing ideas, where there are multiple potential explanations for the link among numerous explanatory variables, regression analysis is occasionally a good fit (Rubinfeld, 2000). Sharaunga & Wale (2013) state that Ordinary Least Squares (OLS) regression can be used to estimate the parameters of an equation that shows the proportion of land allocated to cereal crops (as a fraction of the total arable land) as the dependent variable. However, for a proportion-dependent variable ranging between zero and one, the classical OLS is inappropriate because the prediction can be beyond the zero–one limits (Papke & Wooldridge, 1993; Sharaunga & Wale, 2013). For this reason, the study by Sharaunga and Wale (2013) employed a logit transformation procedure, a method also used by Birkhaeuser *et al*. (1991) and Wale (2010)

(Sharaunga & Wale, 2013). This approach is also applicable to this study, as the dependent variable is a proportion variable with a value ranging from 0 to 100%. The logit transformation procedure was applied to convert the dependent variable (Return on Investment) into a logit variable.

The logit transformation is very useful in rescaling data to make it more understandable and reader-friendly to the average reader (Janzen, 2019). Janzen (2019) confirms that transforming a variable into a logit function does not affect the skewness or linearity of the data, but changes the spread of the numbers. It also provides estimates and the direction of change resulting from the change of one or more variables (Janzen, 2019). In this model, the dependent variable, Return on Investment (expressed as a percentage, ROI%), was transformed into a new variable through a log10 transformation. The Logit Transformation helps reduce the possibility of misleading conclusions produced by data points near 0% or 100% (Marin, 2021).

The model is specified as follows:

Y_i (LROI) $= \beta_0+\beta_1X_1+ \beta_2X_2+ ……..+ \beta_kX_k$ Where;

Y_i = Return on investment expressed as a percentage ;

logit Y_i (LROI)= Log10 of Y_i variable that was transformed from ROI% using a Logit function then employed into a Linear Odds Model;

B_1…….B_k= are regression coefficients associated with X variables in TABLE 1;

X_1……X_k= are values of independent variables in TABLE 1;

β_0 = is the intercept coefficient.

4.3.3. Tests for Variable Reliability

A test for multicollinearity among the variables was performed to assess the sensitivity and specificity of the variables. Gaskin (2024) and DATAtab Team (2024) concur that the results indicate that the model is acceptable if the Tolerance (T) level is not less than 0,1 or the Variance Inflation Factor (VIF) is not greater than 10. The values of the multicollinearity test in Table 2 indicate that no variable has a value of $T < 0.1$ and $VIF > 10$.

TABLE 2: Test for Multicollinearity

Coefficients		
Model	**Collinearity Statistics**	
	Tolerance	**VIF**
Land_size_Ha	0,126	7,918

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Land_utilized_Ha	0,124	8,078
Mangt_Experience	0,865	1,156
Education_years	0,93	1,075
Advisory_days	0,919	1,088
Training_days	0,832	1,201
Depndents#	0,612	1,634
No_in_entity	0,68	1,47
Prod_costs	0,507	1,973
Labour_days	0,708	1,413
Marketing_cost	0,897	1,115
Age	0,748	1,337
Total_grant	0,827	1,209
Chem+FuelZAR	0,614	1,629
Dependent Variable: LROI		

4.3.4. Suitability of the Model

The model test for fitness was conducted, and the results are displayed in TABLE 3. The Deviance value of 0.271 and the Pearson Chi-square value of 0.271 indicate a relatively good fit model.

TABLE 3: Goodness of Fit Test for Linear Odds Model

Goodness of Fit			
	Value	**df**	**Value/df**
Deviance	46,573	172	0,271
Scaled Deviance	187	172	
Pearson Chi-square	46,573	172	0,271
Scaled Pearson Chi-square	187	172	
Log Likelihood	-135,368		
Akaike's Information Criterion (AIC)	302,736		
Finite Sample Corrected AIC (AICC)	305,936		
Bayesian Information Criterion (BIC)	354,434		
Consistent AIC (CAIC)	370,434		
Dependent Variable: LROI			
Model: (Intercept), Land_utilized_Ha, Mangt_Experience, Education_years, Advisory_days, Training_days, HH_size#, Labour_days, Age, Total_grant, Chem+FuelZAR, No_in_entity, Land_size_Ha, Prod_costs, Marketing_cost			

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4.4. Methods of Data Collection

This section discusses the study area, population, sampling method, data collection instruments and data analysis techniques employed in the study.

4.4.1. Study Area

The study focused on the 10 districts of KZN. The districts are Amajuba, Harry Gwala, iLembe, King Cetshwayo, uGu, uMkhanyakude, uMgungundlovu, uMzinyathi, uThukela and Zululand. The study area was considered to be the whole province because the land reform programme is implemented across all districts, and the spread is not uniform across districts. Any reduction would have reduced the sample size, which does not enable proper statistical analysis of the data provided. A smaller sample size would have resulted in validity challenges (Lakshmi & Mohideen, 2013; Sekaran, 2016), as inferences would not be made to the population since the number of assisted land reform enterprises per district significantly differs.

4.4.2. Population

This study considered all land reform farmers in KZN who benefited from redistribution, tenure reform, and restitution programmes, and received acquisition and post-acquisition support from the government, and were using the land for agricultural purposes. Farmers meeting the set criteria were 389.

4.4.3. Sampling of Farmers

The sampling method for this study was purposive sampling. The reason for selecting this sampling method is that the population of land reform beneficiaries in KZN is held by the Department of Agriculture, Land Reform and Rural Development (DALRRD), and information is not publicly available. Additionally, this ensures the researcher is well aware of the study population, as data on farms transferred to land reform beneficiaries has been provided to the researcher upon request by DALRRD in KZN. The farmers were selected to ensure representation of various programmes, i.e., PLAS, LRAD, RLCC, and other programs. The other programmes represent farms that are acquired through joint funding from the state and either a bank loan to the farmer or the farmer's contribution from their own capital. The population of 389 is not a large enough number to allow for more options of sampling, particularly if the data is analysed through statistical tests. Leedy and Ormrod (2005) and Patel and Patel (2019) agree that in purposive sampling, people or other units are chosen for a

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specific purpose, and that the researcher must justify the appropriateness of the chosen sampling method.

The sample for the study consisted of 262 land reform farmers from the province of KZN, distributed across 10 districts. The sample taken was representative of the total population (67.4%), hence inferences can be made about the total population.

4.4.4. Data Collection Instruments

The data was collected on two levels: primary and secondary data. The initial list of farmers was requested from DALRRD, which included the farmers' information. The farmers who met the qualifying criteria were then selected to form the study population, which totalled 389. The structured questionnaire was divided into five sections: social and demographic, training and experience, marketing and production performance, resources (jobs, machinery, and assets), and financial performance information. The variables were formulated within each category and operationalised to ensure measurability and consistency. As it is challenging to simultaneously optimise internal and external validity, efficacy data from traditional controlled trials are often complemented by evidence from practical trials or observational studies that assess the performance of an intervention under conditions more closely resembling the routine practice of sampled populations (Kennedy-Martin *et al*., 2015). Hence, the structured questionnaire was then piloted to identify shortcomings in the information contained in the form. After piloting and addressing the questionnaire's shortcomings, data were collected from farmers using the revised structured questionnaire.

To mitigate the bias of self-reported data, the farmers provided information on numbers, production records, and all quantifiable data, referencing their previous farm records. In cases where information is provided and cannot be reconciled with the records due to unavailability, industry norms were verified to ensure that the provided information is consistent with the norm. Additionally, information received from the DALRRD, including details on farmer acquisition, farm sizes, and other historical data, was verified. All information provided through the structured questionnaire was then captured in Microsoft Excel format and later transferred to SPSS and the DATATab Online Statistics Calculator for analysis.

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4.5. Data Analysis

The primary aim of this study was to identify factors influencing the success and failure of land reform beneficiary farms. The options for econometric models to analyse the variables determining profitability included the Multiple Linear Regression Model, the Log-linear Hazard Model, the Transformed Logit and Linear Odds Model (also known as Generalised Logistic Regression Model). The dependent variable, ROI%, is expressed as a percentage, ranging from 0% to 100%. This variable cannot be measured using Ordinary Least Squares (OLS) because OLS will predict both negative and positive values, and can exceed the 100% limit (Sharaunga & Wale, 2013). Hence, for this study, the linear odds model was employed, as it can accommodate a percentage-dependent variable. Before this model was employed, a Transformed Logit model was used to transform the dependent variable into a Logit variable, as stated in sections 4.3.2 and 4.3.4, which outlined the selection and suitability of the model. The new variable of log ROI was then regressed through the Linear Odds Model.

5. RESULTS AND DISCUSSIONS

5.1. Descriptive Details of Respondents

The sample comprised 61.8% males and 38.2% female farmers (N = 262). Of the total farmers, 87.4% were African, 10.7% were Indian, and 1.9% were Coloured. In terms of marital status, 58.4% were married, 27.1% were single, 10.3% were divorced, and 4.2% were widowed. The mean age of respondents was 46.77 years (SD = 9.91 years). The smallest farm size was 10 hectares, and the largest was 2,247 hectares. The youngest farmer was 24 years old, and the oldest was 72 years old. The average farm size was 351.93 hectares (SD = 246.729 hectares).

TABLE 4: Relationship of ROI with Classified Respondents

Mean & Std. Deviation of ROI %			
Classification	**ROI %**	**Mean ROI %**	**Std. Deviation**
African	229	21,59%	36,77%
Indian	28	53,50%	79,83%
Coloured	5	10,26%	13,49%
Married	153	26,58%	49,00%
Single	71	26,06%	37,39%
Separated/divorced	27	9,87%	16,19%
Widowed	11	28,13%	55,86%
Female	100	28,60%	52,55%

Male	162	22,42%	37,94%
Amajuba	19	14,70%	35,93%
Harry Gwala	18	10,76%	19,96%
iLembe	23	70,58%	85,02%
King Cetshwayo	39	38,92%	55,06%
uGu	26	26,15%	39,16%
uMkhanyakude	15	37,49%	45,95%
uMgungundlovu	43	19,69%	21,41%
uMzinyathi	28	3,99%	7,50%
uThukela	19	5,51%	8,05%
Zululand	32	17,92%	29,92%
Average total	**55,16**	**24,88%**	**38,26%**

In TABLE 4, the mean ROI% for each classification is displayed. By racial demographics, Indians have the highest ROI percentage at 53.50%, followed by Africans and Coloureds with 21.59% and 10.26%, respectively. The ROI% ranges from 26% to 28% across marital statuses, except for separated or divorced individuals, who have the lowest at 9.87%. By gender, females have a higher ROI% than male respondents, with 28.60% and 22.42%, respectively. When considering the districts across the board, the mean ROI% varies significantly, with the iLembe district being the highest at 70.58% and uMzinyathi having the lowest at 3.99%. Across all the classifications, the Standard Deviations vary significantly from the means. The overall mean ROI% across the classes is 24.88% (SD = 38.26%).

TABLE 5: Distribution of Farms by Programme and District

Acquisition of Farms by Programme										
District	**PLAS**		**LRAD**		**RLCC**		**Other**		**Total**	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Amajuba	10	3.8%	0	0%	6	2.3%	3	1.1%	19	7.3%
Harry Gwala	11	4.2%	2	0.8%	3	1.1%	2	0.8%	18	6.9%
iLembe	13	5%	5	1.9%	3	1.1%	2	0.8%	23	8.8%
King Cetshwayo	26	9.9%	5	1.9%	4	1.5%	4	1.5%	39	14.9%
uGu	15	5.7%	1	0.4%	5	1.9%	5	1.9%	26	9.9%
uMkhanyakude	11	4.2%	2	0.8%	2	0.8%	0	0%	15	5.7%
uMgungundlovu	27	10.3%	2	0.8%	9	3.4%	5	1.9%	43	16.4%
uMzinyathi	13	5%	0	0%	9	3.4%	6	2.3%	28	10.7%
uThukela	11	4.2%	3	1.1%	3	1.1%	2	0.8%	19	7.3%
Zululand	18	6.9%	1	0.4%	8	3.1%	5	1.9%	32	12.2%

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Total	**155**	**59.2%**	**21**	**8%**	**52**	**19.8%**	**34**	**13%**	**262**	**100%**

TABLE 5 presents the distribution of land reform farms in KZN by acquisition programme and district. The highest category is PLAS farms, with 59.2% of the total dataset. The second-highest category is RLCC farms, accounting for 19.8%, followed by LRAD at 8% and other programs, including bank loans and blended finance, at 13%. There are more farms acquired under the uMgungundlovu district, with an overall 16.4%, followed by the King Cetshwayo District with 14.9%. The district with the lowest acquisition rate is uMkhanyakude, at 5.7% of the total sample.

5.2. Findings of the Study

TABLE 6: Model Summary for Linear Odds Model

Omnibus Test		
Likelihood Ratio Chi-square	**df**	**Sig.**
90,489	14	<0,001
Dependent Variable: LROI		
Model: (Intercept), Land_utilized_Ha, Mangt_Experience, Education_years, Advisory_days, Training_days, HH_size#, Labour_days, Age, Total_grant, Chem+FuelZAR, No_in_entity, Land_size_Ha, Prod_costs, Marketing_cost		
Model: Compares the fitted model against the intercept-only model.		

The overall regression model shows that the predictors in TABLE 6 retained a statistically significant model, with a likelihood ratio chi-square of 90,489; $P < 0.001$.

TABLE 7: Test of Model Effects for Linear Odds Model

Tests of Model Effects			
	Type III		
Source	**Wald Chi-square**	**df**	**Sig.**
(Intercept)	**3,677**	**1**	**0,055**
Land_utilized_Ha	**0,244**	**1**	**0,621**
Mangt_Experience	**3,236**	**1**	**0,072**
Education_years	**0,081**	**1**	**0,776**
Advisory_days	**13,402**	**1**	**<0,001**
Training_days	**3,875**	**1**	**0,049**
HH_size#	**5,193**	**1**	**0,023**
Labour_days	**28,22**	**1**	**<0,001**
Age	**0,416**	**1**	**0,519**
Total_grant	**0,003**	**1**	**0,954**

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Chem+FuelZAR	**1,152**	**1**	**0,283**
No_in_entity	**0,004**	**1**	**0,947**
Land_size_Ha	**0,824**	**1**	**0,364**
Prod_costs	**8,197**	**1**	**0,004**
Marketing_cost	**15,103**	**1**	**<0,001**
Dependent Variable: LROI			
Model: (Intercept), Land_utilized_Ha, Mangt_Experience, Education_years, Advisory_days, Training_days, HH_size#, Labour_days, Age, Total_grant, Chem+FuelZAR, No_in_entity, Land_size_Ha, Prodcost_Ha, Marketing_cost			

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TABLE 8: Parameter Estimates for Linear Odds Model

Parameter Estimates							
Parameter	**B**	**Std. Error**	**95% Wald Confidence Interval**		**Hypothesis Test**		
			Lower	**Upper**	**Wald Chi-square**	**df**	**Sig.**
(Intercept)	0,602	0,3141	-0,013	1,218	3,677	1	0,055
Land_utilized_Ha	0	0,0004	-0,001	0,001	0,244	1	0,621
Mangt_Experience	-0,016	0,0088	-0,033	0,001	3,236	1	0,072
Education_years	0,004	0,0142	-0,024	0,032	0,081	1	0,776
Advisory_days	0,032	0,0086	0,015	0,048	13,402	1	**<0,001**
Training_days	0,006	0,0033	0,000028	0,013	3,875	1	**0,049**
HH_size#	-0,018	0,008	-0,034	-0,003	5,193	1	**0,023**
Labour_days	0,00005	0,00001	0,00003	0,00007	28,22	1	**<0,001**
Age	0,003	0,0042	-0,005	0,011	0,416	1	0,519
Total_grant	0,00000	0,00000	0,00000	0,00000	0,003	1	0,954
Chem+FuelZAR	0,00000	0,00000	0,00000	0,00000	1,152	1	0,283
No_in_entity	0,001	0,0207	-0,039	0,042	0,004	1	0,947
Land_size_Ha	0	0,0004	-0,001	0	0,824	1	0,364
Prod_costs	0,00002	0,00001	0,00001	0,00003	8,197	1	**0,004**
Marketing_cost	-0,003	0,0008	-0,004	-0,001	15,103	1	**<0,001**
(Scale)	0,249	0,0258	0,203	0,305			
Dependent Variable: LROI							
Model: (Intercept), Land_utilized_Ha, Mangt_Experience, Education_years, Advisory_days, Training_days, HH_size#, Labour_days, Age, Total_grant, Chem+FuelZAR, No_in_entity, Land_size_Ha, Prodcost_Ha, Marketing_cost							
a. Maximum likelihood estimate							

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5.3. Summary of Findings

A dependent variable, Return on Investment expressed as a percentage (ROI%), was transformed through a logit function to create a new variable, which is a log function of the ROI%, Y_i (LROI). A Linear Odds Model analysis was performed to examine the influence of the Predictor variables: Land area utilised (*Land_utilized_Ha*), Management farming experience (*Mangt_Experience*), Farmer's level of education (*Education_years*), Extension advisory service (*Advisory_days*), Training received from government and stakeholders (*Training_days*), Household size dependent on farm income (HH_size#), Labour man-days (*Labour_days*), Farmer's age (*Age*), Total grant funding received (*Total_grant*), Chemicals and fuel costs (*Chem+FuelZAR*), Number of people in entity (*No_in_entity*), Total farm size (*Land_size_Ha*), Production inputs cost (*Prod_costs*), and Marketing costs (*Marketing_cost*) on the dependent variable logit of Return on Investment Y_i (LROI). TABLE 8 shows the parameter estimates generated through the model, and significant variables at a 0.05 significance level are highlighted in bold.

5.4. Discussions of Study Results

The diagnostic test for the model fit is indicated in TABLE 3. The study's findings show that when all independent variables (X1—X14) are equal to zero, the value of the dependent variable LROI is 0.602. Because this is a positive value, it implies a positive slope. The study found that there is a statistically significant influence of variables Extension advisory service (*Advisory_days*), Training received from government and stakeholders (*Training_days*), Household size dependent on farm income (*HH_size#*), Labour man-days (*Labour_days*), Production inputs cost (*Prod_costs*) and Marketing costs (*Marketing_cost*), [X_4, X_5, X_6, X_7, X_{13} and X_{14}].

The results of the study show that there is statistical significance ($P < 0.001$) in the effect of extension advisory service (Advisory_days) on the profit generated, Y_i (LROI). For every 1-unit increase in the unit of extension advisory service, there is a 0.032 (3.2%) increase in the Return on Investment, Y_i (LROI). This finding is consistent with a study by Van den Berg (2013), as well as Qwabe et al. (2023) and Makamane et al. (2025) who highlighted the importance of extension services, which established that an increase in the frequency of extension advisory visits imparts knowledge and information that leads to increased income generation for farmers, thereby enhancing profits. Agricultural extension services provide information and inputs that enhance human capital, potentially improving rural well-being (Anang *et al*., 2020). This means that

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extension advisory services must be prioritised in order to enable farmers to learn about efficient and emerging technologies, tactics, and current challenges, so that they can succeed in farming. Farmers get to learn about new varieties of crops, the attractive markets and precision in their current farming ventures. Both education and extension advisory are very critical for farmers in enabling the adoption of new technologies (Oni *et al*., 2011). This result justifies the provision of extension advisory services to farmers as critical, and a lack thereof results in declining profitability on land reform farms. Rahman and Connor (2022) argue that fewer studies have examined the effects of provider type, whether private or public, as well as the frequency (i.e., the number of extension visits) on farm welfare, despite many studies having evaluated the impact of extension services. Most studies treat the presence or absence of extension as a binary variable to test treatment effects (Ragasa & Mazunda, 2018; Rahman & Connor, 2022). According to the findings by Rahman and Connor (2022), there is a significantly different result between farmers who received one extension visit, multiple extension visits, and those who used private provisions as opposed to public sector extension. One area of improvement required in the extension advisory service is consistency and needs-based advisory. Farmers should not be surprised when receiving extension, but rather, it should be well-timed and within schedule, responding to the prevailing challenges at the time, or routinely followed to ensure the sustenance of results.

