

**Assessing the performance of smallholder cattle farmers in uMgungundlovu
District, KwaZulu-Natal, South Africa: management practices, productivity, and
market access**

By

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Exact wording of the title of the dissertation as appearing on the electronic copy submitted for examination:

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I further declare that I have not previously submitted this work, or part of it, for examination at Unisa for another qualification or at any other higher education institution.



SIGNATURE

DATE: 20 /01/2026

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To the loving memories of my late mother, Mrs Jabulile Mkhize, and my father, Mr Patrick Mkhize, who dedicated all their lives to ensuring that I am well equipped with the necessary education and life needs. May their soul rest in peace. Amen.

Thanks to God for every event in my life!

Mkhize RS

Dedication

This thesis is dedicated to my late mom, Jabulile Philomena Mkhize, and my late dad, Patrick Mkhize, who gave me the light of education, and my children, Nokubonga and Mthombo, who showed love and support during the years of study.

Abstract

Smallholder beef cattle farming remains pivotal in sustaining rural livelihoods and forms part of South Africa's government efforts to promote rural development. However, the poor performance of the sector, driven by poor management practices, limited access to formal markets, and weak profitability, continues to raise concerns. This study investigated the performance of smallholder beef cattle farmers in the uMgungundlovu District, KwaZulu-Natal, focusing on livestock management practices, productivity, and profitability. A cross-sectional survey was conducted with 397 farmers across four purposively selected municipalities (uMngeni, Richmond, iMpofana, and Impendle). A simple random sampling technique was applied in Microsoft Excel within each municipality, in which each registered smallholder farmer was assigned a random number, and the required sample was drawn from those numbers. Descriptive statistics were used to profile farmers and their practices. To determine the factors influencing farmers' market choice, a multinomial logit regression model was used. Moreover, an ordinal regression model was employed to assess the impact of socio-economic and management factors on revenue outcomes, as revenue was operationalised as an ordinal categorical variable classified into three income brackets.

The farming population was predominantly aged 51 to 70 (43.1%), followed by 35.5% aged 31 to 50. Just under half (48.2%) of farmers had received formal training in livestock production. This finding ($p < 0.001$) reinforces the central role of education in income determination. Better-educated individuals tend to earn more and diversify their income sources. This study found that the livestock farming population is primarily composed of middle-aged, male, semi-educated, and resource-poor individuals, who rely significantly on traditional farming methods and government assistance. The multinomial logit regression revealed that farmers' market choices were significantly influenced by education level ($p < 0.001$), extension service quality ($p < 0.05$), access to quality bulls ($p < 0.05$), and breeding knowledge. . Specifically, secondary and tertiary education reduced the likelihood of participating in auction markets relative to informal markets, while limited breeding knowledge and poor extension services further constrained participation in formal channels.

The results further revealed the predominant use of informal methods such as visual appraisal of animal weight and market price, with limited record-keeping by farmers. Furthermore, a significant positive correlation was found between higher cattle prices and achieving higher revenue categories. Specifically, cattle prices above R4 000 per head had a significant positive effect on higher revenue categories ($p < 0.001$). However, mid-range labour costs (R1 500–R2 000) exerted a negative influence on revenue ($p < 0.004$). This suggests improvement in labour efficiency to raise revenues for smallholder beef cattle farmers. This study makes an original contribution by being the first to simultaneously integrate management practices, market dynamics, and revenue outcomes within a single district-level analytical framework in uMgungundlovu, KwaZulu-Natal. Unlike previous studies that have examined these dimensions in isolation, this research provides an integrated evidence base that directly links socio-economic and management factors to market channel choice and revenue categories, a contribution that is both empirically novel and policy-relevant at the district level. Therefore, It is recommended that the Department of Agriculture, Land Reform and Rural Development (DALRRD), together with extension officers and agricultural cooperatives, establish structured performance measurement systems and improved herd and management interventions for smallholder farmers. Moreover, government policies that target strengthening extension services, promoting training in record-keeping and breeding management, and enhancing farmers' bargaining power in formal markets are crucial for improving the profitability, sustainability, and commercialization of smallholder beef enterprises.