This study also shows statistical significance (P = 0.049) in the effect of training received by land reform farmers from government and stakeholders (Training_days) on profit generated, Y_i (LROI). For every 1-unit increase in training, the profitability (ROI) changes by 0.006 units (i.e., 0.6%). Additionally, this indicates a positive slope, which signifies a significant contribution of training to profitability. This finding is consistent with those of Libago (2017), who concluded that when training is provided to farmers, profitability increases by 16.4% as a result of the farmers gaining more insights about production. Chauke *et al*. (2013) and Shushu et al. (2024) also found that farmers who did not receive training remain at risk and have no access to new forms of technology in farming, which enables them to access financial services through technology. These farmers only rely on their own assets to generate capital (Chauke *et al*., 2013). This finding also aligns with Rahman and Haider (2023), who concluded that farmers who received training exhibited a significant increase in their farm management knowledge compared to their counterparts who did not receive any training. The delay in training and extension results in significant losses, as farming cannot be paused or suspended (Ellenson & Madhanpall, 2014). The

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findings of this study are also in line with those of Antwi and Chagwiza (2019), who found that the number of trainings attended by the farmer, along with the average net farm income of the project, had a positive and significant effect on the farmer's ability to save from their proceeds. Borthakur *et al*. (2015) assert that the primary obstacles to farmers' use of new technology are a lack of experienced labour, knowledge, training, and experience.

In a study by Begum *et al*. (2013), training and involvement in farmer associations were found to have a statistically significant influence on farmers' technical efficiency in farming (Begum *et al*., 2013). Serin *et al*. (2009) further contend that where farming requires more labour, as is the case in developing countries, than in industrialised nations, farmers' human capital – including their education and technical training – is increasingly crucial. Importantly, not only is formal education deemed to be influential in farming productivity, but also "on the job" or specific training is an important source of productivity and growth (Serin *et al*., 2009). Moyo (2010) argues that indigenous knowledge is still widely used in agricultural management methods in most African countries and has a significant influence on farmers' decision-making processes. Hence, these can be integrated into transferring knowledge to farmers, as it is information they already know and relate to. As Salami *et al*. (2020) suggest, indigenous knowledge of agriculture remains essential in the production of food for urban residents. Anderson (1997), as cited by Serin *et al*. (2009), suggests that education and training are essential for managing and promoting the changes that farmers need to be sustainable. A speedy resolution of agricultural challenges can be achieved by integrating technological advances, as well as indigenous and conventional methods, to increase productivity (Muthee *et al*., 2019).

Notably, the age factor remains critical in training. While the age of the farmer may be neglected (Manenzhe *et al*., 2016), age remains a critical variable, as training and acquiring commercial skills is a lengthy process that requires the ability to comprehend as one learns (Sihlobo & Nel, 2016). Dagada *et al*. (2015) confirmed the finding of this study, stating that low levels of education necessitated increased training needs to raise the profitability of fruit farmers in Limpopo. Rohani *et al*. (2020) also observed that formal education is more prevalent among the younger generation, while non-formal education, for example, on-farm training, is more suitable for farmers who currently do not pursue formal education due to limitations such as age. Hence, the integration of

both formal and non-formal education bridges the gap between the different age groups in farming, balancing the transfer of skills to all.

This study also found statistical significance in the effect of Household size on farm income (HH_size#), P = 0.028. The coefficient of the Y_i (LROI) changes by -0,018 (-1,8%) for every 1 unit increase in the number of household members dependent on farm income. This finding aligns with the findings by Omiti *et al*. (2009) and Kyaw *et al*. (2018), who confirmed that higher household size reduces farmers' participation in markets. Swanepoel and Van Niekerk (2018) and Swanepoel et al. (2021) similarly found connections between household size, food security, and agricultural participation. Hlatshwayo *et al*. (2021) confirm that an increased household size reduces the total products sent to the market, as more products are allocated for own household consumption as opposed to market supply. The negative coefficient illustrates that as the household size increases, the quantity of goods sold to the market decreases. As a result, larger households would have less produce to provide to the market compared to smaller households (Kyaw *et al*., 2018). This is sed by Mango *et al*. (2014), who confirm that household food security is affected by household size, with larger households experiencing reduced food security. However, Mango *et al*. (2014) conclude that little can be done with household size except to improve household education levels, labour participation, and market information, as reducing household size is impossible. In a study by Hlatshwayo *et al*. (2021), an unexpected outcome emerged where the household size was found to contribute positively to farmers' market participation. This, according to Hlatshwayo *et al*. (2021), is justified when family farms utilise family labour for production, thereby reducing labour costs. The reduced labour costs positively contribute to the aggregate farm returns, thereby raising farm profits.

The study found statistical significance in the effect of Labour man-days (Labour_days) on profitability (P < 0.001). The coefficient of the Y_i (LROI) changes by 0,00005 (0,005%) for every 1 unit increase in the labour man-days. This finding aligns with the study by Asuming-Brempong *et al*. (2013), who confirmed that both land productivity and labour productivity are key determinants of commercialisation in farming. In the study by Asuming-Brempong *et al*. (2013), labour productivity was found to be significant in increasing the value of farm sales, which in turn increases profitability. Also, the farm income and labour productivity were positively correlated (Asuming-Brempong *et al*., 2013). Balancing the efficiency of employed labour is equally critical

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for a productive farming operation. Farms that can balance the efficiency are found to be more profitable (Deming *et al*., 2019). Among other tasks, farmers also need to determine whether the use of internal labour remains efficient or if they should consider other alternatives, such as contracting. Deming *et al*. (2019) argue that some tasks on the farm can be replaced with machinery, although there are associated costs. However, they also argue that the savings associated with it should be noted (Deming *et al*., 2019). Compared to human labour, contractors generally have larger equipment, which reduces the time spent on tasks (Deming *et al*., 2019). While labour input contributes positively to the farm's profitability, the farmer must also consider the balancing of applicable tasks.

This study also found statistical significance in the effect of production input costs (Prod_costs) with P = 0.004. The coefficient of the Y_i (LROI) changes by 0,00002 (0.002%) for every 1 unit change in costs of production inputs. This finding is not consistent with many studies. For example, Kassali's (2011) finding showed that an increase in the production costs of sweet potato farmers leads to a decrease in the profit generated by farmers. Additionally, Adeyemo *et al*. (2010) found that farmers need to reduce variable production costs to increase their profits. Ideally, this should be done through comparison of marginal costs and marginal revenue to ensure that cost reduction does not negatively affect the returns due to compromised inputs and services on the farm. However, according to Palia and De Ryck (2016), this finding is not unprecedented. Palia and De Ryck (2016) recommend using the unit cost of production performance analysis to identify instances where the unit costs of production of one or more product lines are above or below the average.

Adeyemo *et al*. (2010) and Libago (2017) further mention that, in general, the variable costs of production include labour; hence, a reduction in labour costs greatly results in increased profit margins for farmers. In this study, the finding that increasing production costs raise profits is well integrated with the finding that labour man-days increase the farm's profitability. Hence, with increased precision of labour inputs in production, there will be an increase in production costs, which will lead to a higher increase in profits. This is supported by Tey and Brindal (2015), who contend that different production costs should have varying impacts on farm net incomes. Furthermore, Van den Berg (2013) concurred with this finding, stating that the relatively high production costs are associated with high labour costs on farms operated by the elderly, as they

rely on hired labour due to old age. Kumbhakar (1994) argues that more than 50% of the farms in land reform have an inefficient use of resources, including inputs such as fertiliser, manure, and labour. The costs of inputs include the fertiliser, water, electricity, labour, and costs of purchasing seeds, seedlings, breeding stock, etc. As a result, strengthening the controls on production costs should be informed by the correct application of rates and scales of production inputs.

This study also found statistical significance on the effect of marketing costs (*Marketing_cost*), P < 0,001. The coefficient of Yi (LROI) changes by –0.003 (–0.3%) for every 1-unit increase in marketing costs. This finding aligns with Makhura's (2002) research, which found that marketing costs for emerging small-scale farmers have a negative impact on profitability, particularly when farmers lack access to relevant market information. Palia and De Ryck (2016) argue that small-scale farmers are consistently disadvantaged by marketing costs compared to large corporations. Omiti *et al*. (2009) further confirm that distance to the market negatively affects farmers' decisions to participate in the market and the volume of output marketed. Large farming operations can identify areas to focus their marketing efforts based on the volumes and scale of production (Palia & De Ryck, 2016). Again, the finding of this study is confirmed by Hardesty and Leff (2010), who found that significant costs associated with marketing affect profitability, including labour and marketing services. However, Hardesty and Leff (2010) state that significant variations exist between marketing costs across the marketing channels. While the farmers' markets may be considered minimal in terms of costs, the significant labour activity and proper packaging costs do affect the gains received by the farmers through the farmers' markets (Hardesty & Leff, 2010). This finding is confirmed by studies by Kyaw *et al*. (2018) and Asad *et al*. (2019), who found that farmers lack marketing knowledge, resulting in most of their crops being sold at lower prices at the farmgate or in local markets. The cure for marketing challenges is to revive farmer associations, which will increase farmers' bargaining power. Proper training and extension advisory services should target the farmers' challenges, ensuring that critical market information is shared during the visits. Transparency in the marketing system, including charges and compliance statutory fees associated with certain markets, should be emphasised at all times so that farmers consider themselves equal role players in the market.

Lastly, for the study's results to be sound, they must be generalisable in a different environment with similar conditions (Kennedy-Martin *et al*., 2015). This makes the study's contribution to

adding value and solutions to problems elsewhere with similar circumstances (Peters *et al*., 2018). The challenge typically encountered is the resource constraints faced by the implementers of the recommended solutions, which in turn reduces the impact of the implemented recommendations (Peters *et al*., 2018). Furthermore, it is essential to carefully consider the limitations of any intervention before implementing the actual recommendations, in order to achieve the best possible results from the intervention.

6. POLICY IMPLICATIONS

This study recommends that, as a policy position, before providing any financial support that will be controlled by the farmer for operations, training should be provided to maximise the impact of the government's and stakeholders' financial investments.

7. LIMITATIONS OF THE STUDY

Some members of land reform enterprises who wished to participate in the study on farms owned by Trusts and Communal Property Associations (CPAs) withdrew due to fear of victimisation. This prevents the researcher from obtaining valuable information to study the real circumstances on the ground in farming communities. Additionally, farms where allocated farm beneficiaries have passed away and the government is in the process of allocating a new beneficiary cannot be assessed due to a lack of a responsible individual to provide information on farm operations. Some of these farms were managed by interim caretakers to prevent theft and property damage.

Some challenges arose from the availability of farmers, who would often be busy with other farm operations and preferred that the questionnaire be left for them to complete at a later stage. Some of these questionnaires were never returned, which disadvantaged the researcher in eliciting important information that could improve the analysis. However, this incident occurred rarely and does not affect the analysis and inferences of the study. On farms not operated coherently by entities or where enterprise members are in conflict, the information received was sometimes uncoordinated, and when verified, it showed no correlation with the expected norm. In such cases, the information was verified with the respondents to ensure coherence with the industry norms and production standards. The incoherence would mainly emanate from the farming operation not being run optimally. However, these were included in the analysis to provide a comprehensive picture of the status of land reform farms.

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Due to the geographic spread of farms in areas such as Zululand, Amajuba, and uMzinyathi districts, data collection on some farms can be conveniently conducted based on the proximity of farmers in the same area. In cases where only one farm is located at an outlier location, and the farmer does not have an email address or cannot be reached by phone, the data were not collected due to the spatial dispersion of the area. However, this condition would have no bearing on the findings and inference made since a good representation of the total population was achieved, at 67%.

To address the limitations of the study, future research should consider employing mixed-methods approaches to ensure that a diverse farmer population is reached and that information is collected. This could include digital methods, such as an online questionnaire that respondents can fill out at their convenience using modern technology. This will ensure that even spatially remote areas are accessible, and also that respondents will not be victimised by their peers due to the commotion created by the in-and-out movement of data collectors, drawing attention. Electronic reminders, such as short messages sent to respondents who have not participated in the study, should also be considered to enhance the return rate of the questionnaires. These strategies will enhance future studies and maximise their impact for the betterment of farming communities.

8. CONCLUSIONS

This study concluded that extension advisory services (X4), training received from government and stakeholders (X5), household size (X6), labour man-days (X7), production input costs (X13), and marketing costs (X14) are key factors that influence the profitability of land reform enterprises in KwaZulu-Natal. Any plan that seeks to address the productivity and profitability of land reform enterprises must include the key areas of intervention on these factors for maximum impact.

Skilling farmers through training and extension advisory services will improve their farming skills and business acumen, enabling them to make informed decisions that raise their farm profits and ensure continuous growth on land reform farms. Extension advisory and training encourage farmers to adopt new technology, access financial systems, and also encourage them to save their own funds to continue operations during off-seasons or in the event of disasters. During these trainings, pertinent information about industry changes is communicated, and farmers are able to seek clarification where necessary.

This study also concludes that training and extension advisory services are non-negotiable instruments through which the outlook of small-scale farming can be enhanced. In addition, the government should also strengthen the extension programme to align with the needs of land reform. This is paramount since agriculture strongly depends on seasonality. Hence, any delays in implementing certain activities result in severe losses for the farmer. The challenge is that there appears to be no alignment between the introduction of the land reform programme and the preparation of new farmers, some of whom have never farmed at the scale of production they now operate after benefiting from land reform. This assessment should be made in comparison with international extension and training standards, emulating the best practices from the best-performing countries in training and extension.

The size of the household has a significant impact on the farm's profitability. As stated by other studies, there is little that can be done by adjusting household size. Increased labour man-days and dedication to the farm operations have also shown signs of increasing profitability. Ensuring the regulation of specified man-days for farm operations is useful in circumventing over-compensation of labour and ensuring that costs paid for activities are market-related. Overcompensating beyond the specified rates disadvantages the business, while undercompensating discourages employees (or their family members), and they start to consider other employment opportunities elsewhere to earn better salaries.

The control of production input costs through analysis of unit production costs helps farmers greatly reduce unnecessary costs that do not add value to the business. For example, a sudden reduction in production input costs may reduce the benefits generated by inputs on farm productivity. However, a comparison of marginal costs and marginal returns on operations will enable farmers to make informed decisions about whether to invest in a particular enterprise.

The farmer's level of education is significantly associated with their ability to comprehend abstract texts, read instructions, and apply correct measurements of inputs, as well as forecast production and returns in farming. This promotes operational efficiency and reduces post-harvest losses and resource waste. Furthermore, both formal and informal training are necessary to cater to the diverse needs of different categories of farmers. While literature suggests that farmers' age significantly impacts their ability to learn, integrating technical knowledge with indigenous knowledge systems can substantially reduce the knowledge gap across farming generations. In

addition, elderly farmers will find it easy to relate to indigenous knowledge since they have experienced and lived it. Hence, there needs to be a way to incorporate the indigenous knowledge system into the government's selection criteria for allocation. The current systems only recognise formal qualifications and experience.

In terms of markets, farmers' access to markets is a key factor that enhances their profitability. It is essential to consider the market's efficiency itself. The same can be said for access to credit; while some farmers may be constrained in accessing services to produce their products, some marketers find it easy to provide bridge finance to their suppliers during the off-season to buy inputs and pay for services. Farmers who are constrained from accessing credit often struggle to afford new and improved technology that can help them grow their businesses and produce high-quality products. In this way, marketers themselves will be certain to have a product in the future due to this reliable relationship based on mutual interest. While a lack of access to credit negatively affects profitability, it is crucial to revamp the funding systems to better cater to farmers' needs. Even farmers who may qualify for credit often find that the repayment periods are not suitable for their farming calendar. Hence, receiving credits from mutually beneficial partners reduces the risk of paying exorbitant interest and arrears in the future, based on misunderstandings or miscalculations of incorrect payment terms. This will help farmers establish their own credit record over time.

Lastly, the cost of marketing also drives the profitability of farming enterprises. The study concludes that the marketing factors for land reform farm enterprises need to be considered for transparency. Currently, there is no single unified marketing strategy among the farmers, even those in the same commodity. Each chooses their market based on personal preferences. Additionally, other important aspects, such as road infrastructure, distance to the market, and the availability of the market itself, are key. The costs of marketing are not always clearly defined in terms of their breakdown, including agency fees and the marketer. Due to a lack of resources and transparency in market information, farmers are more price takers than price makers. Participation in the marketing process will enable farmers to make informed decisions about choosing their market, considering factors such as location, pricing, product quality, service quality, and volumes delivered over a specified period.

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9. RECOMMENDATIONS OF THE STUDY

From the results of this study, the following recommendations are made:

- It is recommended that, where family labour is available, farmers be encouraged to prioritise hiring family members at the appropriate labour task rates to reduce the negative effect of high household size on profitability while creating employment opportunities.
- It is recommended that market engagements between farmers and marketing agents be encouraged to establish relationships that assist resource-constrained farmers. For example, this could involve bridge financing at discounted interest rates for production inputs during off-season, which would guarantee the delivery of the product at the correct time, form, and quality.
- This study recommends a comprehensive overhaul of the training and extension advisory service, incorporating practical Key Result Areas (KRAs) and target areas for land reform enterprises, drawing on knowledge from countries with efficient extension advisory and training support systems.
- It is recommended that further studies investigate the lack of primary producer farmer direct participation in prime agricultural markets, the breakdown of marketing costs, and ways to encourage transparency in marketing information.

10. DISCLOSURE

The authors declare that they have no competing interests in this study.

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Socioeconomic and Behavioural Factors Influencing Electrical Appliance Adoption Among Rural Farming Households: An Endogeneity Switching Regression Analysis

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ABSTRACT

In rural areas, household agricultural income has a significant influence on the adoption of new technologies, including electrical appliances. Despite technological advancements, adoption rates remain inconsistent due to socioeconomic disparities and behavioural patterns. This study examines the impact of socioeconomic and behavioural factors, as well as agricultural income, on the adoption of electrical appliances among farming households in South Africa's Eastern Cape Province. Data were collected from 224 households using structured questionnaires and analysed through descriptive statistics and Endogeneity Switching Regression (ESR). The results show that variables such as age ($p<0.01$), years of schooling ($p<0.05$), occupation ($p<0.01$), family size ($p<0.05$), access to extension services ($p<0.05$), off-farm income activities ($p<0.05$), and distance to markets ($p<0.01$) significantly influence the likelihood of adopting electrical appliances. The ESR model confirms a statistically significant and positive relationship between adoption and household agricultural income. The Average Treatment Effect on the Treated (ATT) indicates an income gain of ZAR2,757 ($p<0.01$), while the Average Treatment Effect on the Untreated (ATU) suggests potential gains of ZAR1,765 ($p<0.01$) if non-adopters were to adopt. The study recommends targeted interventions, including expanded extension services, adult education programs, and gender-sensitive strategies to empower female-headed households. Strengthening rural

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electrification and promoting affordable, energy-efficient technologies are also crucial for enhancing energy security and improving productivity in rural farming systems.

Keywords: Energy-Efficient Technologies, Rural Electrification, Sustainable Farming Practices.

1. INTRODUCTION

In many developing countries, particularly in rural areas, poverty and food insecurity persist as significant challenges. Limited access to energy significantly impedes efforts to alleviate poverty, stimulate economic growth, and improve quality of life, particularly in agriculture (Doll & Pachauri, 2010). While electricity serves essential household functions, such as lighting and communication, its broader role in driving economic and agricultural development is profound. Access to electricity supports entrepreneurship, boosts productivity, and aligns with global development agendas such as the United Nations' Sustainable Development Goals (SDGs) (United Nations, 2015).

Agricultural production contributes directly to SDG 1 (No Poverty) and SDG 2 (Zero Hunger). Electricity access enhances food preservation, crop processing, and access to educational and health services. Lack of refrigeration, for instance, leads to spoilage of perishable goods, worsening food insecurity (Arthur, 2009). Therefore, rural electrification is crucial for enhancing agricultural productivity and overall livelihoods. Despite infrastructure development, the adoption of electrical appliances in farming households, especially in the Eastern Cape Province, remains limited. Socioeconomic disparities and behavioural constraints often hinder adoption. Understanding these influences is essential for guiding policies that promote sustainable technology use.

Adopting electrical appliances can significantly enhance agricultural productivity (Kageni, 2015; Melesse, 2015; Mekonnen, 2017). However, household decisions to adopt technology are shaped by income levels, education, access to finance, and attitudes toward innovation. Higher incomes and educational attainment typically increase the likelihood of adoption (Peters & Sievert, 2016), while financial constraints and cultural resistance can deter investment in new technologies (Mandipaza, 2022). Tailored interventions are necessary to bridge these gaps and foster inclusive rural development (Sharma & Singh, 2015; Obayelu, 2017).

Socioeconomic variables, such as income, education, and access to credit, significantly affect households' willingness and ability to invest in technology (Nkhoma, Mwale, & Ngonda, 2024). Lower-income households often lack the financial flexibility to purchase appliances, but targeted microloans, subsidies, or financial literacy programs can improve accessibility (Shi & Qamruzzaman, 2022). Bridging these disparities can support the equitable diffusion of technology.

Behavioural dimensions also shape technology adoption. Positive attitudes toward innovation increase the uptake of innovation (Akroush *et al*., 2019; Blimpo & Cosgrove-Davies, 2019). Households that recognise the utility of electrical appliances in boosting efficiency and yields are more likely to invest (Ali, Shafiq, & Andejany, 2021). Conversely, cultural norms and fear of financial risk can impede progress (Mandipaza, 2022). Community outreach, peer testimonials, and tailored education programs can counter misconceptions and resistance. External factors, including electricity reliability and market access, further influence adoption (Odhiambo, 2015; Mudi, 2020). Without a stable energy infrastructure, households cannot utilise appliances effectively. Additionally, geographic distance from suppliers or service providers adds logistical barriers. Financial incentives, policy support, and infrastructural investment are crucial for creating an enabling environment for adoption (Pothitou, Hanna, & Chalvatzis, 2017).

1.1. Problem Statement

Despite significant rural electrification efforts in South Africa, the adoption of electrical appliances among farming households in the Eastern Cape remains uneven. A complex mix of socioeconomic, behavioural, and infrastructural barriers influences this disparity. Addressing these issues is critical to unlocking the full benefits of electricity in improving agricultural productivity and rural livelihoods. This study aims to identify these key influencing factors and assess the impact of appliance adoption on household agricultural income using an Endogeneity Switching Regression approach.

2. MATERIAL AND METHODS

2.1. Description of the Study Area

This study was conducted in Mnquma Local Municipality (MLM), located in the Eastern Cape Province of South Africa at 32° 19′ 0″ S and 28° 8′ 0″ E. MLM is part of the Amathole District

Municipality and falls within the former Transkei region, an area historically marked by high poverty levels, underdeveloped infrastructure, and heavy reliance on small-scale agriculture. The municipality has a dual economy, where urban centres, such as Butterworth, Centane, and Ngqamakhwe, have better infrastructure, while rural villages face challenges related to limited market access, poor service delivery, and energy insecurity.

According to Stats SA (2021), Mnquma has an estimated population of 252,390 people, residing in 69,732 households, spread across an area of 3,328 km². Many households in rural Mnquma depend on subsistence farming and small-scale agricultural activities as their primary source of income. However, access to modern farming technologies, including electrified equipment, remains limited due to socioeconomic disparities and infrastructure challenges. Access to electricity plays a crucial role in enhancing productivity, reducing labour intensity, and improving household well-being, making it an essential factor in rural development.

The Integrated National Electrification Programme (INEP) has expanded electricity access in rural South Africa, yet many areas still face energy insecurity and unreliable service delivery.

FIGURE 3.1: Map of the Study Area

2.2. Research Design and Unit of Analysis

This study employed a quantitative cross-sectional research design, collecting data at a single point in time to analyse various demographic and socioeconomic factors influencing the

adoption of electrical appliances following rural electrification. Data was gathered through questionnaires administered to selected households. Proper research planning was crucial for selecting appropriate variables, determining the types of data required, and establishing realistic means of data collection and interpretation (Leedy & Ormrod, 2010).

The unit of analysis, defined as the person or object from whom data is collected (Bless *et al*., 2016), comprised rural agricultural households from three electrification stages in three purposively selected villages. The household representative in Mnquma Local Municipality was surveyed on behalf of all household members, with a focus on those who shared the same electricity budget. This approach minimised costs and time by questioning only one member per household rather than every member.

2.3. Sampling Procedure

The sampling procedure involved selecting a representative subset of the population that accurately reflects the characteristics of the entire population. To assess the impact of electrification on household agricultural income and the adoption of electrical appliances, this study focused on three villages at different stages of electrification within the Mnquma area.

Mgomanzi (electrified village): Households in this village have had access to electricity for an extended period, allowing for the sustained adoption of appliances. Qobo-qobo (recently electrified village): Households here gained access to electricity only recently, providing an opportunity to examine early adoption trends. Qina (non-electrified village): Households in this village still rely on alternative energy sources such as firewood, paraffin, and solar power, making it a useful comparison group for understanding barriers to appliance adoption. These villages were selected to represent different stages of electrification and appliance adoption, allowing for a comparative analysis of how access to electricity, agricultural income, and socioeconomic factors influence technology adoption. Out of the total 854 households in these villages (Stats SA, 2011), 313 households were electrified, 260 were recently electrified, and 281 remained non-electrified.

A sample of the study was determined using Yamane's formula, ensuring a 95% confidence level. The total population of households across these three villages was 854, according to the 2011 census data. To achieve the desired sample size, simple random sampling was employed. This technique ensured that each household had an equal chance of being included in the study,

thereby minimising selection bias. The sampling frame was provided by the local authorities, who supplied lists of households for each village (Bless *et al*., 2016). The application of Yamane's formula is as follows (1967):

$$n= \frac{N}{1+Ne^2}$$

Where n = sample size; N = number of households, 854 (total number of households of the three selected villages obtained from the census 2011) and e = degree of precision (95%)

$$=\frac{N}{1+Ne^2}$$

$$= \frac{854}{1+854\times0.05^2}$$

n=272

This calculated sample size of 272 households provided a robust basis for the study, ensuring that the findings would be generalisable to the broader population of the three villages. However, due to the limited number of farmers, the study was able to conduct a survey on 224 farming households, which was also significant enough to draw conclusions that represented the entire population.

2.4. Data Collection

The study utilised a structured questionnaire as the primary data collection tool to ensure the systematic gathering of relevant information from respondents. Face-to-face survey interviews were conducted to improve response accuracy by allowing interviewers to clarify questions, probe for details, and address any misunderstandings. This method was particularly beneficial in rural settings where literacy levels may vary, ensuring that all respondents fully understood the questions before answering (Leedy & Ormrod, 2010). The survey targeted household heads, as they are typically responsible for decision-making regarding agricultural activities, income allocation, and the adoption of technology. However, in cases where the household head was unavailable, a close relative or next of kin was interviewed to maintain data consistency. This approach helped minimise information gaps while ensuring that responses accurately reflected the household's circumstances. The questionnaire incorporated both closed-ended and open-ended questions to provide a balanced approach to data collection. Closed-ended questions facilitated easy quantification and comparison of responses, while open-ended questions

allowed respondents to elaborate on specific issues, providing deeper insights into their experiences and perceptions of electrification and agricultural income.

The collected data focused on four key aspects: household demographics, electricity availability, adoption of electrical appliances, and the perceived benefits of electricity. Demographic data covered age, gender, education level, household size, income sources, and farming activities, providing a socioeconomic profile of respondents. Information on electricity availability helped classify households into three categories: electrified, recently electrified, and non-electrified. The section on electrical appliance adoption assessed the types of appliances owned, their usage patterns, and factors influencing adoption decisions. Lastly, the study examined the perceived benefits of electricity, specifically its role in enhancing agricultural productivity, generating income, and improving household well-being. By integrating both qualitative and quantitative elements, the questionnaire was designed to capture comprehensive data, aligning with the study's objective of examining the relationship between agricultural income, electrification, and the adoption of electrical appliances in Mnquma Local Municipality.

2.5. Data

This section presents data which was collected from smallholder farmers. Table 1 below illustrates the collected data from smallholder maize farmers.

TABLE 1: Data Collected from Maize Farmers

Variables	**Variable description**	**Expected sign**
Adoption outcome variables	**Outcome indicator**	
Binary adoption variable	Dummy = 1 for electricity appliance adopters, 0 otherwise	
Household characteristics		
Sex	Dummy =1, if a farmer is the male household head, 0 otherwise	+/-
Age	Age of the household head (years)	+

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Household monthly income	Total household monthly income (actual amount)	+
Farm size	The actual size of the farm (actual hectares)	+
Family size	Total family size (in adult-equivalent)	+/-
Years spent in school	Total number of years of schooling of the household head (years)	+/-
Asset ownership	The initial value of assets owned by the household	+/-
Off-farm employment	Dummy = 1 if the farmer participates in off-farm income-generating activities; 0 otherwise	+
Extension visits	Dummy = 1 if the farmer accessed the extension service; 0 otherwise	+/-
Access to credit	Dummy = 1 if the farmer accessed credit; 0 Otherwise	+
Member of farm organization	Dummy = 1 if the farmer is a member of a farm organization. 0 otherwise	+
Access to electricity appliances	Dummy = 1 if the farmer has access to electricity appliances in the village; 0 otherwise	+
Market access	Dummy = 1 if a village has access to the primary market	+

3. DATA ANALYSIS

Data analysis is a crucial component of this study, enabling the examination of patterns, testing of hypotheses, and drawing of inferences from the sample to the broader population (Bless *et al*., 2016). This study utilised three key methods: descriptive statistics, binary logistic regression (BLR), and endogeneity switching regression (ESR). Each of these methods was chosen based on the nature of the research questions and the data, with justifications for their use provided below.

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3.1. Descriptive Statistics

Descriptive statistics were employed to summarise key household characteristics, electrification status, and appliance adoption rates. This involved calculating frequencies, percentages, means, and standard deviations to represent the demographic and household data. The data were presented using graphs and tables for clarity and easy interpretation. SPSS version 24 was used for the descriptive analysis. Descriptive statistics are helpful in presenting an overview of the data, particularly when working with large datasets of household data. They help to identify patterns and trends, such as the distribution of electrification status and appliance adoption. Studies such as Matinga and Annegarn (2013), which focused on the adoption of modern energy sources in South Africa, and Tucho and Nonhebel (2017), who analysed energy consumption patterns in rural Ethiopia, have also employed descriptive statistics in similar contexts. These studies demonstrate the utility of descriptive methods in exploring energy access and adoption patterns in rural areas.

3.2. Binary Logistic Regression Model

3.2.1. Model Specification

Binary choice models, such as the logit or probit models, are appropriate for analysing models with binary response-dependent variables. These models assume both deterministic utility and probabilistic decision processes (Mdoda *et al*., 2022; Greene, 2012) and are commonly used in adoption decision studies involving binary choices. The study employed a binary logistic regression model, which was found to perform better than the multinomial logit model (Nontu & Taruvinga, 2021; Mdoda *et al*., 2019), to analyse factors influencing household adoption of new electrical appliances based on electricity availability.

Binary logistic regression analyses data and explains the relationship between a binary dependent variable and one or more independent variables at the nominal, ordinal, interval, or ratio level. The dependent variable, energy security status, was coded as 1 if the household was energy-secured and 0 otherwise. The logistic model is expressed as:

According to Greene (2012), the logistic model takes the form:

$$\log(P_i\ /(1 - P_i)\ = logP_i = \beta_0 + \beta_1 X_1 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (1)$$

Where P_i is the probability of energy security and X_1 is a predictor variable. Therefore, the parameter β_0 gives the coefficient Exp (β) of the dependent variable.

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The probability of the occurrence of an event relative to non-occurrence is called the odds ratio and given by the following equation:

$P_i \; /(1 - P_i) \; = \exp(\beta_0 + \beta_1 X_1) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$

Or in terms of probability outcomes

$P_i = \exp(\beta_0 + \beta_1 X_1)/(1 + exp(\beta_0 + \beta_1 X_1)) \ldots\ldots\ldots\ldots\ldots\ldots (3)$

The model is set as follows

$P_I = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots. B_n + \mu_i \ldots\ldots\ldots\ldots\ldots\ldots (4)$

Where: β_0=intercept term; U_i = Error or disturbance term

The model was used to estimate the relationship between socioeconomic characteristics and household agricultural income on energy security among selected agricultural households. The explanatory variables included gender, age, marital status, household size, occupation, total household monthly income, and agricultural income. The dependent variable, energy security status, was determined by assigning a value of 1 for energy-secured households and 0 for energy-insecure households. This model helped estimate the influence of these factors on energy security and the adoption of electrical appliances in rural farming households.

3.3. Endogeneity Switching Regression (ESR)

Endogeneity Switching Regression (ESR) was applied to measure the causal impact of appliance adoption on agricultural income, addressing concerns of selection bias and endogeneity that can arise when individuals self-select into adoption. ESR is particularly useful when treatment (appliance adoption) is not random, and when both the decision to adopt and unobserved factors might influence the outcome (agricultural income). The ESR model is a two-stage process. In the first stage, a selection equation is estimated using a probit model to predict the likelihood of appliance adoption. The second stage, the outcome equation, uses instrumental variables to correct for any endogeneity and measures the impact of adoption on agricultural income. The model can be written as:

Adoption Equation: PR (Adopt=1|X) = Φ ($y_0 + y_1 X_1 + y_1 X_1 + \cdots + y_n X_n$

Where:

- Φ is the cumulative distribution function of the normal distribution,
- $X_1, X_2, \ldots\ldots, X_n$ are the explanatory variables,

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- y_0, y_1,……., y_n are the coefficients.

In the second stage, the outcome equation assesses the impact of appliance adoption on agricultural income:

Income Equation: $Y_i = \alpha_0 + \alpha_1 Adopt_i + \alpha_2 Z_i + \epsilon_i$

Where:

- Y_i is the agricultural income for household iii,
- $Adopt_i$ is the adoption status of appliance iii (from the first stage),
- Z_i represents control variables (e.g., household size, education),
- ϵ_i is the error term.

ESR corrects for endogeneity by considering the simultaneous relationship between appliance adoption and agricultural income, ensuring unbiased estimates. Studies such as Di Falco *et al*. (2011), who used ESR to assess the impact of climate change adaptation on farm productivity, and Mekonnen *et al*. (2021), who applied ESR to evaluate the impact of improved cooking stoves on household welfare, illustrate the model's effectiveness in evaluating the causal impact of adoption decisions in agriculture and rural settings.

The Endogeneity Switching Regression (ESR) model was selected for this study due to its suitability in addressing the complex relationship between appliance adoption and agricultural income, particularly in the presence of selection bias and potential endogeneity. In this context, the decision to adopt electrical appliances is not random; rather, it is likely influenced by both observed and unobserved characteristics of the household. These factors may include income levels, education, and household composition, as well as latent traits such as risk preferences, time preferences, or exposure to information—variables that cannot always be directly measured but may influence both the likelihood of adoption and agricultural income outcomes.

Traditional estimation techniques, such as Ordinary Least Squares (OLS) or Propensity Score Matching (PSM), may fail to provide unbiased estimates under these circumstances. OLS assumes exogeneity and homogeneity, whereas PSM can only control for observable covariates and does not correct for selection bias due to unobservable variables. In contrast, ESR allows for a more rigorous approach by jointly modelling the selection into adoption and the outcome (agricultural income), explicitly accounting for the possibility that the two processes are correlated through unobserved factors.

The ESR model operates in two stages. The first stage involves estimating a selection equation using a probit model to determine the probability that a household adopts electrical appliances. This step helps to isolate the factors influencing the adoption decision. The second stage consists of estimating separate income equations for adopters and non-adopters, thereby allowing the analysis to capture heterogeneity in outcomes based on adoption status. The ESR model corrects for endogeneity by incorporating the correlation between the error terms of the selection and outcome equations, ensuring that the estimated impact of adoption on income is not biased by self-selection.

This modelling framework has been widely applied in agricultural and rural development studies where treatment assignment is non-random. For example, Di Falco *et al*. (2011) employed ESR to evaluate the impact of climate change adaptation strategies on agricultural productivity, while Mekonnen *et al*. (2021) used the model to assess the welfare effects of adopting improved cooking technologies. Following this tradition, the application of ESR in this study is both methodologically sound and contextually appropriate, as it enables a credible estimation of the causal effect of adopting electrical appliances on agricultural income in rural settings.

4. RESULTS AND DISCUSSION

4.1. Socio-Demographic Characteristics of Smallholder Farmers

Table 2 outlines key differences between adopters and non-adopters of electrical appliances. Electrified households were more often female-headed (64% vs. 52%) and married (52% vs. 48%), suggesting that access to electricity supports proactive, stable household structures. Though access to credit was limited across both groups, electrified households tended to have larger families (5 members), larger farms (2 hectares), and were located closer to markets (average distance of 20.16 km), facilitating adoption and maintenance of technologies (Mdoda *et al*., 2023; Makamane *et al*., 2023).

Education and income levels were notably higher among electrified households, with an average of 13 years of schooling and a monthly income of ZAR 6,234.14. These factors enhance the ability to invest in and manage new technologies. Although the average age across households was 54 years, older farmers tended to adopt less due to risk aversion (Mdoda *et al*., 2024). Non-electrified households, meanwhile, relied more heavily on social grants and

agriculture (58%), indicating traditional income sources that may limit their ability to adopt technological change (Qange *et al*., 2024; Nontu *et al*., 2024).

TABLE 2: Demographic Characteristics Between New Technology Adopters and Non-Adopters of Farming Rural Households

Variables	**Electrified**	**Non-electrified**	**Overall**	**T-test**
Gender: Female	0.64	0.52	0.58	0.015**
Access to credit: No	0.28	0.26	0.27	0.008***
Marital status: Married	0.52	0.48	0.50	0.14**
Occupation: pensioner and farmer	0.34	0.44	0.39	1.234
Source of income: social security and agricultural activities	0.54	0.58	0.56	0.003***
Access to information: Yes	0.52	0.37	0.45	0.024**
Cooperative membership	0.44	0.28	0.36	0.009***
Variable	**Electrified**	**Non-electrified**	**Overall**	**Chi-squared**
Age	52.3	56.4	54.4	0.004***
Family size	5.3	3.9	4.6	0.015**
Farm size	2.4	1.9	2.2	0.000***
Years spent in school	13.4	9.4	11.4	0.028**
Household monthly income	6 234.14	4 689.58	5 461.86	0.045**
Distance to markets	20.16	34.26	27.21	0.018**

Note: ** $p < 0.05$ and *** $p < 0.01$ represent the significant levels, respectively.