Keywords: Smallholder cattle farmers, Management practices, Farm performance, Market access

Isifinyezo

Ukufuywa kwezinkomo ezisetshenziselwa ukutshala inyama kubalimi abancane kusabalulekile ekulondolozeni izindlela zokuziphilisa zasemakhya futhi kuyingxeny yemizamo kahulumeni wase Ningizimu Afrika yokukhuthaza ukuthuthukiswa kwezindawo zasemakhaya. Kodwa ke ukusebenza kabi kwalomkhakha ngenxa yemikhuba emibi yokuphatha, ukufinyelela okulinganiselwe ezimakethe ezisemthethweni, Kanye nenzuzo ebuthakathaka kuyaqhubeka kubangela ukukhathazeka. Lolu Cwaningo lwalufuna ukuhlola ukusebenza kwabalimi bezinkomo ezincane ezifuywayo esifundeni sase uMgungundlovu, KwaZulu-Natal, kugxilwe emikhubeni yokuphathwa kwemfuyo, ukukhiqiza Kanye nenzuzo. Kwaqhutshwa inhlobo enqamula abalimi abangu -385 emadolobheni amane. Ukusetshenziswa kwesampula okuhlosiwe kwasetshenziselwa ukukhetha omasipala abane bendawo esifundeni sase uMgungundlovu esifundeni esiyisikhombisa. Isampula lenziwa kusetshenziswa iMicrosoft Excel, lapho umlimi ngamunye enikezwa inombolo engahleliwe, bese kukhiqizwa isampula elidingekayo, kusuka kulezinombolo. Izibalo ezichazayo zasetshenziselwa ukuhlaziya izindlela zokulinganisa ukusebenza kwabalimi abancane. Ukuze kutholakale izimbangela ezinomthelela ekukhetheni komakethe kwabalimi, kwastshenziswa I modeli ye multinomial logit regression. Ngaphezu kwalokho, kwasetshenziswa I modeli yokuhlehla kwe ordinal ukuhlola umthelela wezici zenhlalo nezomnotho nezokuphatha emiphumeleni yemali engenayo.

Ingxeny enkulu yabalimi (43.1%) yayineminyaka ephakathi kuka 51 no 70, ilandelwa ngu 35.5% owayeneminyaka ephakathi kuka 31 no 50. Cishe ingxeny (48.2%) yabalimi yayithole ukuqeqeshwa okusemthethweni ekukhiqizeni imfuyo. Lokhu okutholakale ($p < 0.001$) ukuqinisa indima ebalulekile yemfundo ekunqumeni umholo. Abantu abafunde kakhudlwana bavame ukuthola imali eningi futhi bahlukanise imithombo yabo yemali.

Lolu cwaningo lwathola ukuthi abantu abafuya imfuyo ngokuyinhloko bangabantu abaneminyaka ephakathi nendawo abesilisa abangafundile, futhi abanemithombo emincane, abathembele kakhulu ezindleleni zokulima zendabuko nasosizweni lukahulumeni. I multinomial logit regression iveze ukuthi ukukhetha kwezimakethe kwabalimi kuthonywa izinga lemfundo. Izinga lenkonzo yothuthukisa ukufinyelela

ezinkonjeni ezisezingeni eliphakeme, Kanye nolwazi lokuzalanisa, konke ukuthonya kakhulu kwezimakethe kwabalimi. Ngokukhethekile imfundo yesibili nephakeme yehlise amathuba okubamba iqhaza ezimakethe ze auction Uma kuqhathaniswa nezimakethe ezingekho emthethweni kuyilapho ulwazi olulinganiselwe lokuzalanisa Kanye nezinsizakalo ezingezinhle zokukhuthaza ukunciphisa ukubamba iqhaza eziteshini ezisemthethweni. Imiphumelo yabuyeyaveza ukusetshenziswa kakhulu kwezindlela ezingekho emthethweni ezifana nokuhlolwa kwesisindo sezilwane Kanye nentengo yemakethe, Kanye nokugcinwa kwamarekhodi okulinganiselwe ngabalimi. Ngaphezu kwalokho kwatholakala ukuhlobana okuphawulekayo Phakathi kwamanani ezinkomo aphakeme, nokufinyelela ezigabeni eziphakeme zemali engenayo, kodwa ke izindleko zabasebenzi eziphakathi nendawo zaba nomthelela omubi emalini engenayo. Lokhu kusikisela ukuthuthukiswa kokusebenza kahle kwabasebenzi ukuze kwenyuswe imali etholwa ngabalimi abancane bezinkomo zenyama. Ngakhoke kunesidingo sokusungulwa kwezinhlelo ezihlelekile zokulinganisa ukusebenza Kanye nokungenelela okuthuthukisiwe emhlambini nasekuphatheni. Izinqubomgomo zika hulumeni ezihlose ukuqinisa izinsizakalo zokufinyelela ukukhuthaza ukuqeqeshwa ekulondolozweni kwamarekhodi nokuphathwa kokuzalanisa, nokuthuthukiswa Amandla okuxoxisana kwabalimi ezimakethe ezisemthethweni kubalulekile ekuthuthukisweni inzuzo ukusimama, nokuthengiswa kwamabhizinisi amancane ezinkomo.

Amagama angukhiye: Ukubamba iqhaza kwimakethe, abalimi, abalimi abancane, izilinganiso zokusebenza, imali engenayo

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Ukufuywa kweenkomo zenyama ngabalimi abancinci kuhlala kubalulekile ekulondolozeni iindlela zokuziphilisa zasemaphandleni kwaye kuyinxalenye Imigudu karhulumente woMzantsi Afrika yokukhuthaza uphuhliso lwasemaphandleni. Nangona kunjalo, intsebenzo embi yeli candelo ngenxa yeendlela zolawulo ezingalunganga, ukufikelela okunqongopheleyo kwiimarike ezisemthethweni, kunye nenzuzo ebuthathaka iyaqhubeka nokuphakamisa inkxalabo. Olu phononongo luye lwazama ukuphanda ukusebenza kwabalimi abancinci beenkomo zenyama kwiSithili uMgungundlovu, KwaZulu-Natal, kugxininiswa kwiindlela zolawulo lwemfuyo, imveliso kunye nenzuzo. Uhlolisiso olwenziwe kumacandelo ngamacandelo lwenziwa kumafama angama-385 kumasipala abane. Iisampulu ezenzelwe injongo zasetyenziswa ukukhetha omasipala abane basekuhlaleni kwiSithili saseMgungundlovu kwisixa esizisixhenxe. Ukwenziwa kwesampulu kwenziwa kusetyenziswa iMicrosoft Excel, apho umfama ngamnye wanikwa inombolo engacwangciswa, kwaye ke isampulu efunekayo yenziwa kula manani. Iinkcukacha-manani ezichazayo zasetyenziswa ukuhlalutya iindlela zokulinganisa ukusebenza kwabalimi abancinci. Ukumisela izinto ezichaphazela ukhetho lwamafama emarikeneni, kusetyenziswe imodeli ye-multinomial logit regression. Ngaphezu koko, imodeli yokubuyela umva kwimiyalelo yasetyenziswa ukuvavanya ifuthe lezinto zentlalo-qoqosho kunye nolawulo kwiziphumo zengeniso. Inxalenye enkulu yamafama (43.1%) yayiphakathi kweminyaka engama-51 nama-70 ubudala, ilandelwa ngama-35.5% aneminyaka engama-31 ukuya kwengama-50 ubudala. Ngaphantsi nje kwesiqingatha (48.2%) sabalimi bafumene uqeqesho olusemthethweni kwimveliso yemfuyo. Oku kufunyanisiweyo ($p < 0.001$) kuqinisa indima ephambili yemfundo ekumiseleni ingeniso. Abantu abafunde kakuhle badla ngokufumana imali engakumbi baze babe nemithombo eyahlukahlukeneyo yengeniso. Olu phando lufumanise ukuba abafuyi bezilwanyana ngabantu abakwiminyaka ephakathi, abesilisa, abantu abangafundanga kangako nabangenazinto zininzi, abaxhomekeke kakhulu kwiindlela zemveli zokufama noncedo lukarhulumente. I-multinomial logit regression ibonakalise ukuba ukhetho lwamafama lwentengiso luphenjelelwa ngumgangatho wemfundo, umgangatho wenkonzo, ukufikelela kwiinkunzi zenkomo ezisemgangathweni, kunye nolwazi lokuzala, zonke ezichaphazela kakhulu ukhetho lwamafama lwentengiso. Ngokukodwa, imfundo