4.2. Energy Security Status Dimension for Farming Rural Households

Figure 2 below illustrates the energy security status in the farming households. The findings from the figure indicate a significant disparity in energy security among the surveyed households. Specifically, 68% of these rural farming households are classified as energy-secure, while 32% are deemed energy-insecure. This distribution highlights that most

households rely on reliable energy access, which is essential for sustaining their agricultural activities and maintaining their daily living standards. Sixty-eight percent of households categorised as energy secure are positioned to leverage stable energy sources effectively. This access is likely to enhance their agricultural productivity and overall quality of life by enabling the use of modern farming tools, improving operational efficiency, and supporting various household needs.

In contrast, 32% of households identified as energy insecure face significant challenges related to energy access. These challenges may hinder their agricultural productivity, limit their use of modern technologies, and adversely affect their overall well-being. The gap between energy-secure and insecure households highlights a critical area for targeted intervention.

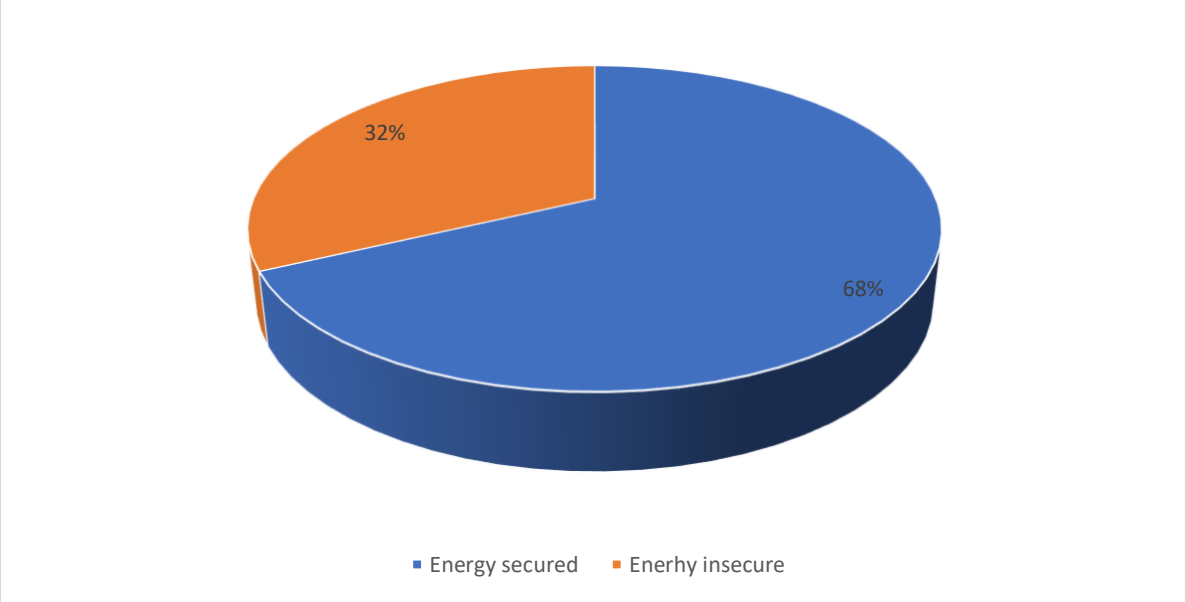

FIGURE 2: **Energy Security Status Dimension for Farming Rural Households**

4.3. Total Household Energy Expenditure of the Farming Households

Table 3 compares energy expenditure across sources for electrified and non-electrified households, categorised into four brackets (0–100, 101–200, 201–300, and >300 units). Among electrified households, 51% spend between 101 and 200 units on electricity, with 23% spending over 300 units, indicating both widespread use and potential financial strain for some. Non-electrified households exhibit high spending on gas, with 34% falling within the 101–200 units range and 21% exceeding 300 units, reflecting their dependence on gas for cooking and heating. Paraffin use is also prevalent: 59% spend 0–100 units and 36% spend 101–200 units, underlining its role as a key energy source. Candle usage, with 34% spending 0–100 units,

highlights the lack of reliable lighting. Some non-electrified households also rely on firewood, with 23% spending between 201 and 300 units. Other sources primarily fall within the lower expenditure brackets, offering varied but limited alternatives. Overall, energy spending patterns reveal the cost burden and inefficiencies faced by households without electricity. These findings emphasise the need for targeted electrification and affordable energy solutions to reduce dependency on less efficient and more costly sources.

TABLE 3: Total Household Energy Expenditure on Energy Sources for Farming Rural Households

	Electrified				**Not-electrified**			
Source	**0-100**	**101-200**	**201-300**	**>300**	**0-100**	**101-200**	**201-300**	>300
Electricity	13	51	13	23	0	0	0	0
Gas	0	5	1	6	0	34	10	21
Paraffin	29	0	0	0	59	36	1	0
Candles	31	0	0	0	34	0	0	0
Firewood	0	0	0	0	0	0	23	3
Other energies	0	0	0	0	17	20	1	0

4.4. Benefits of Electricity with Electric Appliances on Farming Rural Households

Figure 3 below shows the various benefits of electricity and electrical appliances for rural farming households in Mnquma Local Municipality. The most cited benefit is enhanced knowledge, with 90% of respondents reporting improved access to educational resources. This is followed by increased farm productivity (86%), as electricity enables the use of advanced equipment and technology, leading to higher yields and improved agricultural practices.

Improved operational efficiency is recognised by 80% of households, while 78% noted income diversification through new business opportunities. Enhanced food storage, cited by 76%, reduces post-harvest losses and boosts food security. Additionally, 74% of respondents acknowledged an improved quality of life due to better lighting, hygiene, and modern conveniences. Environmental and financial benefits, although slightly less emphasised (74% and 70%, respectively), remain notable, reflecting a reduced reliance on unsustainable energy sources and potential cost savings. While immediate gains, such as productivity and efficiency,

are prioritised, the findings suggest that increased awareness of long-term benefits could further promote adoption.

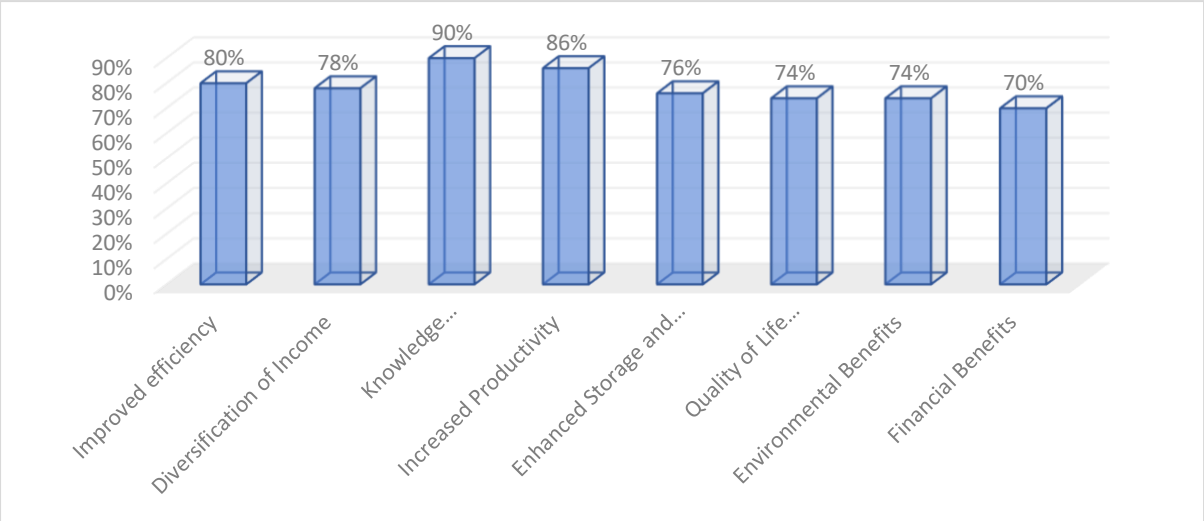

FIGURE 3: **Benefits of Electricity with Electric Appliances on Farming Rural Households**

4.5. Contribution of Electricity to Electricity Appliances on the Socioeconomic Status of Farming Households

Figure 4 illustrates the socioeconomic benefits of electricity and appliance use among farming households. The findings reveal varied impacts, with security and safety being the most recognised, cited by 40% of respondents. Electricity improves household safety, likely through better lighting and the use of security systems. Farming-related benefits were acknowledged by 32%, reflecting the role of electricity in enhancing productivity through improved tools and infrastructure. Business benefits were noted by 18%, highlighting electricity's support for entrepreneurship and small-scale economic ventures.

Only 10% of respondents identified environmental benefits, indicating limited awareness of electricity's role in reducing reliance on unsustainable energy sources. While immediate socioeconomic benefits are widely recognised, environmental impacts are often underappreciated. Overall, the data highlight the transformative impact of electricity on rural development. However, there is a clear need to enhance communication and awareness about its broader environmental advantages. The study affirms electricity's multifaceted contributions to socioeconomic well-being and highlights the need for targeted outreach to amplify less visible benefits such as environmental sustainability.

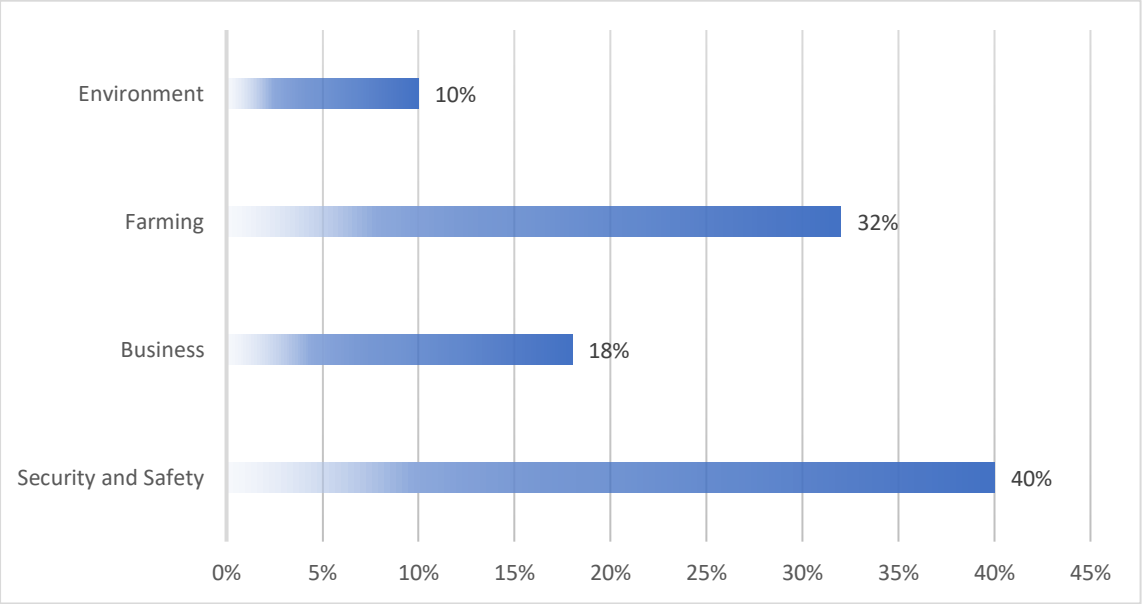

FIGURE 4: **The Additional Impact Electricity Has on Socioeconomic Factors**

Figure 4 highlights electricity's socioeconomic benefits in farming households. Security and safety were cited by 40% of respondents, emphasising the importance of improved household protection through enhanced lighting and security systems. Farming-related benefits (32%) reflect electricity's role in enhancing agricultural practices with better tools and infrastructure. Business impacts (18%) show their support for small enterprises and income generation. Only 10% recognised environmental benefits, indicating a gap in awareness about electricity's role in reducing reliance on unsustainable energy sources. Overall, electricity is valued for its safety, productivity, and contribution to livelihoods, but greater awareness is needed regarding its environmental impact.

4.6. Factors Influencing the Adoption of New Technology (Electricity Appliances) in the Rural Farming Household

Table 4 below shows the results from the model. The model used in the study employs logit regression to evaluate factors influencing the adoption of new technology (electric appliances) in rural farming households. The study results demonstrate a strong performance across key metrics. The chi-squared statistic of 30.2 with 16 degrees of freedom indicates that the model is significantly more effective at predicting the adoption outcome compared to a model with no predictors. The highly significant p-value (Prob > chi2 = 0.000) underscores that the predictors included in the model collectively have a statistically significant impact on

technology adoption. Additionally, the log-likelihood value of -154.76312 reflects substantial improvement over the null model, indicating a better fit of the model to the observed data. Most notably, the Pseudo R^2 of 0.683 suggests that approximately 68.3% of the variation in technology adoption is explained by the model's predictors, reflecting a strong explanatory power and a good fit. Collectively, these metrics confirm that the logit regression model is robust and effectively captures the factors influencing the adoption of electric appliances in rural farming households. The model's fit is supported by strong statistical evidence, highlighting the relevance and impact of the predictors included in the analysis.

TABLE 4: Factors Influencing the Adoption of New Technology (Electricity Appliances) in the Rural Farming Household

Variable	**Coef**	**Std. Err**	**P>z**	**Marginal effect**
Age	-1.986	0.182	0.006***	0.020
Years spent in school	0.547	0.253	0.018**	0.045
Occupation	1.684	0.208	0.006***	0.036
Access to extension services	0.628	0.207	0.028**	0.021
Family size	-0.749	0.351	0.012**	0.038
Off-farm activities	0.835	0.361	0.047**	0.051
Distance to market input/output	0.985	0.248	0.006***	0.055
Con_	1.191	0.543	0,016**	1.976
Observation: 320	Chi^2 (16) = 30.2, Prob > chi^2 = 0.000	Log-likelihood = -154.76312	Pesudo R^2 = 0.683	

Note: **Significant at 5% significance level; ***Significant at one percent significance level.

The logit regression results offer critical insights into the determinants of electric appliance adoption. Age showed a significant negative effect, with a 1% increase in age reducing the likelihood of adoption by 2%. Older farmers tend to adopt less due to risk aversion or limited exposure to technology. Years of schooling positively influenced adoption. Each additional year in school raised the likelihood of adopting appliances by 4.5%. Education improves

understanding, operation, and maintenance of new technologies (Peters & Sievert, 2016). Occupation showed a positive and significant impact. Households with employment beyond farming were 3.6% more likely to adopt. Additional income and exposure through diverse jobs enhance the capacity to invest in innovation. Access to extension services also positively affected adoption. A one-day extension visit raised the likelihood of adoption by 2.1%. These services provide vital training and information (Mdoda *et al*., 2022). Family size negatively influenced adoption. A larger household reduced the probability of adoption by 3.8%, possibly due to increased resource pressure and complexity in managing new systems.

Off-farm activities significantly encouraged adoption. Households with supplementary income sources were 5.1% more likely to adopt technologies. These activities improve financial stability and openness to innovation. Surprisingly, a greater distance to markets also had a positive influence on adoption. A one-kilometre increase in distance raised adoption probability by 5.5%. This suggests that remote households may adopt technology to compensate for logistical constraints.

4.7. The Impact of Adopted Electrical Appliances on Household Agricultural Income

The study employed endogeneity switching regression to estimate the impact of adopting electrical appliances on the household agricultural income of farmers in the study area. These results are presented in Table 5 below.

TABLE 5: Effect of Adopted Electrical Appliance on Household Agricultural Income

Outcomes	**Mean outcome**		**ATT (Adoption effect)**	**ATU (Treatment Effect on the Untreated)**	**t-value**
	Adopters Electrified	**Non-electrified**			
Household agricultural income	(a) 4.782 (0.053)	(a) 2.025(0.067)	2.757 (0.068)		41.72
	(b) 5.952 (0.072)	(b) 4.187 (0.061)		1. 765(0.138)	34.22

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Note: **p<0.05 and ***p<0.01; ATT and ATU refer to the average treatment effects of farming households with and without electricity appliances, respectively.

As the outcome variables in ESR outcome equations are the logs of household agricultural income, the results of the mean outcomes of both groups and the predictions of ATT and ATU are in log forms.

The results in Table 5 reveal a substantial positive impact of adopting electrical appliances on household agricultural income by farming households in the study area. The average agricultural income for households that have adopted electrical appliances is ZAR 4,782, compared to ZAR 2,025 for those without such appliances. The Average Treatment Effect on the Treated (ATT) is ZAR2 757, with a very high t-value of 41.72, indicating a robust and statistically significant increase in income due to adoption. This substantial effect underscores the significant financial benefit that adopting electrical appliances provides to current users. These results align with those of Jena and Tanti (2023), who suggest that adopting electricity appliances can increase agricultural returns by providing farmers with various opportunities. It indicates that the adoption of new technology (such as electricity appliances) indeed increases household farm operating income.

In contrast, the Average Treatment Effect on the Untreated (ATU) estimates the potential impact on households that have not yet adopted electrical appliances. If these non-adopters were to adopt, their average agricultural income would be ZAR 5,952, compared to ZAR 4,187 if they remained non-electrified. The ATU estimate of ZAR1 765, with a t-value of 34.22, is also significant but somewhat lower than the ATT. This suggests that while there is a considerable potential benefit for non-adopters, it is less pronounced compared to the actual benefits experienced by current adopters. The discrepancy could be attributed to factors such as the initial adoption costs or the varying effectiveness of the appliances across different contexts. The high t-values for ATT and ATU confirm the statistical significance of the results, indicating that electrical appliances contribute to boosting household agricultural income. The findings show income gains for both current and potential adopters, underscoring the value of adoption in enhancing agricultural productivity and earnings.

5. CONCLUSION AND RECOMMENDATIONS

The study's findings from both the logit regression and Endogeneity Switching Regression (ESR) analyses provide strong evidence on the factors influencing the adoption of electrical appliances and their positive impact on agricultural income. Socioeconomic variables such as age, education, occupation, family size, and access to extension services significantly affect adoption. Older households were less likely to adopt, while those with higher education, diverse occupations, and access to extension services were more likely to do so. ESR results showed that adopters earned higher agricultural income (ZAR 4,782) compared to non-adopters (ZAR 2,025). The Average Treatment Effect on the Treated (ATT) revealed a ZAR 2,757 income gain for adopters, while the Average Treatment Effect on the Untreated (ATU) showed that non-adopters could gain ZAR 1,765 if they adopted. These findings confirm the economic value of technology adoption in rural areas.

Recommendations include expanding education and training to build technological literacy, particularly for older farmers. Strengthening extension services through more frequent visits and practical demonstrations is essential. Financial mechanisms such as low-interest loans, subsidies, and support for off-farm income activities can empower rural households to adopt technology. Youth-focused agricultural policies, including training and mentorship programs, should be prioritised. Enhancing rural electrification and supporting community-based initiatives can alleviate individual financial burdens and foster widespread adoption. These combined efforts can enhance productivity, increase income, and improve the overall well-being of rural households.

6. ACKNOWLEDGEMENT

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Pricing Strategies Used by Vegetable Street Vendors in Mthatha and Mqanduli, Eastern Cape, South Africa

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ABSTRACT

Street vending is widely acknowledged as a vital component of the informal economy, providing income opportunities for rural households. Street vendors operate in highly competitive environments and are constantly seeking effective ways to attract and retain customers, including strategies for pricing their products. Therefore, the study's main objective was to analyse the pricing strategies employed by vegetable street vendors in two Eastern Cape towns of Mthatha and Mqanduli. Using a longitudinal research design and a quantitative approach, 54 vendors were surveyed on both grant payout and post-grant days. Data were collected through semi-structured questionnaires and analysed using descriptive statistics, Z-tests, t-tests, and chi-square tests. Results revealed that during grant days, vendors employed dynamic pricing (33%) and negotiation-based strategies (33%), capitalising on the heightened purchasing power of consumers. Post-Grant showed that the dynamic pricing strategy and

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negotiation were more utilised, and there was also a shift towards strategies like cost-plus (16.67%) and competitive pricing (13.3%). Significant price differences were found between the two towns, shaped by local market conditions, competition, and consumer behaviour. By understanding pricing dynamics, extension officers can better assist vendors in improving market access, income stability, and resilience against economic fluctuations.

Keywords: Pricing Strategies, Vegetables, Street Vendors, Social Grant, Payout Days.

1. INTRODUCTION

High unemployment rates, particularly in developing countries such as South Africa, have compelled many people to seek alternative sources of income, including street vending (Karunaratna & Tjandra, 2021). In this context, the role of street vending as a major part of an informal economy is well recognised (Chauke et al., 2015). Street vending is an income-generating activity in which individuals sell their items along streets and sidewalks to passing pedestrians and vehicles (Karunaratna & Tjandra, 2021). Such items can be clothing, newspapers, fruits, vegetables, and agricultural inputs (Hlengwa, 2016).

Street vendors set up temporary static structures or mobile stalls at city intersections, major streets, and pavements to offer a variety of goods and services (Biney, 2019). Street vending can include bakkie (pickup truck) vending, mobile push-cart vending, and basket vending, where vendors carry their produce on their heads as they move to various locations in search of potential customers (Chauke et al., 2015).

A bakkie vendor may purchase goods directly from farms or wholesale marketplaces and sell them to the public or other customers by the side of the road (Wegerif, 2023). Street vending is a significant aspect of the informal economy in South Africa, providing livelihoods for many families and contributing 6% to the Gross Domestic Product (GDP) (Stats SA, 2019; Gamieldien & van Niekerk, 2017).

Despite these hardships, street vendors demonstrate remarkable resilience and adaptability, making it a transformative occupation in terms of livelihood creation (Igudia, 2019). Street vendors are often found selling similar products to those sold by other vendors in the same vicinity, which increases competition. Despite this, every vendor has a way of attracting people

to buy their products (Boateng, 2019). Street vendors employ various pricing strategies to achieve profitable results in both the short and long term of their business activities.

A pricing strategy is an approach a business uses to decide how much to charge for its goods and services (Sammut-Bonnici & Channon, 2015). It is a crucial factor in financial modelling, which establishes the revenues generated, the profits earned, and the amount of money invested in business expansion to ensure its long-term viability (Sammut-Bonnici & Channon, 2015). Literature identifies five strategies, namely, competitive pricing strategy (Mwito, 2024), cost-plus pricing strategy (Aborampah, 2016), negotiation and haggling (Forkuor et al., 2017), bundle pricing (Boateng, 2019) and dynamic pricing strategy (Mwito, 2024).

The choice of these strategies differs according to industry, market conditions, the underlying available competitive advantage, buyer expectations and behaviour, in some cases, regulatory constraints (Forman & Hunt, 2005), and by the product and the street vendor in question.

However, there is very little knowledge about the specific pricing strategies used by vegetable street vendors in the Eastern Cape. Therefore, the main objective of this study was to identify and discuss the price strategies employed by vegetable street vendors in Mthatha and Mqanduli during grant days and post-grant days, with a focus on spinach and cabbage street vendors.

Why do the pricing strategies of street vendors matter to agricultural extension? Agricultural extension officers' role is to help farmers understand and solve their own problems (Aliber, 2019). In South Africa, public agricultural extension is primarily responsible for serving smallholder farmers, whose problems and challenges are diverse, ranging from productivity and control of pests and diseases to marketing their agricultural output (Zantsi et al., 2021; von Maltitz et al., 2023). Therefore, information about pricing strategies used by street vendors, who are in fact a more accessible market to smallholders, could enhance extension officers' ability to provide better advice to their clients, i.e., smallholder farmers.

2. METHODOLOGY

2.1. Description of the Study Area

The study was conducted in Mthatha (Fig. 1) and Mqanduli (Fig. 2). Mthatha is the capital of the OR Tambo District Municipality and a main town in the King Sabata Dalindyebo Municipality (KSDM); it has an area of 91.45 km² (McKenna, 2025). Mqanduli is a town in

the OR Tambo District Municipality, with an area of 9.88 square kilometres, and the majority of the area is predominantly Xhosa-speaking.

FIGURE 1: Map Showing the Town of Mthatha (Source: Own Compilation From ArcGIS)

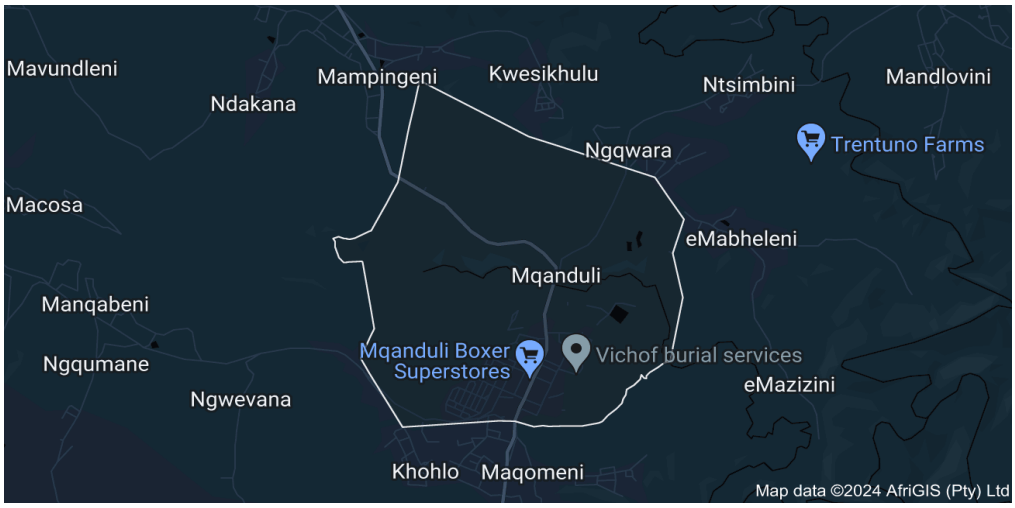

FIGURE 2: Map Showing the Town of Mqanduli (Source: Own Compilation From AgriGIS)

2.2. Conceptual Framework of the Study

The conceptual framework below illustrates the interconnected factors influencing how cabbage and spinach street vendors determine their produce prices. At the core of the framework is the pricing strategy, which encompasses various approaches, including

competitive pricing, cost-plus pricing, negotiation and haggling, bundle and discount pricing, and dynamic pricing. The choice of these strategies is shaped by key factors, including competition, market demand, and the cost of purchasing from the source (e.g., farmer, retailer). These influencing factors and strategies ultimately affect the final product price set by the vendors. The framework illustrates a feedback loop where street vendors are central actors, responding to market conditions and customer behaviour, and using pricing to sustain their income and remain competitive in informal markets.

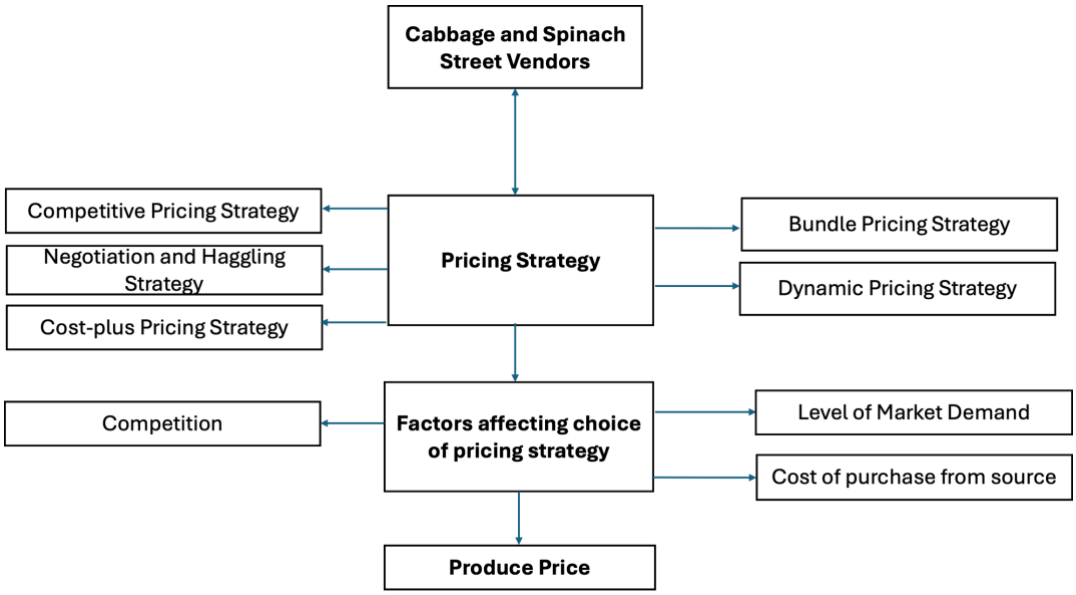

FIGURE 3: Conceptual Framework of the Study

2.3. Sampling and Data Collection

The study employed convenience and snowball sampling techniques to select vegetable street vendors in the towns of Mthatha and Mqanduli. Initially, convenience sampling was used to approach vendors who were easily accessible and willing to participate, such as those stationed near busy taxi ranks, shopping centres, and street corners. This method was suitable because street vendors often operate in high-pressure environments with constant foot traffic and high demand.

Rahayu et al. (2019) support this, noting that high foot traffic near transport hubs, such as taxi ranks, influences vendors' strategic location choices. In this study, grant days were identified as periods of peak demand, enabling the researcher to gather data quickly and efficiently from vendors. After the initial sample was secured, snowball sampling was used to identify

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additional participants who sold only cabbage and spinach, excluding those with broader product offerings. This was especially useful for reaching mobile or less visible vendors. Data were collected from 54 vegetable street vendors across Mqanduli and Mthatha.

Primary data were collected through questionnaires and interviews administered by the researcher and an enumerator. The questionnaires were semi-structured, combining closed-ended and open-ended questions (Cleave, 2023). Closed-ended questions gathered demographic data (e.g., gender), pricing strategies used on grant and post-grant days, the reasoning behind those strategies, and whether the vendors sourced or grew their produce. This format was particularly useful for vendors with varying literacy levels. Open-ended questions focused on variables such as household size, age, prices charged on different days, and the quantity of self-grown produce. Data were collected at two points, grant days and post-grant days, to detect variations in pricing strategies and price levels. Interviews were conducted in the natural settings of vendors: busy streets and taxi ranks.

2.4. Data Analysis

Data were analysed using Microsoft Excel and GNU Regression, Econometrics and Time-series Library (GRETL). A Z-test for different proportions was used to compare pricing strategies used on grant and post-grant days. At the same time, a Chi-square test was applied to determine whether there is a significant association or influence between different factors (e.g., competition) and the selection of pricing strategy, rather than assuming a direct cause-and-effect relationship. A t-test for different means was conducted to assess whether the average prices of cabbage and spinach differed significantly between grant and post-grant days. Descriptive statistics were used to analyse respondents' demographic information.

3. RESULTS AND DISCUSSION

This section presents the results and discussion of the study, based on its objectives. It provides an analysis of the pricing strategies employed by vegetable street vendors in Mthatha and Mqanduli. The findings examine whether vendors grow their own produce or source it from suppliers, as well as the factors that influence their pricing decisions. Additionally, the chapter examines price variations between old age grant payout days and non-grant days. The discussion interprets these findings.

3.1. Socio-Economic Characteristics of the Respondents

Based on the results collected from 13 vegetable street vendors interviewed in Mthatha on the grant day, 62% of the respondents were female, and 38% were male. Similarly, from 11 street vendors interviewed in Mqanduli on the same day, 64% were female, and 36% were male. Of the 18 vegetable street vendors interviewed in Mthatha on the post-grant days, 65% were female, and 35% were male. From 12 street vendors interviewed in Mqanduli on the post-grant day, 50% were female, and 50% were male.

TABLE 1: Age and Household Size of Respondents

Category	Variable	Max	Min	Mean
Mthatha Old Age Grant Day	Age	72	25	49
	Household size	10	4	7
Mthatha, post-grant day	Age	52	24	38
	Household size	8	1	5
Mqanduli Old Age Grant Day	Age	75	19	47
	Household size	9	2	6
Mqanduli, post-grant day	Age	64	24	46
	Household size	10	2	6

Table 1 presents the respondents' ages and household sizes. There were no major differences between our study areas. In Mthatha, on grant day, the average age of respondents was 49, living in a household with an average of seven persons. On the post-grant day, the average age of respondents was 38 years, living in a household of five persons. While in Mqanduli on grant day, the average age of respondents was 47 years, living in a household of six persons. Post-grant day, the average age of respondents was 44 years, living in a household of six persons.

3.2. Pricing Strategies used by Vegetable Street Vendors in Mthatha and Mqanduli.

The data in Table 2 uses a z-test for different proportions to analyse and compare various pricing strategies by vendors before and after a grant day in both towns, focusing on strategies

such as bundle pricing, competitive pricing, dynamic pricing, negotiation and haggling, and cost-plus pricing. Those who used the strategy will be classified as "yes," and those who did not will be classified as "no".

TABLE 2: Pricing Strategies used by street vendors in the Eastern Cape

		Bundle pricing	**Competitive**	**Dynamic**	**Negotiation & haggling**	**Cost-plus**
GRANT DAYs	Yes	0	4	8	8	5
	No	24	20	16	16	19
	Sum	**24**	**24**	**24**	**24**	**24**
		0,0%	16.7%	33.33%	33,33%	20.8%
POST GRANT DAYs	Yes	1	4	7	5	5
	No	29	26	23	25	25
	Sum	**30**	**30**	**30**	**30**	**30**
		3.3%	13.3%	23.3%	16.7%	16,7%
	z	-0.90	0.34	0.83	1.42	0.39
	P-value	0.37	0,73	0,41	0.15	0.70

Table 2 shows that during grant days, the most frequently employed strategies were dynamic pricing (33.33%) and negotiation and haggling (33.33%). Dynamic pricing, negotiation, and haggling are highly favoured on grant days, and this may be because vendors are responding to increased demand and higher customer purchasing power during grant payouts, allowing them to adjust prices or negotiate deals to maximise revenue. Scholz and Kulko (2022) assert that businesses employ this strategy to manage and improve their revenues, and that sellers adjust the price of a product in response to market changes or shifts in demand for the product. In the context of the study, the vendors used dynamic pricing to respond to the increase in demand for the produce resulting from the rise in purchasing power on grant days.

Followed by cost-plus pricing (20.8%) and competitive pricing (16.7%). No vendors used bundle pricing on grant days. On grant days, vendors may choose not to apply bundle pricing due to a shift in customer priorities, with many customers focused on securing specific,

essential products rather than being enticed by bundles that may include unwanted items. This behaviour reflects Diner's (2022) assertion that bundles can be a double-edged sword: while they can increase perceived value, they may also frustrate customers who feel compelled to purchase additional, unnecessary items just to obtain the one product they need.

Post-grant days, there was a slight shift in pricing strategies: bundle pricing increased slightly to 3.3%, while dynamic pricing dropped to 23.3%, and negotiation and haggling decreased to 16.7%. The slight increase in bundle pricing after the grant days may indicate an attempt by vendors to sell leftover produce in packages to incentivise purchases when consumer demand could have been lower (Balachander et al., 2010; Martins et al., 2021). Competitive pricing remained relatively stable, dropping slightly to 13.3%, while cost-plus pricing maintained its consistency at 16.7%. The decrease in these strategies after the grant days suggests that vendors return to more stable pricing as demand normalises.

The results from the test indicate that there were no statistically significant differences in the pricing strategies used by fresh produce street vendors between grant and non-grant days across the two towns, as the p-values are all over 0.05. Although slight changes were observed, such as a small increase in the use of competitive pricing and a decline in negotiation and haggling after grant days, none of these shifts were statistically meaningful. This suggests that the timing of grant payments has a limited influence on how vendors price their produce. The findings imply that vendors in both areas tend to maintain consistent pricing strategies regardless of when grant payments are made. This consistency may reflect entrenched pricing behaviours or a response to broader market factors, such as supply, demand, or customer preferences, that remain relatively stable over the grant cycle. For instance, vendors who use cost-plus pricing tend to adhere to this approach consistently, likely because it ensures they cover their costs.

3.3. Factors Affecting the Choice of Pricing Strategies among Vegetable Street Vendors

The objective of the study was to identify the factors influencing the choice of pricing strategies among vegetable street vendors in Mthatha and Mqanduli and to assess whether there is a significant association between the pricing strategies used on grant days and non-grant days. To achieve this, the study employed the Chi-square test for independence with cross-tabulation to evaluate the relationship between these variables. GNU Regression, Econometrics, and Time-series Library (Gretl) were used to assess these relationships and formulate the test. The

results are presented in two parts: Mthatha and Mqanduli on grant days, and Mthatha and Mqanduli post-grant days. This approach allows for a comparative analysis of the vendors' behaviour during these different periods.

3.3.1. Mthatha and Mqanduli on Grant Days

The cross-tabulation in Table 3 below provides an analysis of the relationship between the primary pricing strategy (rows) and the main factors (columns) used by vendors. The pricing strategies considered are competitive pricing, dynamic pricing, negotiation and haggling, and cost-plus pricing. Bundle pricing was not included because they were not used in both towns on grant days. The primary influencing factors are the level of market competition and the cost of purchase/production. The total number of respondents in Mthatha and Mqanduli on the grant day was 24.

TABLE 3: Chi-square Test for Independence with Cross-Tabulation, Mthatha and Mqanduli on Grant Days

Pricing strategy	Competition	Market Demand	Cost of Purchase/Produce	Total Vendors
Competitive pricing	100%	-	-	10
Dynamic pricing	18.2%	81.8	-	11
Negotiation and haggling	50%	50%		2
Cost Plus pricing	-	-	100%	1
				24

Pearson Chi-Square Test = 38.9287 (6 df, p-value = 7.39175e-007)

The results indicate that competitive pricing was the most widely adopted strategy, used by 10 vendors (41.7% of 24). Competitive pricing strategy was influenced by competition as the primary factor, as indicated by 100% of the 10 vendors. According to a study by Sethu (2023), a competitive pricing strategy is strongly linked to the presence of competition. This is because vendors operating in highly competitive environments tend to adopt competitive pricing to retain or attract customers (Mensah, 2016; Magadla, 2017; Dzvimbo & Monga, 2019).

Dynamic pricing was the second most common strategy, used by 11 vendors (45.8% of 24), with 81.8% or 9 of them basing market demand as an influence for the choice of the strategy, while 18.2% or two vendors considered competition as the main influencing factor for using the dynamic pricing strategy. This suggests that vendors using dynamic pricing adjust their prices in response to fluctuations in demand, but are also somewhat influenced by competition.

According to Wamsler et al. (2022), dynamic pricing is heavily influenced by demand variability, which is consistent with the 81.8% result in the table, suggesting that vendors respond primarily to demand shifts. A smaller proportion of two vendors used negotiation and haggling, with an equal split between competition (50%) and market demand (50%) as influencing factors. This reflects a balanced influence from both competition and market demand when it comes to vendors engaging in a negotiation-based pricing strategy.

Cost-Plus Pricing (5) is solely associated with the cost of purchase/production, with one vendor using this strategy, basing it entirely on their costs. The Pearson chi-square statistic is 38.93 with six degrees of freedom, and the associated p-value is 7.39e-07, which is extremely small (much less than the standard significance level of 0.05). Therefore, this suggests a highly significant association between the choice of pricing strategy and the influencing factors. These results are supported by Bennett (2023), who notes that multiple factors, including costs, customer demand, competitive pricing, and value perception, influence pricing strategies. Runting (2023) supports this view, asserting that pricing strategies can be based on a variety of factors, including costs, competition, demand, and customer behaviour.