yamabanga aphakamileyo nephakamileyo yehlise amathuba okuthabatha inxaxheba kwiimarike zentengiso xa kuthelekiswa neemarike ezingekho semthethweni, ngelixa ulwazi olunqongopheleyo lokuzala kunye neenkonzokukhuthaza ezingekho semgangathweni zandisa ukuthatha inxaxheba kwiindlela ezisemthethweni. Iziphumo zikwabonise ukusetyenziswa kakhulu kwendlela ezingacwangciswa ezifana nokuvavanywa kobunzima bezilwanyana kunye nexabiso lentengiso, kunye nokugcinwa kwembali okuncinci ngabalimi. Ngaphezu koko, kwafunyaniswa unxibelelwano oluhle phakathi kwamaxabiso enkomo aphezulu kunye nokufezekisa indidi zengeniso ephezulu. Nangona kunjalo, indleko zabasebenzi eziphakathi zinempembelelo embi kwingeniso. Oku kubonisa ukuphuculwa kokusebenza kakuhle kwabasebenzi ukuze kunyuswe ingeniso yabalimi abancinci benkomo zenyama. Ngoko ke, kukho imfuneko yokuseka iinkqubo zokulinganisa ukusebenza ezicwangcisiweyo, ukuphucula umhlambi kunye nokungenelela kulawulo. Iinkqubo zikarhulumente ezijoliswe ekuqiniseni iinkonzokokwazisa, ukukhuthaza uqeqesho ekugcinweni kweerekhodi kunye nolawulo lokuzala, kunye nokwandisa amandla okuxoxisana amafama kwiimarike ezisemthethweni zibalulekile ekuphuculeni inzuzo, uzinzo, kunye nokuthengiswa kwamashishini amancinci enyama yenkomo.

Amagama angundoqo: Ukuthatha ixhaxheba kwi marike, amafama, amafama amancinci, imilinganiselo yokusebenza, ingeniso



Article

Determinants of Market Choices Among Beef Cattle Farmers in uMgungundlovu District of Kwa-Zulu Natal, South Africa

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Abstract

Globally, the demand for beef and beef-related products has significantly escalated over the past decade. This study aimed to evaluate the factors influencing the market participation of smallholder beef cattle farmers in uMgungundlovu, South Africa. The study employed a cross-sectional research design, which followed a mixed-methods approach to collect data. Survey data were collected from smallholder cattle farmers from the uMgungundlovu District in KwaZulu-Natal using a semi-structured questionnaire. Purposive sampling was employed to select four local municipalities from the uMgungundlovu District out of a total of seven, whereas a simple random sampling was used to recruit farmers. The sampling was conducted using Microsoft Excel, whereby each farmer was allocated a random number, and then the required sample was generated from those numbers. To determine factors that influence farmers' market choice, a multinomial logit regression model was used. A significant proportion of the farmers (43.1%) were aged between 51 and 70, followed by 35.5% aged 31 to 50. Just under half (48.1%) of farmers had received formal training in livestock production. This finding ($p < 0.001$) reinforces the central role of education in income determination. Better-educated individuals tend to earn more and diversify their income sources. This study underpinned that the livestock farming population is dominated by primarily middle-aged, male, semi-educated, and resource-poor individuals, and they rely significantly on traditional farming methods and government assistance. The multinomial logit regression revealed that farmers' market choices are influenced by education level, extension service quality, access to quality bulls, and breeding knowledge significantly influenced farmers' market choices. Specifically, secondary and tertiary education reduced the likelihood of participating in auction markets relative to informal markets, while limited breeding knowledge and poor extension services further constrained participation in formal channels.

Keywords: beef; smallholder farmers; market participation; market channels; commercialization; uMgungundlovu

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1. Introduction

Globally, the demand for beef and beef-related products has significantly escalated over the past decade [1]. The major contributing country to this rise is China's 5.1%

Article

Management Practices, Market Dynamics, and Profitability of Smallholder Beef Cattle Farmers in uMgungundlovu District, KwaZulu-Natal, South Africa

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Abstract

Smallholder beef cattle farming remains pivotal in sustaining rural livelihoods and forms part of South Africa's government efforts to promote rural development. However, the poor performance of the sector due to poor management practices, limited access to formal markets, and weak profitability continues to raise concerns. This study sought to investigate the performance of smallholder beef cattle farmers in the uMgungundlovu District, KwaZulu-Natal, focusing on livestock management practices, productivity, and profitability. A cross-sectional survey was conducted with 397 farmers across four municipalities. Descriptive statistics were used to analyse the performance measurement methods of smallholder farmers. Moreover, an ordinal regression model was used to determine the effect of socio-economic and management factors on revenue outcomes. The results revealed the predominant use of informal methods such as visual appraisal of animal weight and market price, with limited record-keeping by farmers. Furthermore, the results further revealed the significant positive influence of higher cattle prices on achieving higher revenue categories. However, mid-range labour costs had a negative influence on revenue. This suggests improvement in labour efficiency to raise revenues for smallholder beef cattle farmers. Therefore, there is a need for the establishment of structured performance measurement systems, improved herd and management interventions. Government policies that target strengthening extension services, promoting training in record-keeping and breeding management, and improving farmers' bargaining power in formal markets are critical for enhancing the profitability, sustainability, and the commercialization of smallholder beef enterprises.

Keywords: smallholder cattle farming; performance measurement; revenue; ordinal logistic regression; KwaZulu-Natal

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1. Introduction

The profitability of beef cattle enterprises, particularly among smallholder farmers in Sub-Saharan Africa, is shaped by a range of interrelated factors. These factors include economic, social, environmental, and technological dimensions. Understanding these factors is crucial for gauging and developing the necessary interventions that are aimed at improving the livelihoods of these smallholder farmers and enhancing the sustainability of

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List of Acronyms and Abbreviations

ASALs	Arid and Semi-Arid Lands
CASP	Comprehensive Agricultural Support Programme
DAFF	Department of Agriculture, Forestry and Fisheries
DARD	Department of Agriculture and Rural Development
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
ICT	Information Communication Technology
IDC-Sal	Industrial Development Corporation of South Africa Ltd
IFAD	International Fund for Agricultural Development
NDA	National Department of Agriculture
PES	Presidential Employment Stimulus

Chapter 1: Introduction

1.1. Background

In South Africa, smallholder livestock farming, particularly cattle production, constitutes a critical component of rural livelihoods and plays a significant role in the broader rural economy. The sector contributes not only to household income and food security but also to employment creation and socio-economic stability in predominantly rural communities. Livestock production plays a significant role in the agricultural subsector in developing countries worldwide, especially in sub-Saharan Africa, and contributes approximately 40% to the agricultural Gross Domestic Product (GDP) in the region (Sejian *et al.*, 2016). Food and Agriculture Organisation (FAO) suggested that the demand for animal products as a source of food is growing rapidly around the world, and it shows that the livestock sector will need to expand to accommodate this growing demand (FAO, 2012).

Livestock is by far the most significant agricultural sub-sector in South_Africa, contributing an estimated 25-30% to total agricultural output per year (Blignaut *et al.*, 2014; Maltou, 2019). Cattle, sheep, and goat farming in South Africa occupy approximately 53% of all agricultural land (Ngarava *et al.*, 2019). Population and income growth, increasing demand for livestock products, globalization, lifestyle changes, and rural-urban migration are among the factors driving rapid growth in the livestock industry in South Africa (Nyam *et al.*, 2021). Cattle farming is a foundation of rural livelihoods and provides a source of income, food security, and socio-cultural relevance (Mapiye *et al.*, 2020). For smallholder farmers, cattle are not only a means of generating income through the sale of meat, milk, and by-products but also serve as a form of savings and investment, helping to ensure that households are resilient to economic shocks (De Haan *et al.*, 2016).

The rapid growth in demand for livestock products will increase pressure on livestock farmers to increase production, and higher production is expected to improve their incomes and livelihoods, especially smallholders in developing countries who depend on livestock production for their livelihoods (Thornton *et al.*, 2010). Cattle farming offers smallholders a wide range of opportunities to participate in the agricultural value

chain (Jordaan *et al.*, 2014). In addition to meat production, cattle also provide valuable by-products such as hides and manure, which are used for leather production and to improve soil fertility (Patel *et al.*, 2022). Furthermore, cattle play a crucial role in sustainable agricultural practices, including rotational grazing and soil conservation, thus contributing to environmental sustainability (Baronti *et al.*, 2022)

Mathinya *et al.* (2020) have stated that due to several production and marketing constraints, most smallholder farmers in South Africa are yet to experience growth in livestock production. Most of the increases in livestock production are taking place outside the smallholder sector. Like most developing countries, smallholder farmers in South Africa depend on livestock production for their livelihood. The livestock sector is characterized by a dual system with a large-scale commercial system and a smallholder/subsistence system (Van Marle-Köster *et al.*, 2023)

Several studies have measured the constraints and competitiveness of smallholder livestock production in Africa (Amankwah *et al.*, 2012; Ndoro *et al.*, 2014; Gobena, 2016; Mahirwe & Wei, 2018; Ngarava *et al.*, 2019). Smallholder cattle farming in Africa presents a range of challenges, successes, and opportunities (McDermott *et al.*, 2010). In terms of management practices, smallholder farmers often face constraints related to limited access to extension services, veterinary care, and technical knowledge (Justus *et al.*, 2013). This can lead to sub-optimal productivity and increased vulnerability to disease outbreaks and climate variability (Koirala *et al.*, 2017). Despite the support for commercially oriented small-holder farmers, there is growing evidence that these farmers continue to be weighed down by low productivity- and poor access to markets (Swanepoel *et al.*, 2010).