3.3.2. Mthatha and Mqanduli Post Grant Days

The cross-tabulation in Table 4 presents an analysis of the main pricing strategies (rows) and main factors (columns) used by vendors in Mthatha and Mqanduli after the grant period. The total sample size is 30 respondents. The pricing strategies examined are bundle pricing (1), competitive pricing (2), dynamic pricing (3), negotiation and haggling (4), and cost-plus pricing (5). The influencing factors considered are competition (1), level of market demand (2), and cost of purchase/production (3).

TABLE 4: Chi-square Test for Independence with Cross-Tabulation, Mthatha and Mqanduli Post Grant days

Pricing strategy	Competition	Market Demand	Cost of Purchase/Production	Total Vendors
Bundle pricing	-	100%	-	1
Competitive pricing	91.7%	8.3%	-	12
Dynamic pricing	10%	90%	-	10
Negotiation and haggling	-	100	-	2
Cost Plus pricing	-	20%	80%	5
				30

The results reveal that one vendor (3.3% of 30) employed bundle pricing, and their decision was solely influenced by market demand (100%). Twelve vendors (40% of 30) adopted a competitive pricing strategy, with the majority (91.7%) considering competition as a major influence, while 8.3% were influenced by market demand. This suggests that vendors tend to align their pricing strategies with the most pressing external factors they face. Those in highly competitive environments are more likely to adjust prices in response to rival pricing, while those using bundle pricing respond directly to consumer buying behaviour. The finding that competitive pricing strategy is influenced by competition is consistent with a study conducted by Gerpott and Berends (2022), which examined competitive pricing in online markets. According to the study, competitive pricing is influenced by demand and competition, with demand increasingly shaped by the pricing strategies of competitors. As a result, competitor prices should not be overlooked when formulating pricing decisions.

A study conducted by Chodota et al. (2024), which looked at the influence of competitive pricing strategy on business performance, found that there is a significant relationship between competitive pricing strategy and market demand and an increase in the number of customers, which suggests that the pricing strategy has an impact on market demand.

Ten vendors (33.3% of 30) used a dynamic pricing strategy, with the majority (90%) basing their pricing on market demand, while only 10% considered competition. These results are

supported by a study by Chen et al. (2010), who investigated optimal pricing and replenishment decisions in an inventory system with price-sensitive demand, focusing on the benefits of the inventory-based dynamic pricing strategy. They found that demand variability impacts the benefit of dynamic pricing. Two vendors (6.7%) practised negotiation and haggling strategies, and both relied entirely on competition (100%). Five vendors (16.7%) used cost-plus pricing (Strategy 5), where 80% determined prices based on the cost of purchase/production, and 20% considered competition.

The p-value is extremely small ($p = 6.07e-07$), which is well below the common significance level of 0.05, indicating that the distribution of main factors is significantly different across the various main strategies. Vegetable street vendors do not choose their pricing strategies randomly; rather, their choices are strongly influenced by specific factors, such as competition and demand, meaning that different main strategies are closely associated with different key factors.

3.4. Prices Charged by Vegetable Street Vendors

This section presents a t-test for comparing different means (assuming unequal variances) to compare the prices charged by vegetable street vendors (Table 5). The analysis focuses on the prices of spinach and cabbage (both large and loose medium sizes) sold on Grant Day versus those sold post-Grant Day in Mthatha and Mqanduli.

The t-test, assuming unequal variances, compares the mean prices of cabbage between vendors in Mthatha and Mqanduli (Table 5). The average price for Mthatha cabbage vendors is R28.08, while for Mqanduli vendors, it is slightly higher at R30.00. The price variance in Mthatha (39.74) is larger than in Mqanduli (13.64), indicating that prices fluctuate more among Mthatha vendors compared to Mqanduli. The t-statistic is -0.939, and the corresponding p-value for the one-tailed test is 0.179, which is above the conventional 0.05 significance level, indicating that the difference in means is not statistically significant. Similarly, the p-value for the two-tailed test is 0.359. The calculated t-statistic is lower than both the one-tailed critical value (1.725) and the two-tailed critical value (2.086), supporting the conclusion that there is no significant difference in cabbage prices between the two towns.

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TABLE 5: Combined T-Test Summary for Prices of Cabbage and Spinach for Grant Day(s)

Statistics	**Mthatha Cabbage**	**Mqanduli Cabbage**	**Mthatha Spinach**	**Mqanduli Spinach**
Mean	R28.08	R30.00	R17.00	R24.00
Variance	39.74	13.64	7.50	17.50
Observations	13	12	5	5
Hypothesized Mean Difference	0	0	0	0
Degrees of Freedom (df)	20		7	
t Stat	-0.9391		-3.1305	
P(T<=t) one-tail	0.1794		0.0083	
t Critical one-tailed	1.7247		1.8946	
P(T<=t) two-tail	0.3589		0.0166	
t Critical two-tailed	2.0860		2.3646	

The t-test, assuming unequal variances, compares the prices of spinach between vendors in Mthatha and Mqanduli. The mean price for spinach in Mthatha is R17, while in Mqanduli, it is R24, indicating that Mqanduli vendors charge significantly more for spinach on average. The variances are 7.5 for Mthatha and 17.5 for Mqanduli, showing more price variability among Mqanduli vendors.

The t-statistic is -3.13, and the corresponding p-value for the one-tailed test is 0.0083, which is well below the conventional 0.05 significance level. This means that the difference in spinach prices between the two towns is statistically significant. The two-tailed p-value of 0.0166 further confirms this significance. Both the one-tailed (1.895) and two-tailed (2.365) critical t-values are exceeded by the calculated t-statistic, indicating strong evidence to conclude there is a difference in prices. Thus, the results suggest that Mqanduli vendors charge significantly higher prices for spinach than those in Mthatha. This statistically significant difference suggests that the market dynamics between the two towns differ, likely due to factors such as demand, supply, or competition.

TABLE 6: Combined T-Test Summary for Prices of Cabbage and Spinach for Post Grant Day(s)

Statistics	Mthatha Cabbage	Mqanduli Cabbage	Mthatha Spinach	Mqanduli Spinach
Mean	R27.65	R30.00	R16.4	R21.00
Variance	15.99	13.64	48	3
Observations	17	12	5	3
Hypothesised Mean Difference	0	0	0	
Degrees of Freedom (df)	22		5	
t Stat	-2.9777		-3.2857	
P(T<=t) one-tail	0.0029		0.0109	
t Critical one-tailed	1.6991		1.8946	
P(T<=t) two-tail	0.0058		0.0218	
t Critical two-tailed	2.0452		2.2706	

The t-test, assuming unequal variances, compares the mean prices of cabbage between vendors in Mthatha and Mqanduli (see Table 6). The mean price for cabbage in Mthatha is R27.65, while in Mqanduli, it is higher at R31.79. This indicates that, on average, cabbage prices in Mqanduli are significantly higher than in Mthatha. The price variance is similar, with 15.99 for Mthatha and 13.87 for Mqanduli, showing that both towns have a comparable spread in cabbage prices.

The t-statistic is -2.98, indicating a statistically significant difference in the means. The p-value for the one-tailed test is 0.0029, and for the two-tailed test, it is 0.0058—both of which are well below the conventional 0.05 significance level. This indicates that the difference in cabbage prices between the two towns is statistically significant. The calculated t-statistic exceeds both the one-tailed critical value of 1.699 and the two-tailed critical value of 2.045, providing strong evidence to conclude that there is a notable difference.

The t-test, assuming unequal variances, compares the mean prices of spinach between vendors in Mthatha and Mqanduli (Table 6). The mean price for spinach in Mthatha is R16.40, while in Mqanduli, it is significantly higher at R21. The variance in prices is 4.8 for Mthatha and 3 for Mqanduli, indicating that price variability is slightly higher in Mthatha than in Mqanduli. The

t-statistic is -3.29, indicating a notable difference between the mean prices of spinach in the two locations.

The p-value for the one-tailed test is 0.0109, which is below the conventional 0.05 significance level, indicating that the difference in spinach prices is statistically significant. The two-tailed p-value of 0.0218 further confirms the significance of the result. The calculated t-statistic also exceeds both the one-tailed critical value of 2.015 and the two-tailed critical value of 2.571, providing strong evidence to show a statistically significant difference in spinach prices between Mthatha and Mqanduli, with Mqanduli vendors charging higher prices on average.

The study observes a trend indicating that street vendors in Mqanduli charge higher prices for cabbage and spinach on grant days and post-grant days compared to their counterparts in Mthatha. Mqanduli, being a smaller and more rural town (KSDM, 2022), has fewer vendors and limited access to alternative retail outlets, which reduces competition and grants vendors greater pricing power.

In contrast, Mthatha has a larger urban centre and a more competitive informal market, with a higher concentration of vendors, supermarkets, and fresh produce outlets (KSDM, 2020), which may constrain vendors from significantly increasing prices.

3.5. Analysis of Produce Sourcing: Self-Production and External Suppliers Among Street Vendors

Tables 7 and 8 below provide an analysis of the number of vendors selling a particular produce and sources from which vegetable street vendors in Mqanduli and Mthatha obtained their produce during the old age grant day and post-grant days, respectively. The sources are farmers 'buy it from farmers”, self-production "I grow it” and external sources "other". The data is categorised based on the type of produce sold on a particular day, representing the total number of vendors selling each type of produce.

The study reveals that out of the 8 vegetable street vendors selling only cabbage in Mthatha on Grant Day, four vendors noted that they bought cabbage from farmers, 3 sourced it from other suppliers, while only 1 vendor grew their own cabbage. Similarly, for spinach vendors, out of the two spinach vendors, one vendor sourced from "Other" and only one vendor grew it themselves. For the three vegetable vendors selling both cabbage and spinach, one reported

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that they purchased their produce from farmers, two grew their own produce, and none of the three vendors selling both cabbage and spinach sourced their produce from external sources, such as wholesalers. The total number of vegetable vendors interviewed in Mthatha on grant day was 13. The results suggest that Mthatha vendors relied more on farmers, likely due to higher market demand.

TABLE 7: Produce Sourcing, Mthatha and Mqanduli Grant Day

	Mthatha Grant Day			
Produce selling	**Buy it from farmers**	**I grow it**	**Other**	**Total**
Cabbage	4	1	3	8
Spinach	0	1	1	2
Both cabbage and spinach	1	2	0	3
Total				13
	Mqanduli Grant Day			
Produce selling	**Buy it from farmers**	**I grow it**	**Other**	**Total**
Cabbage	2	4	0	6
Spinach	0	1	0	1
Both cabbage and spinach	0	4	0	4
Total				11

In contrast, Mqanduli vendors exhibited a stronger reliance on self-production. Among the 6 cabbage vendors, four grew it themselves, while two purchased it from farmers. Notably, none were sourced from "Other" external suppliers, indicating that Mqanduli vendors either cultivate their crops or buy directly from farmers. One vendor selling only spinach indicated that they grew their produce. Additionally, the four vendors selling both cabbage and spinach in Mqanduli were exclusively self-sufficient, with four vendors growing their own produce. The total number of vegetable vendors interviewed on the grant day was 11. The results reflect greater agricultural engagement among Mqanduli vendors compared to their Mthatha counterparts.

TABLE 8: Produce Sourcing, Mthatha and Mqanduli Post-Grant Day

	Mthatha post-Grant Day			
Produce selling	**Buy it from farmers**	**I grow it**	**Other**	**Total**
Cabbage	4	3	1	8
Spinach	2	0	0	2
Both cabbage and spinach	5	3	0	8
Total				18
	Mqanduli post-Grant Day			
Produce selling	**Buy it from farmers**	**I grow it**	**Other**	**Total**
Cabbage	5	4	0	9
Spinach	0	0	0	0
Both cabbage and spinach	0	3	0	3
Total				12

In Mthatha post-grant day, the study revealed that a total of eight vendors sold only cabbage, with the majority purchasing their produce from farmers. Specifically, four vendors bought cabbage from farmers, three reported that they grew their produce, and only one indicated that they sourced from external supplies, "other". Notably, spinach-only vendors were fewer in number (two in total), and they exclusively sourced their produce from farmers. Out of the total of eight vendors selling both cabbage and spinach, five vendors purchased both cabbage and spinach from farmers. Self-production was also a significant sourcing method, as three vendors grew both cabbage and spinach, and none reported sourcing from external sources. The study suggests minimal reliance on alternative sources, as only one vendor sourced their produce from external sources. A total of 18 vegetable street vendors were interviewed post-grant day.

In Mqanduli, a total of 12 vendors participated in selling vegetables, with a strong emphasis on self-production and farmer purchases. Among the nine vendors selling only cabbage, five bought from farmers, while four grew their own produce. Vendors selling both cabbage and

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spinach exclusively relied on self-production (three vendors), showing that those selling multiple crops in Mqanduli were more likely to cultivate them independently. Interestingly, there were no vendors selling spinach alone, which could suggest either a lack of demand or challenges in sourcing spinach independently. Unlike in Mthatha, no vendors in Mqanduli sourced their produce from "Other" suppliers, indicating that vendors in this area primarily depended on local farming or direct farmer purchases for their stock.

4. CONCLUSION AND RECOMMENDATIONS

The study's outcomes reveal a flexible and adaptive approach to pricing strategies, influenced by market dynamics, particularly during grant days. Vendors employed dynamic pricing, negotiation, and haggling, adjusting to increased demand and customer purchasing power, while bundle pricing remained underutilised. Post-grant periods showed that the dynamic pricing strategy was more utilised, and there was also a shift towards strategies like cost-plus and competitive pricing. Sourcing patterns highlighted a strong reliance on direct sourcing from farmers and self-production, particularly in Mqanduli. These approaches reflect efforts to manage costs and maintain a consistent supply. Competition and demand were key drivers of pricing decisions. T-tests showed significant price differences between the two towns, shaped by local market conditions, competition, and consumer behaviour. These findings can help extension officers/agricultural advisors to give better and informed advice to their clients (smallholder farmers) about how to optimise their vegetable production in the market. Smallholders often struggle to secure formal markets, and most rely on the few informal markets available.

To enhance pricing strategies in Mthatha and Mqanduli, vegetable street vendors should receive training in pricing, negotiation, business management, and financial literacy. This will enable them to adapt to market fluctuations, particularly during high-demand periods, such as grant days. Additionally, training on the use of social media and digital platforms can help vendors promote their products, engage with customers, and boost sales. The study further recommends encouraging a bundle pricing strategy, as it boosts sales and reduces wastage, especially when produce is perishable or in surplus.

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Gendered Dimensions of Livestock Ownership in Lesotho: An Analysis of Socioeconomic Determinants

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ABSTRACT

This study examines the gendered aspects of household livestock ownership in Lesotho from the perspectives of Feminist Political Ecology (FPE). Drawing on nationally representative cross-sectional data from the 2023–2024 Lesotho Demographic and Health Survey (LDHS), involving 9,810 households, the study utilises logistic regression to examine how gender, marital status, education, wealth, land tenure, rurality, and ecological zones influence livestock ownership. Findings reveal that male-headed households have significantly higher ownership rates than their female-headed counterparts, highlighting persistent patriarchal norms in resource access and decision-making. Ownership is positively associated with rural residence, land access, household size, and specific agro-ecological zones such as the Mountains and the Senqu River Valley. Additionally, higher educational attainment is inversely related to livestock ownership, especially among men, suggesting a shift away from agricultural livelihoods. The study emphasises the structural nature of gender disparities and calls for policy interventions that address land tenure reforms, enhance support for female-headed households, and tailor rural development strategies to ecological and social contexts. These insights are essential for promoting inclusive and equitable livestock development in Lesotho.

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1. INTRODUCTION

Lesotho, a landlocked country in Southern Africa, faces persistent challenges of food insecurity, hunger, and poverty, with 58% of its population living below the poverty line (Government of Lesotho, Ministry of Agriculture and Food Security, Department of Livestock Services [GoL MoAFS DLS] 2019; Ogunleye *et al*., 2024). The agricultural sector, particularly livestock farming, is crucial for rural livelihoods; however, its contribution to GDP has declined to 16.5% (GoL MoAFS DLS, 2019). Despite its importance to economic stability, livestock productivity remains constrained by socioeconomic and environmental factors. Lesotho's geography, comprising four agro-ecological zones—Mountains (59%), Foothills (15%), Lowlands (17%), and the Senqu River Valley (9%)—significantly influences livestock farming (Pitikoe, 2018; Leduka *et al*., 2019). With only 10% of the land being arable, rangelands support extensive livestock production, which is essential for food security and household resilience (Danso-Abbeam *et al*., 2024). However, rural households engaged in agriculture remain vulnerable to food insecurity, despite livestock having the potential to provide income, food, and social stability (Ahmed *et al*., 2017; Danso-Abbeam *et al*., 2024).

Livestock ownership enhances financial security, food production, and social cohesion, offering benefits such as income generation, fertiliser, and draught power (Nkonki-Mandleni *et al*., 2019; Herrero *et al*., 2013). It serves as a financial asset, strengthens community ties, and reduces labour burdens (Dumas *et al*., 2018; Taruvinga *et al*., 2022; Manyike *et al*., 2025). However, ownership patterns are influenced by socioeconomic factors, such as wealth, education, and access to land, as well as demographic factors, including gender and household size (Nigussie *et al*., 2024). Gender disparities, particularly in decision-making and access to resources, further limit ownership opportunities for women and young people, necessitating inclusive policies to address these inequalities (Hoag, 2018; Hegde, 2019). These factors underscore the need for policies that address inequalities, thereby ensuring broader access to livestock ownership and promoting more inclusive agricultural growth.

The objectives of this study, therefore, are to examine whether a relationship exists between livestock ownership and the socioeconomic characteristics of households in Lesotho and to determine the extent to which these factors influence livestock ownership. This approach helps

us understand how rural households in the country can secure a stable food supply through livestock, as well as inform the design of targeted interventions and policies. Identifying these factors and their impacts enables the development of strategies and policies that are better aligned with the realities faced by livestock owners, ultimately promoting sustainable and equitable growth within the sector.

2. THEORETICAL FRAMEWORK: A FEMINIST POLITICAL ECOLOGY APPROACH TO LIVESTOCK OWNERSHIP

This study employs Feminist Political Ecology (FPE) as its primary theoretical framework to examine the complex interplay between gender, power relations, and access to resources in livestock ownership patterns. FPE, according to Clement *et al*. (2019), is a framework that explores how power operates not only through visible hierarchies— such as formal laws, institutions, and traditional gender roles—but also through everyday relationships and interactions. It focuses on how gender, along with other social factors such as class, age, and race, influences people's roles, responsibilities, and access to environmental resources. FPE sees gendered power as complex, shifting over time, and deeply influenced by social, cultural, and economic systems. These overlapping systems of power shape how individuals and communities interact with environmental resources, resulting in diverse experiences, knowledge systems, and varying levels of vulnerability or empowerment. In this way, FPE emphasises that people's relationships with the environment are neither neutral nor universal, but are instead deeply influenced by social positioning and historical context. It explores how access to resources, decision-making power, and environmental responsibilities are unequally distributed, and how these inequalities are often justified or maintained through socio-cultural norms and everyday practices (Sundberg, 2017). FPE provides perspectives to understand and challenge unjust systems. It challenges mainstream development approaches and illustrates how power, particularly in relation to gender and social roles, is intricately intertwined with environmental governance. FPE, therefore, offers a framework for rethinking more equitable and inclusive approaches to sustainability, resource management, and community resilience (Resurrección & Elmhirst, 2020).

FPE offers a critical perspective on understanding how socio-cultural norms and environmental factors intersect to create and perpetuate gendered disparities (Sundberg, 2017) in agricultural systems. At its core, FPE challenges conventional political ecology by centring gender as a

crucial analytical category that interacts with class, ethnicity, and other axes of difference in influencing resource access and control (Sundberg, 2017; Vercillo, 2022). This framework is particularly salient for our investigation of livestock ownership in Lesotho for three key reasons:

i. FPE's emphasis on gendered resource governance helps unpack how patriarchal systems influence access to productive assets. As demonstrated in similar sub-Saharan African contexts (Dumas *et al*., 2018; Vercillo, 2022), customary land tenure systems often systematically disadvantage women in livestock ownership through inheritance practices and decision-making norms. The framework predicts that these structural barriers will manifest in measurable disparities between male-headed and female-headed households.
ii. FPE's attention to intersectional vulnerabilities provides crucial context for understanding how environmental and economic pressures compound gender inequalities. Research in northern Ghana (Vercillo, 2022) has shown how climate variability and agricultural commercialisation can exacerbate existing gendered disparities in resource access. This insight is particularly relevant for Lesotho's varied agro-ecological zones and changing rural economy.
iii. FPE's focus on the gendered division of labour illuminates the often-overlooked disparities between women's substantial contributions to livestock care and their limited control over benefits (Dumas *et al*., 2018). This aspect helps frame our examination of labour inputs versus decision-making authority in Lesotho's livestock sector.

The framework also highlights how social identities are constituted through everyday practices and relations with nature (Sundberg, 2017). This perspective informs our analysis of how gender roles and livestock ownership mutually reinforce each other in Lesotho's cultural context. Critically, FPE moves beyond merely identifying gender disparities to interrogating the power structures that produce and maintain them (Nam, 2018). This theoretical orientation directly informs our study's focus on factors influencing livestock ownership patterns.

This theoretical foundation will subsequently inform our methodological approach to measuring livestock ownership disparities and interpreting their socio-cultural dynamics. The FPE perspective provides both an explanatory framework for understanding observed patterns of livestock ownership and a normative foundation for evaluating potential policy interventions.

3. METHODOLOGY

3.1. Research Framework, Approach, and Data Collection

This study utilised a quantitative cross-sectional design, using data from the 2023–2024 Lesotho Demographic and Health Survey (LDHS-8). The LDHS provides nationally representative data on demographics, health, agriculture, asset ownership, and socioeconomic factors (Ministry of Health, Lesotho & Inner-City Fund [ICF], 2024). A stratified, multi-stage sampling method ensured broad geographical representation, with 9,810 households surveyed to examine the determinants of livestock ownership.

3.2. Analytical Framework and Statistical Methods

The relationship between livestock ownership and its predictors was modelled using the following equation:

$$LO_i = \beta_0 + \beta_1 household\ head\ gender + \beta_2 household\ head\ age + \beta_3 household\ head\ marital\ status + \beta_4 household\ head\ education\ attainment + \beta_5 household\ size + \beta_6 place\ of\ residence + \beta_7 ecological\ zone + \beta_8 district + \beta_9 wealth\ status + \beta_{10} ownership\ of\ agricultural\ land + e_t \ldots\ldots\ldots\ldots\ldots (1)$$

Where: LO_i = livestock ownership, β_1 = intercept, $\beta_1 - \beta_{10}$ = coefficients of the independent variables, e_t = error term. The coefficients ($\beta_1 - \beta_{10}$) indicate the likelihood of a household owning livestock as a function of changes in the corresponding independent variables.

To evaluate these relationships, both descriptive and inferential statistical techniques were applied. All analyses were performed using STATA version 15.1 (StataCorp LLC, College Station, TX, USA). A chi-square test was used to assess the associations between categorical variables, although it does not indicate the strength or direction of these associations. Logistic regression was employed to estimate the specified model and determine the effect size and direction of predictors on the binary outcome of livestock ownership. Logistic regression is well-suited for binary-dependent variables, with parameter estimates derived using the maximum likelihood estimation (MLE) method to ensure accuracy. The analysis produced detailed outputs, including coefficients, standard errors, and p-values. Model fit was evaluated using Pearson's goodness-of-fit test to confirm the model's appropriateness for the data.

TABLE 1: Summary Description of Variables

Variables	**Description**
Ownership of livestock	1 = Yes; 0 is otherwise
Gender of Head	
Age	The age of the household's head in years
Marital Status of Household Head	
Never Married	1 = Yes; 0 is otherwise
Married	1 = Yes; 0 is otherwise
Widowed	1 = Yes; 0 is otherwise
Divorced	1 = Yes; 0 is otherwise
Not Living Together	1 = Yes; 0 is otherwise
Educational: Level of education of household head	
<= Preschool	1 = Yes; 0 is otherwise
Primary	1 = Yes; 0 is otherwise
Secondary	1 = Yes; 0 is otherwise
Higher	1 = Yes; 0 is otherwise
Do not know	1 = Yes; 0 is otherwise
Household size	
Urban	1 = Yes; 0 is otherwise
Ecological zone	
Lowlands	1 = Yes; 0 is otherwise
Foothills	1 = Yes; 0 is otherwise
Mountains	1 = Yes; 0 is otherwise
Senqu River Valley	1 = Yes; 0 is otherwise
District	
Butha-Buthe	1 = Yes; 0 is otherwise
Leribe	1 = Yes; 0 is otherwise
Berea	1 = Yes; 0 is otherwise
Maseru	1 = Yes; 0 is otherwise
Mafeteng	1 = Yes; 0 is otherwise
Mohale's Hoek	1 = Yes; 0 is otherwise
Quthing	1 = Yes; 0 is otherwise

Qacha's Nek	1 = Yes; 0 is otherwise
Makhotlong	1 = Yes; 0 is otherwise
Thaba-tseka	1 = Yes; 0 is otherwise
Household Wealth Status: Household Wealth Index	
Poorest	1 = Yes; 0 is otherwise
Poorer	1 = Yes; 0 is otherwise
Middle	1 = Yes; 0 is otherwise
Richer	1 = Yes; 0 is otherwise
Richest	1 = Yes; 0 is otherwise
Ownership of agric. land	1 = Yes; 0 is otherwise

4. RESULTS AND DISCUSSION

4.1. Overview of Livestock Ownership Patterns

The ownership patterns revealed in Figure 1 demonstrate how gender fundamentally structures access to livestock assets in Lesotho. While the national ownership rate appears balanced at 50.02%, disaggregation reveals that male-headed households (MHHs) maintain 54.35% ownership compared to just 43.63% for female-headed households (FHHs) – a statistically significant 10.72 percentage point gap rooted in patriarchal systems. This, for example, aligns with Lesotho's 2022 Agricultural Census, which shows that men control 81% of cattle herds (Ministry of Finance and Development Planning, Bureau of Statistics, 2022), reflecting cultural norms that position livestock as a form of masculine capital (Taruvinga *et al*., 2022). FHHs are more engaged in rearing small stock such as poultry (Hoag, 2018; Manyike *et al*., 2025), which require less land and capital.

Structural barriers exacerbate this disparity. As Leduka *et al*. (2019) noted in their analysis of Lesotho's land governance, customary tenure systems often exclude women from inheriting grazing rights. This limits the ability of FHHs to use land as collateral for livestock investments, creating exclusions from both physical and financial assets. Even when women provide 60–80% of livestock care labour, decision-making authority typically remains with male relatives, perpetuating cyclical disadvantage (Dumas *et al*., 2018).

Our findings suggest three pathways for reform: First, policies promoting equitable land distribution and access to commonage land are essential. Community-based land management

initiatives may also be effective in ensuring sustainable and fair access to grazing resources while mitigating resource-related conflicts. Implementing Land Act provisions for joint titling could strengthen FHHs tenure security. Second, gender-targeted extension programmes could address knowledge gaps identified by Mokati *et al*. (2024). Third, microfinance products tailored to small stock enterprises might bypass traditional collateral requirements, building on models discussed in the Organisation for Economic Co-operation and Development [OECD] (2012) empowerment frameworks.

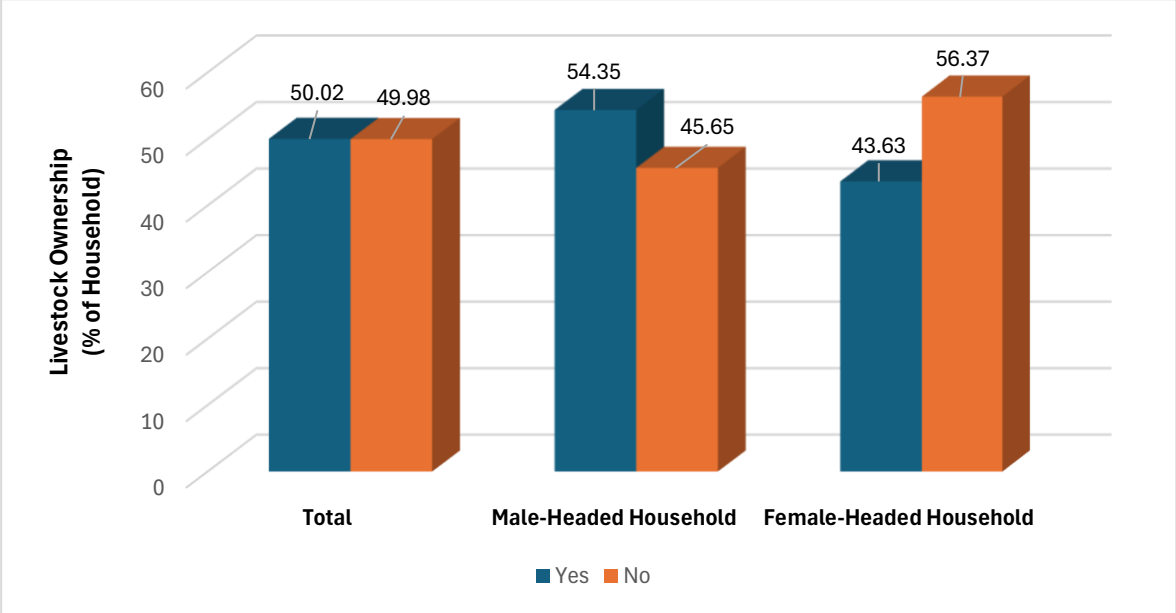

FIGURE 1: Livestock Ownership by Household

4.2. Socioeconomic Determinants of Livestock Ownership

Table 2 presents an analysis of livestock ownership in relation to various socioeconomic factors across households. The results reveal significant differences in livestock ownership based on gender, marital status, education, place of residence, ecological zone, wealth status, and land ownership. MHHs consistently show higher livestock ownership rates than FHHs across multiple socioeconomic factors.

The chi-square statistics and significant p-values (consistently below 0.05) further validate that these factors are strongly associated with livestock ownership, highlighting the importance of socioeconomic variables in influencing livestock ownership patterns in Lesotho. These findings reflect the complex, multifaceted nature of livestock ownership, emphasising its reliance on factors such as gender, education, geographical location, and wealth status.

TABLE 2: Socioeconomic Distribution of Sample by Livestock Ownership

Variables	Total		Female-Headed Household		Male-Headed Household	
	No %	Yes %	No %	Yes %	No %	Yes %
Gender						
Female	56.37	43.63	-	-	-	-
Male	45.65	54.35	-	-	-	-
	Pearson χ^2 (1) = 108.68 Pr = 0.000		-	-	-	-
Marital Status						
Never Married	75.86	24.14	85.48	14.52	68.85	31.15
Married	42.69	57.31	61.88	38.13	39.70	60.30
Widowed	45	55	45.13	54.87	44.40	55.60
Divorced	69.12	30.88	72.44	27.56	64.44	35.56
Not Living Together	68.78	31.22	77.11	22.89	62.72	37.28
	Pearson χ^2 (4) = 583.50 Pr = 0.000		Pearson χ^2 (4) = 369.62 Pr = 0.000		Pearson χ^2 (4) = 270.80 Pr = 0.000	
Education Attainment of Head						
<= Preschool	33.17	66.83	50.68	49.32	29.35	70.65
Primary	41.56	58.44	46.29	53.71	37.54	62.46
Secondary	63.73	36.27	70.14	29.86	59.31	40.69
Higher	76.25	23.75	79.80	20.20	73.97	26.03
Don't Know	48.97	51.03	56.48	43.52	42.96	57.04
	Pearson χ^2 (4) = 750.46 Pr = 0.000		Pearson χ^2 (4) = 263.31 Pr = 0.000		Pearson χ^2 (4) = 492.03 Pr = 0.000	
Place of Residence						

Urban	72.71	27.29	78.00	22.00	69.00	31.00
Rural	38.92	61.08	45.53	54.47	34.53	65.47
	Pearson χ^2 (1) = 986.09 Pr = 0.000		Pearson χ^2 (1) = 377.90 Pr = 0.000		Pearson χ^2 (1) = 612.15 Pr = 0.000	
Ecological Zone						
Lowlands	59.47	40.53	64.58	35.42	56.06	43.94
Foothills	33.97	66.97	41.21	58.79	29.25	70.75
Mountains	40.46	59.64	49.60	50.40	34.67	65.33
Senqu River Valley	44.84	55.16	50.15	49.85	40.23	59.77
	Pearson χ^2 (3) = 374.75 Pr = 0.000		Pearson χ^2 (3) = 113.67 Pr = 0.000		Pearson χ^2 (3) = 271.62 Pr = 0.000	
District						
Butha-Buthe	48.70	51.30	58.65	41.35	42.88	57.12
Leribe	54.07	45.93	64.92	35.08	47.56	52.44
Berea	56.62	43.38	61.27	38.73	53.69	46.31
Maseru	67.32	32.68	68.87	31.13	66.36	33.64
Mafeteng	44.97	55.03	51.64	48.36	40.00	60.00
Mohale's Hoek	44.07	55.93	48.68	51.32	39.88	60.12
Quthing	46.90	53.10	50.94	49.06	43.17	46.83
Qacha's Nek	52.58	47.42	57.61	42.39	48.75	51.25
Makhotlong	43.95	56.05	55.38	44.62	37.67	62.33
Thaba-Tseka	34.64	65.39	44.11	55.89	28.95	71.05
	Pearson χ^2 (4) = 307.77 Pr = 0.000		Pearson χ^2 (9) = 89.53 Pr = 0.000		Pearson χ^2 (9) = 250.89 Pr = 0.000	
Wealth Status						
Poorest	34.51	65.49	40.55	59.45	30.62	69.38
Poorer	40.90	59.10	45.18	54.82	37.84	62.12
Middle	55.67	44.33	63.00	37.00	50.09	49.91
Richer	69.03	30.97	74.31	25.69	65.23	34.77

Richest	62.51	37.49	73.31	26.69	56.67	43.33
	Pearson χ^2 (4) = 689.99 Pr = 0.000		Pearson χ^2 (4) = 318.23 Pr = 0.000		Pearson χ^2 (4) = 387.44 Pr = 0.000	
Own Agricultural Land						
No	77.85	22.15	77.56	22.44	78.09	21.91
Yes	40.86	59.14	37.73	62.27	42.56	57.44
	Pearson χ^2 (1) = 1.4e+03 Pr = 0.000		Pearson χ^2 (1) = 645.02 Pr = 0.000		Pearson χ^2 (1) = 756.06 Pr = 0.000	

4.3. Analysis of Factors Influencing Household Livestock Ownership

The results presented in the logistic regression analysis in Table 3 provide a comprehensive examination of the factors influencing household livestock ownership. The goodness-of-fit statistics for the logistic regression model, as shown in Table 3, demonstrate strong model performance. The likelihood ratio chi-square of 2878.95 with a p-value of 0.000 indicates that the model fits significantly well as a whole. The Pearson chi-square test yields a chi-square statistic of 9,524.59 (P> χ^2 = 0.5740), indicating that the model fits the data well.

TABLE 3: Logistic regression on Factors Influencing Household Ownership of Livestock

hv246	**Coefficient**	**Std. Err.**	**t-value**
Gender of Head (Male)	0.545***	0.063	8.60
Age of Head	0.012***	0.002	6.82
Marital Status of Head (base category: Never Married)	0	.	.
Married	0.531***	0.090	5.88
Widowed	0.335***	0.103	3.27
Divorced	0.154	0.183	0.84
Not living together	-0.140	0.117	-1.20
Educational Attainment of Head (base category: No education, preschool/early childhood education)	0	.	.

Primary	0.062	0.079	0.78
Secondary	-0.254***	0.095	-2.67
Higher	-0.648***	0.123	-5.25
Do not know	-0.364**	0.163	-2.24
Household Size	0.180***	0.012	15.06
Wealth Status of Household (base category: Poorest)	-	.	.
Poorer	0.124*	0.072	1.72
Middle	-0.120	0.079	-1.51
Richer	-0.136	0.094	-1.45
Richest	0.359***	0.110	3.25
Urban	-0.742***	0.066	11.32
Ecological zone (base category: Lowlands)	-	-	.
Foothills	0.183*	0.096	1.90
Mountains	0.624***	0.141	4.44
Senqu River Valley	0.361***	0.139	2.60
District (base category: Butha-Buthe)	-	.	.
Leribe	-0.061	0.106	-0.57
Berea	-0.114	0.108	-1.06
Maseru	-0.232**	0.107	-2.16
Mafeteng	0.224**	0.108	2.06
Mohale's Hoek	0.293**	0.119	2.45
Quthing	-0.068	0.165	-0.41
Qacha's Nek	-0.534***	0.165	-3.23
Mokhotlong	-0.416**	0.169	-2.46
Thaba-Tseka	-0.183	0.165	-1.11
Ownership of agricultural land	1.124***	0.051	21.83
Constant	-3.720***	0.21	-17.73
Number of Observations	9810		
LR chi2 (29) =	2878.95; Prob> chi2 = 0.000		
Pearson chi2 (9551) =	9524.59; Prob> chi2 = 0.5740		
*** p<.01, ** p<.05, * p<.1			

4.3.1. Gender Disparities in Livestock Ownership

The study reveals significant gender disparities in livestock ownership, with MHHs exhibiting 54.4% ownership compared to 43.6% for FHHs ($p < 0.01$). This 10.8 percentage point gap reflects deeply entrenched socio-cultural norms in Lesotho; livestock management has traditionally been male-dominated due to patriarchal inheritance systems and unequal access to productive resources (Hoag, 2018; Taruvinga *et al*., 2022). While some recent studies suggest that FHHs are increasingly engaging in small stock rearing (Manyike *et al*., 2025), Taruvinga *et al*. (2022) confirm that they remain disadvantaged in owning larger, more economically valuable animals, such as cattle and sheep.

A Feminist Political Ecology perspective helps to unpack the structural nature of these disparities. The findings exemplify FPE's central tenet that access to resources is mediated through gendered power relations (Sundberg, 2017), where patriarchal systems transform women's labour into assets controlled by men (Dumas *et al*., 2018). The preference for large livestock among MHHs reflects a process in which culturally valued assets become markers of male status. Meanwhile, FHHs' concentration on small stock mirrors the relegation of women to less profitable agricultural activities. These patterns cannot be explained by economic factors alone; they arise from intersecting inequalities in land tenure, decision-making authority, and cultural norms, which FPE illuminates.

This disparity has profound implications, as livestock serve not only as economic assets but also as social capital in rural communities (Dumas *et al*., 2018; Nkonki-Mandleni *et al*., 2019; Danso-Abbeam *et al*., 2024). The findings align with broader regional patterns observed in Ghana and Ethiopia, where FHHs face similar structural barriers (Duku *et al*., 2011; Debela, 2017). Addressing these inequities requires transformative policies that challenge existing gender norms while providing FHHs with targeted support, including land rights reforms, improved access to extension and veterinary services, credit facilities, and other essential production resources and services.

4.3.2. Household Structure and Age Factors

The analysis demonstrates important variations in ownership patterns across different household structures. Married households exhibit the highest livestock ownership rates (60.3% for married households with children and 38.1% for married households without children), likely benefiting from combined labour resources and economic stability. In contrast,

households that are divorced or separated exhibit significantly lower ownership levels, suggesting that marital dissolution often leads to the depletion of assets. Taruvinga *et al*. (2022) found that marital status has a positive effect on ownership, particularly of goats and pigs, due to the need for intensive labour and the advantages for larger families. This suggests that household structure and labour availability are important factors in livestock ownership.