This is due to several management constraints including drought, stock theft, feed shortages, diseases and parasites, and lack of markets and financial resources (Khapayi & Celliers, 2016; Mapiye *et al.*, 2009). Apart from these, low productivity could be due to a lack of livestock farming information facilities and inadequate access to appropriate extension information by the farmers (Brhane *et al.*, 2017; Moyo & Salawu, 2010). This is because a lack of appropriate information impairs farmers' management capacity and, consequently, their responses to challenges and opportunities (Zondi *et al.*, 2024; Mbanda-Obura *et al.*, 2017).

Smallholder farmers in developing countries have largely depended on public extension services for livestock farming information (Adetayo & Eunice, 2013; Sebeho & Stevens, 2019). Along with the public extension, farmers also acquire information from other farmers, friends, and relatives (Mbanda-Obura *et al.*, 2017) and information communication technology (ICT)-based sources such as the Internet, mobile phone, television, and radio (Zondi *et al.*, 2024; Motiang & Webb, 2015); and print media (Mtega *et al.*, 2016). However, it has become difficult for smallholder farmers to continuously rely on the public extension system (Moyo & Salawu, 2010). The underlying concern is that the public extension systems especially from developing countries besides being extension agent-based have generally become weak (Zondi *et al.*, 2024) and this is largely attributed to a lack of resources, inefficiencies, and bureaucratic processes (Adetayo & Eunice, 2013).

Currently, livestock productivity is much lower in lower-middle-income countries (LMICs) than in high-income countries (Gerosa & Skoet, 2012). Moreover, increasing per-animal productivity is essential for environmental sustainability as systems intensify. For example, sub-Saharan Africa is a livestock greenhouse gas emissions intensity hotspot mainly because yields are low (McDermott, 2010). Poor productivity is caused by many factors including unimproved genetic stock, inadequate veterinary provision, and a general scarcity of high-quality inputs (Bahta & Nyaki, 2024). Access to high-quality feed is generally agreed to be the main constraint on better productivity (Ayantunde *et al.*, 2005; Thornton, 2010). The livestock feed challenge has proved to be intractable despite considerable research and development efforts over the past three decades. This effort has included many programs aimed at delivering high-quality feed options to smallholder livestock keepers, but the evidence for their effectiveness is sparse (White *et al.*, 2013)

Production challenges in smallholder cattle farming include inadequate feed, water scarcity, and soil degradation, which can limit herd growth and productivity (Mapiye *et al.*, 2018). Successes in overcoming these challenges have been achieved through the introduction of sustainable land management practices, improved animal husbandry techniques, and the introduction of drought-resistant cattle breeds (Sanz *et al.*, 2017) There are also opportunities for innovation and the introduction of technologies, such as mobile-based veterinary services and digital market platforms,

which can improve production efficiency and market access for smallholder farmers (Mapiye *et al.*, 2023)

The cattle industry in South Africa exhibits a dual nature, comprising both commercial and smallholder sectors (Meissner, 2013). While the commercial sector is characterized by large-scale, intensive production systems, the smallholder sector consists of subsistence and semi-commercial farmers operating on smaller landholdings with limited resources (Jaleta *et al.*, 2009). However, successful interventions such as community-based extension programs and farmer cooperatives have demonstrated the potential to improve livestock management practices and increase productivity (Kabane *et al.*, 2020).

Differences between the commercial and smallholder cattle farming sectors include access to resources such as land, capital, and infrastructure, as well as production scale and market orientation (Abafita *et al.*, 2016). Commercial farmers often benefit from economies of scale, advanced technology, and formal market linkages, enabling them to achieve higher productivity and profitability (Poulton *et al.*, 2010). In contrast, smallholder farmers face challenges related to land tenure insecurity, limited access to credit and markets, and inadequate support services, which constrain their ability to compete in the broader livestock market (Salami *et al.*, 2010).

The commercialization of smallholder livestock farming is of great importance for the improvement of rural livelihoods and economic development in Africa (Belay *et al.*, 2021). By switching from subsistence to commercial production systems, smallholder farmers can gain access to formal markets, increase their income, and improve their standard of living. Commercialization also stimulates investment in agricultural value chains, creates employment opportunities, and contributes to poverty reduction and food security (Nassirou, *et al.*, 2016).

However, the commercialization process is not without its challenges. Smallholder farmers often lack access to the necessary resources, including land, finance, technology, and market information, to effectively engage in commercial farming (Magakwe *et al.*, 2025). In addition, inadequate infrastructure, such as transportation and storage facilities, as well as regulatory barriers, such as cumbersome certification procedures, can hinder market access and competitiveness (Langyintuo *et al.*,

2020). There is also a risk that vulnerable groups, particularly women and historically disadvantaged communities, may be excluded from or bypassed by the commercialisation process, thereby exacerbating existing inequalities within the livestock sector (Aregu *et al.*, 2010).

Given the importance of the smallholder livestock sector to rural livelihoods and economic development, there is an urgent need for research to explore the challenges and opportunities faced by smallholder livestock keepers in South Africa and Africa as a whole. Research in this area can contribute to evidence-based policy interventions, technological innovations, and capacity-building initiatives aimed at improving smallholder productivity, market access, and resilience. By fostering interdisciplinary collaboration and knowledge sharing, research can play a critical role in unlocking the full potential of the smallholder livestock sector and promoting inclusive and sustainable development in rural communities.

The uMgungundlovu District Municipality was selected as the study area for several compelling reasons. First, it is one of the districts in KwaZulu-Natal (KZN) with a documented concentration of registered smallholder cattle farmers, as evidenced by the KZN Department of Agriculture and Rural Development (DARD) livestock database (KZN DARD, 2022). Second, uMgungundlovu has been a priority target area for government livestock development programmes, including the Comprehensive Agricultural Support Programme (CASP) and the Provincial Extension Support and Intervention (PESI), making it a strategic site for evaluating smallholder performance outcomes. Third, the district represents a microcosm of the broader KwaZulu-Natal smallholder challenge, combining resource-constrained communal farming with proximity to formal beef markets; a combination that makes the management-productivity-market access nexus particularly pertinent. No district-level study integrating these three dimensions has previously been conducted in uMgungundlovu, constituting the geographic justification for this research.

1.2. Research problem

There have been several attempts by the government and other stakeholders to improve the performance of smallholder cattle farmers in South Africa (Nyamushamba *et al.*, 2017). However, little progress has been made. The main problem has been the lack of capacity among the farmers to perform at the expected level. The cattle herd in the smallholder sector is an underutilized resource for beef production, although it has the potential to reduce beef imports, which are between 10 and 15% of local production per annum (National Department of Agriculture (NDA, 2022; FAO, 2020). There are calls for the need to increase output and off-take, which currently stands at 5%, from the smallholder areas (Nontu *et al.*, 2025).

Several programs have been initiated in the past to transform smallholder farming into commercially oriented production as part of the National Development Plan (NPC, 2013). These programs include the Comprehensive Agricultural Support Programmes (CASP) (2003 - present), the Land Care Programme (Mulder *et al.*, 2006), the Presidential Employment Stimulus (PESI), and the COVID-19 Grant Programme (Academy of Science of South Africa, 2021), among others. The programs supported smallholder cattle farmers with inputs (animal medication, vaccines, feed, JoJo tanks, fencing material), purchase of new livestock breeds, livestock infrastructure, rangeland management (removal of alien species in grazing areas), and direct funding (Tripathi *et al.*, 2021). However, the evaluation of some of these programs, such as CASP, shows that they have not comprehensively achieved their objectives (Ntombela *et al.*, 2019). This could be related to the poor design, management, accountability, and monitoring inherent in most government programs. However, gaps remain because it is evident that the farmers are performing poorly at the auction and abattoirs where they sell their cattle.