Interestingly, widowed households maintain relatively strong ownership rates (55%), indicating that livestock serve as crucial safety nets for vulnerable groups. Age emerges as another significant factor, with older household heads more likely to own livestock ($\beta = 0.012$, $p < 0.01$), consistent with findings from across sub-Saharan Africa (Pica-Ciamarra *et al*., 2015; Debela, 2016; Moyo & Mlilo, 2019; Taruvinga *et al*., 2022), which attribute this trend to greater wealth, experience, and access to resources. This reflects both lifecycle accumulation of assets and the traditional nature of livestock rearing, although it raises concerns about intergenerational transfer and youth engagement in the sector.

These patterns reflect FPE's fundamental perspective that access to resources is mediated through household power structures (Sundberg, 2017). The marital status gap exemplifies how women's entitlement rights remain conditional on male relationships (Vercillo, 2022), with divorce exposing FHHs' systemic disadvantages in maintaining livestock assets. The sustained ownership among widowed households (55%) aligns with FPE's recognition of livestock as a critical safety net when formal systems fail women (Dumas *et al*., 2018), though their smaller herds reflect the feminisation of subsistence farming (Manyike *et al*., 2025). The age correlation further demonstrates FPE's emphasis on lifecycle inequalities - where older women's accumulated experience cannot overcome structural barriers to resource control (Nyantakyi-Frimpong, 2019).

4.3.3. Education, Wealth and Rural Livelihood Strategies

Contrary to expectations, higher educational attainment correlates negatively with livestock ownership ($\beta = -0.65$ for tertiary education, $p < 0.01$), suggesting that education facilitates an exit from agricultural livelihoods (Manyike *et al*., 2025). This trend reflects broader patterns across sub-Saharan Africa, where education enables access to non-agricultural employment (e.g., formal wages, entrepreneurship), thereby reducing reliance on livestock (Lesorogol *et al*., 2011; Van Anda *et al*., 2021). Educated individuals are more likely to migrate to urban areas in

search of better job opportunities, further diminishing their engagement in agriculture and livestock farming.

Figure 2 illustrates the interaction plot showing the effect of gender and education level on livestock ownership:

- Both male- and female-headed households show a decline in ownership as education level increases.
- MHHs consistently own more livestock than FHHs across all education levels.

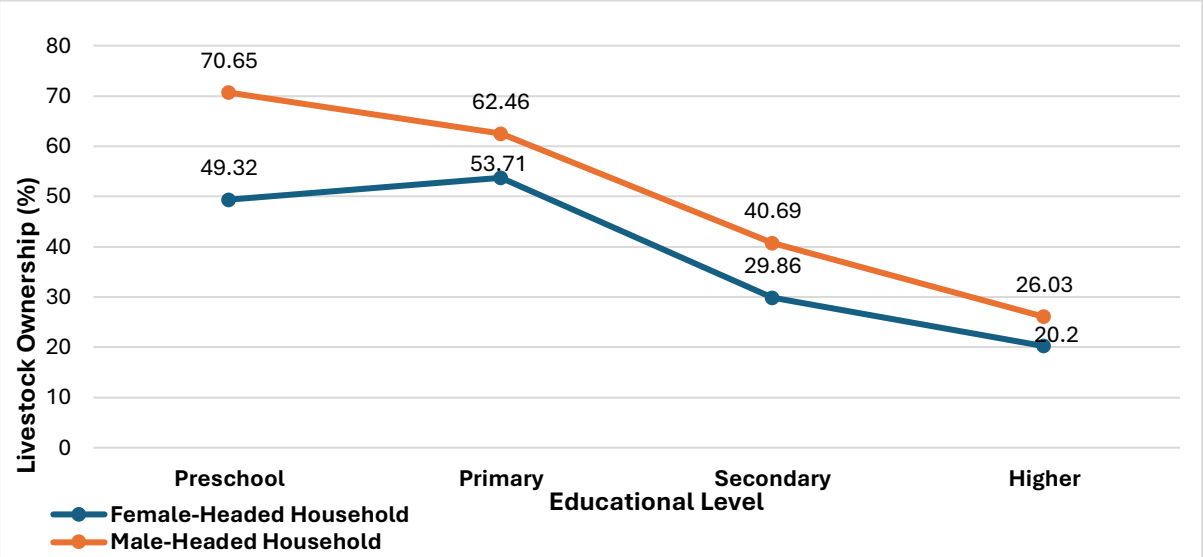

FIGURE 2: Interaction Plot – Gender and Education Level on Livestock Ownership

Youth aspirations further drive this shift, as younger, educated households often perceive livestock rearing as low status (Lesorogol *et al*., 2011). Research by Magagula and Tsvakirai (2020) highlighted that, despite ongoing government efforts to promote agricultural entrepreneurship, many young people remain reluctant to pursue careers in the agricultural sector. This reluctance is often rooted in persistent cognitive biases and economic challenges that influence their career decisions, limiting their involvement in the sector. This disengagement risks depleting the sector of skilled labour.

This trend can also be understood through the perspective of gender, social, and generational imbalances in the agricultural sector. As Nigussie *et al*. (2024) observed, gender and structural inequalities in agriculture limit opportunities for women and young people, thereby curbing their participation and innovation. This suggests that youth disengagement from livestock

farming is not merely a matter of individual choice or educational attainment, but also the result of deep-rooted systemic barriers influenced by intersecting socioeconomic and generational dynamics. Older individuals, by contrast, are better positioned to invest in and sustain livestock due to accumulated wealth and access to productive resources. To address youth disengagement, policy responses must modernise livestock farming and align it with the aspirations of younger, educated populations. Interventions should include youth-focused training in modern husbandry practices, the integration of agricultural education into formal curricula, and the expansion of financial support mechanisms such as grants and microloans. Integrating agricultural education into formal education systems could help bridge the gap between traditional practices and emerging economic opportunities, promoting a more inclusive and resilient agricultural sector. Additionally, the introduction of digital extension platforms, value-chain incentives (Gebremedhin *et al*., 2016; Jaiswal *et al*., 2023), and climate-resilient livestock systems could further enhance the sector's appeal to educated youth. Such approaches would not only improve sectoral resilience but also encourage more inclusive participation across age and gender groups.

Wealth patterns reveal that both the poorest (65.5% ownership) and wealthiest (37.5%) households maintain significant livestock holdings, albeit for fundamentally different reasons, while middle-income groups show lower engagement. For poorer households, livestock serve as critical safety nets for subsistence and risk mitigation (Hoag, 2018; Collishaw *et al*., 2023), aligning with evidence from Zambia where smallholders rely on animals to buffer shocks (Miura *et al*., 2012). Conversely, wealthier households treat livestock as investment assets (Pica-Ciamarra *et al*., 2015), using them for collateral, social capital (e.g., dowry), or speculative gains (Nganga *et al*., 2013). Middle-income households' disengagement likely reflects diversification into non-farm enterprises or constraints, such as limited grazing access, despite having modest capital.

These disparities emphasise the necessity for tailored support programmes addressing the distinct needs of different wealth groups. For impoverished households, interventions could focus on strengthening safety nets through livestock insurance schemes and feed subsidies to prevent asset depletion during crises. Middle-class households would benefit most from targeted credit facilities that enable small-scale intensification practices, such as stall-feeding and poultry production, helping them transition to more sustainable operations. Meanwhile, wealthier households require incentives for commercial investments in climate-resilient breeds

and value-added production, implemented in ways that do not marginalise smaller producers. Such differentiated approaches would more effectively address the varying roles livestock play across the socioeconomic spectrum while promoting inclusive sector growth. These findings emphasise that livestock policies must consider the multifaceted roles livestock play across socioeconomic strata—from subsistence to accumulation—while addressing structural barriers, such as limited land access and youth disinterest, that perpetuate inequalities.

4.3.4. Geographical and Ecological Dimensions

The study highlights striking spatial variations in ownership patterns. Rural households are nearly twice as likely to own livestock as urban households (61.1% vs 27.3%, $p < 0.01$), reflecting agriculture's central role in rural livelihoods (Pitikoe, 2018). Ecological conditions further influence these patterns, with foothills and mountainous zones exhibiting particularly high ownership rates (66.0% and 59.6% respectively) due to favourable grazing conditions. In contrast, lowland areas face intense competition for land, thereby constraining livestock activities. These geographical disparities suggest that blanket national policies may be ineffective; instead, support programmes should be tailored to local agro-ecological conditions (Danso-Abbeam *et al*., 2024).

Figure 3 highlights how ownership is highest in the foothills and mountainous zones. Male-headed households consistently show higher ownership rates across all zones. The gap is especially wide in Mountain zones, reinforcing spatial and gendered patterns in livestock access.

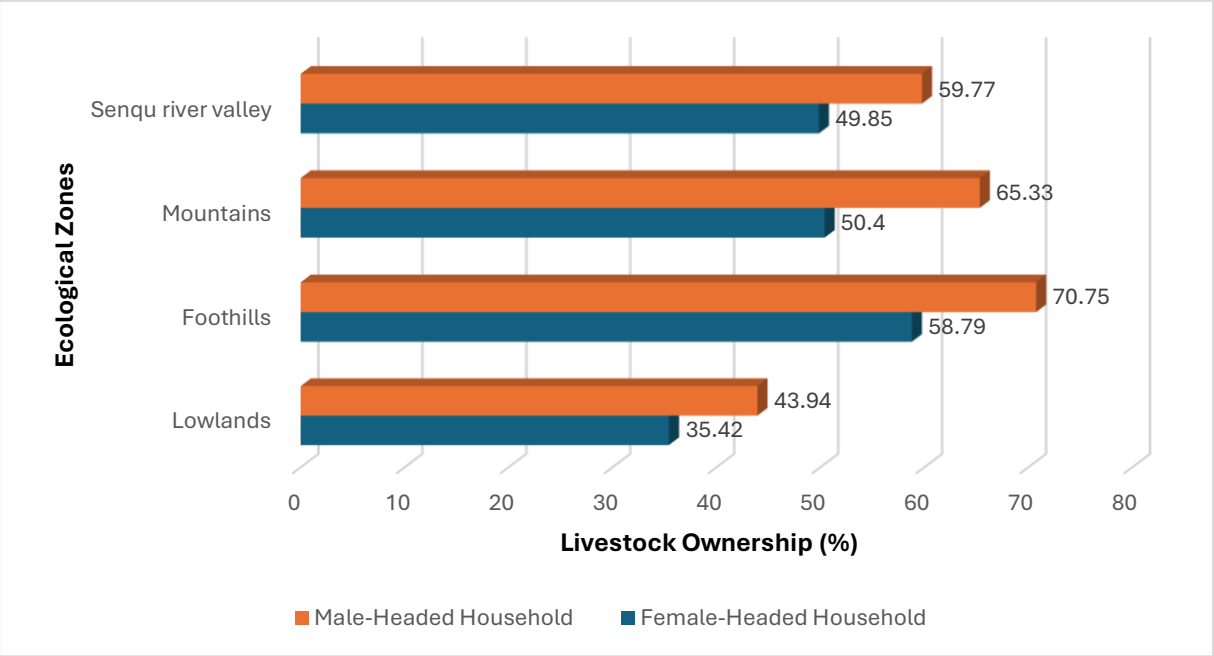

FIGURE 3: Livestock Ownership by Ecological Zone and Gender

4.3.5. Land Tenure as the Fundamental Constraint

Owning agricultural land is the strongest predictor of livestock ownership (coefficient = 1.124, $p < 0.01$). Households with access to land are significantly more likely to own livestock, underscoring the importance of secure land tenure in supporting sustainable livestock farming. A lack of land ownership severely limits households' ability to rear animals, thereby reinforcing economic disadvantages for landless groups. The current land tenure system, combining formal leasehold and customary arrangements, presents both opportunities and challenges (Leduka *et al*., 2019). While customary grazing rights enable poorer households to maintain small herds, insecure tenure discourages long-term investments in pasture improvement or animal health. With 77.9% of households lacking formal land titles, tenure insecurity represents a significant barrier to sector development (Leduka *et al*., 2019; Nkonki-Mandleni *et al*., 2019). Addressing these constraints requires comprehensive land governance reforms that balance customary practices with the need for secure, transferable rights, particularly for vulnerable groups such as FHHs and young farmers.

4.4. Gender Dynamics in Factors Influencing Livestock Ownership

The results presented in Table 4 reveal important gender-based variations in the factors influencing livestock ownership in Lesotho. While some predictors such as age (β=0.012 for FHHs, β=0.013 for MHHs, $p<0.01$), household size (β=0.187 for FHHs, β=0.168 for MHHs,

p<0.01), urban residence (β=-0.625 for FHHs, β=-0.809 for MHHs, p<0.01), and agricultural land ownership (β=1.145 for FHHs, β=1.116 for MHHs, p<0.01) show consistent patterns across male- and female-headed households, other factors demonstrate distinct gendered effects that warrant closer examination through the FPE perspective.

The analysis reveals particularly striking differences in the effects of marital status. Widowed FHHs show significantly stronger positive coefficients (β=0.917, p<0.01) compared to their male counterparts (β=-0.230, ns), while divorced FHHs also demonstrate stronger ownership likelihood (β=0.579, p<0.01) versus divorced MHHs (β=-0.092, ns). These patterns align with FPE's emphasis on how women's access to resources is often mediated through marital status and household structures (Nyantakyi-Frimpong, 2019). The findings suggest that for many women in Lesotho, livestock serve as crucial safety nets following marital dissolution, providing economic security where formal support systems may be lacking (Dumas *et al*., 2018). However, FPE reminds us that this apparent resilience should not obscure the structural inequalities that make livestock ownership a necessity rather than a choice for many FHHs. The smaller scale of women's livestock operations compared to men's further reflects what FPE scholars identify as gendered patterns where women are systematically channelled into smaller-scale, less profitable agricultural activities (Taruvinga *et al*., 2022; Vercillo, 2022).

The gender disparities in education effects are particularly revealing. While higher education shows a negative association with livestock ownership for both genders, this relationship is significantly stronger for MHHs (β = -0.950, p < 0.01) compared to FHHs (β = 0.112, ns). This pattern reflects FPE's perspectives about how gender intersects with education to create differential livelihood opportunities. The results suggest that educated men in Lesotho have greater freedom to transition to non-agricultural livelihoods, while educated women may face persistent barriers to exiting livestock production entirely due to their gendered roles in household resource management (Dumas *et al*., 2018).

Ecological patterns also demonstrate clear gender dimensions. MHHs show significantly stronger positive effects in mountainous (β=0.864, p<0.01) and river valley regions (β=0.521, p<0.01) compared to FHHs (β=0.316 and β=0.163, respectively, both ns). These geographic disparities exemplify FPE's concept of how environmental factors interact with gendered resource control (Vercillo, 2022). The concentration of MHHs in ecologically favourable zones for livestock farming, despite women's substantial contributions to animal care labour,

highlights the systemic nature of resource allocation inequalities (Nyantakyi-Frimpong, 2019) in rural Lesotho.

These findings collectively highlight FPE's central argument that gender serves as a fundamental organising principle in natural resource access and control (Sundberg, 2017). The variations observed across marital status, education, and ecological zones cannot be explained solely by individual choices or economic factors; rather, they reflect deeper structural inequalities in how livestock resources are distributed and managed (Vercillo, 2022). From a policy perspective, this FPE-informed understanding suggests that interventions must move beyond simply improving women's access to livestock and instead challenge the patriarchal norms and practices that systematically disadvantage female-headed households (Nam, 2018). Future research could productively employ FPE's qualitative methodologies to explore further how these structural dynamics play out in the everyday lives of livestock owners across Lesotho's diverse communities.

TABLE 4: Logistic Regression by Gender of Household Head

	Female Headed-Household		**Male Headed-Household**	
	Coefficient	**Std. Err.**	**Coefficient**	**Std. Err.**
Age of Head	0.012***	0.003	0.013***	0.002
Marital Status of Head (base category: Never Married)	0	.	0	.
Married	0.926***	0.168	0.301***	0.112
Widowed	0.917***	0.160	-0.230	0.149
Divorced	0.579**	0.260	-0.092	0.266
Not living together	0.223	0.202	-0.335**	0.147
Educational Attainment (base category: No education, preschool/early childhood education)	0	.	0	.
Primary	0.331**	0.161	-0.019	0.094

Secondary	0.185	0.186	-0.411***	0.115
Higher	0.112	0.232	-0.950***	0.150
Do not know	0.016	0.268	-0.536**	0.213
Household Size	0.187***	0.018	0.168***	0.017
Wealth Status (base category: Poorest)	0	.	0	.
Poorer	0.171	0.112	0.085	0.096
Middle	-0.245**	0.122	-0.017	0.106
Richer	-0.275*	0.148	-0.036	0.123
Richest	0.063	0.184	0.558***	0.141
Urban	-0.625***	0.106	-0.809***	0.084
Ecological zone (base category: Lowlands)	0	.	0	.
Foothills	0.047	0.151	0.275**	0.126
Mountains	0.316	0.216	0.864***	0.190
Senqu River Valley	0.163	0.207	0.521***	0.190
District (base category: Butha-Buthe)	0	.	0	.
Leribe	-0.070	0.180	-0.039	0.133
Berea	0.081	0.179	-0.205	0.136
Maseru	0.124	0.179	-0.407***	0.135
Mafeteng	0.264	0.175	0.236*	0.140
Mohale's Hoek	0.517***	0.187	0.158	0.159
Quthing	0.350	0.252	-0.355	0.224
Qacha's Nek	-0.136	0.256	-0.810***	0.221
Mokhotlong	-0.191	0.269	-0.593***	0.223
Thaba-Tseka	0.139	0.259	-0.385*	0.220
Agricultural land ownership	1.145***	0.082	1.116***	0.067
Constant	-4.381***	0.365	-2.985***	0.247
Number of Observations	3961		5849	
LR chi2 (29)	1134.58		1704.56	

Prob > chi2	0.000	0.000
Pearson chi2	3810.25	5677.23
Prob > chi2	0.7502	0.4076
*** p<.01, ** p<.05, * p<.1		

5. CONCLUSION AND POLICY IMPLICATIONS

This study demonstrates that complex interactions between socio-cultural norms, household characteristics, economic factors, and environmental conditions influence livestock ownership in Lesotho. Through an FPE perspective, the findings reveal how deeply entrenched male-controlled systems mediate women's access to livestock resources, with marital status, education levels, and ecological zones creating distinct gendered patterns of ownership. The results highlight how FHHs often rely on livestock as critical safety nets, while facing systemic barriers to accessing prime grazing lands and transitioning to alternative livelihoods.

Three key policy priorities emerge from this analysis. First, transformative interventions must address gender disparities by improving women's access to resources that could facilitate enhanced livestock production. Second, differentiated support programmes should recognise how livestock's economic role varies across household types and ecological contexts. Third, integrated rural development strategies must connect livestock policies with broader initiatives in land reform, education, and social protection to create meaningful change. Importantly, the study emphasises that equitable livestock development requires moving beyond superficial empowerment approaches to tackle the structural roots of gender inequality.

6. FUTURE RESEARCH DIRECTIONS

To build on the findings of this study, future research should adopt qualitative or mixed methods approaches to explore how shifting gender norms, youth aspirations, and household dynamics influence livestock ownership in Lesotho. Longitudinal studies could provide perspectives into how ownership patterns evolve over time and in response to policy or environmental changes. Expanding research across more ecological zones and communities would also help uncover regional variations in gendered livestock practices. Ultimately, a greater focus on power relations, land tenure, and decision-making dynamics is crucial to inform policies that extend beyond access and promote genuine gender equity in livestock development.

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