Majority of the Eastern Cape population focus on producing livestock and livestock products due to erratic rainfall and high incidence of droughts in the province (Nontu *et al.*, 2025; Bahta & Nyaki, 2024). Livestock farming has consequently been identified as the agricultural enterprise with the greatest potential to improve household food security, alleviate poverty, and enhance rural livelihoods in communal farming areas of South Africa. This recognition is reflected in national policy frameworks including the National Development Plan (NDP, 2030) and the Agricultural and Agro-processing

Master Plan (AAMP, 2022) (Slayi *et al.*, 2023; Mathinya *et al.*, 2023). Although livestock thrives well in marginalized environments, the market off-take rate is low. Off-take rates between 5 and 10% have been reported, compared to 25% in the commercial sector (StatsSA, 2024). The poor performance of the livestock enterprise is associated with poor livestock management practices (Molefi *et al.*, 2017). Gaps exist in knowledge, modern farming technologies, animal health, and feed management. Other studies showed that farmers still traditionally raise their cattle with low healthcare intervention (Miranda *et al.*, 2010; Mthi *et al.*, 2020).

A study on cattle production and breeding practices in the communal farming system in the Eastern Cape Province found that the major constraints to cattle production in the area included a lack of infrastructure, tick-borne diseases, and feed shortages, among others (Mthi *et al.*, 2020). This shows that poor breeding management contributes to poor livestock enterprise performance in communal areas (Mthi *et al.*, 2020). It is therefore important to identify the capacity gap among cattle farmers regarding cattle management practices. Addressing these gaps will improve herd performance (productivity, calving percentage, etc.) and ultimately result in more income, improved livelihoods, and growth in the local economy (Temoso *et al.*, 2016). This study seeks to identify and evaluate the current livestock management practices farmers use. It will also determine the extent to which the current practices affect the beef enterprise performance.

In livestock production, a sustainable farming system is characterized by improved herd productivity and profitability. Reproductive performance is one of the factors influencing farm productivity, as successful pregnancy and parturition rates drive farm profit (Tep *et al.*, 2020). The reproductive performance of beef cattle under extensive systems has been reported as low for over a decade with average calving rates of less than 48% (Scholtz *et al.*, 2010; Stroebel *et al.*, 2011; Mmbengwa *et al.*, 2015; Mugwabana *et al.*, 2018; Van der Westhuizen *et al.*, 2020; Grobler *et al.*, 2022). This figure is lower than the established industry standard of 65% calving rate in commercial herds and the Department of Agriculture, Land Reform, and Rural Development's recommended national average of 85% for beef cattle in South Africa (SA) (Grobler *et al.*, 2019; Department of Agriculture, Land Reform, and Rural Development, 2019). To date, beef cattle farming in smallholder farms in SA reports

no measures of herd selection for reproductive performance indicators. Moreover, a lack of understanding of basic herd management principles and the use of uncontrolled breeding systems are the norm on most farms (Tep *et al.*, 2020; Mapiye *et al.*, 2018; Mthi *et al.*, 2020; Budisatria *et al.*, 2021).

Smallholder beef farmers in South Africa are having difficulty meeting cattle market standards. The reasons for this could include poor management practices, lack of knowledge, and limited resources (Nkosi & Kirsten, 1993). However, attempts have been made in the past to improve the knowledge and practices of smallholder cattle farmers to meet market expectations. These efforts include training workshops and information support provided by government Extension Officers and Farmer Associations. Despite these efforts, not much has been achieved. In their study, Alemneh *et al.* (2019) found that sales of live animals in smallholder farming are taken as a last resort, and large ruminants such as cattle are generally sold when they are old, culled, or barren.

In South Africa, studies have shown that the poor condition of livestock is important, but the age of animals (too old) when farmers do sell is equally contributing to poor prices. Mudau *et al.* (2022) stated that the poor condition of livestock is also attributable to inadequate grazing and the extreme degradation of natural resources. The lack of suppliers of important agricultural inputs for livestock farmers, such as vaccines and feed supplements, and the common problem of animal genetic inferiority further reduce the desirability of animals. Nengovhela *et al.*, (2021) reported that low levels of technology adoption further compound the problem. The growth of smallholder cattle farming will not be achieved without improving their ability to meet market expectations and obtain the best value for their production (Livingston *et al.*, 2011).

Most of these abattoirs are linked to feedlots. The number of cattle slaughtered in South Africa reached approximately 3.26 million heads in 2022, sustaining demand-driven growth in the beef sector, with beef production valued at approximately R48 billion in 2023 (DALRRD, 2022; USDA-FAS, 2024). Mpumalanga accounts for the greatest share of beef production in South Africa at 20% (2018/19), followed by Free State (19%), Gauteng (17%), and North West (10%) (DALRRD, 2020) Communal farmers largely avoid using abattoir channels to market their animals due to several

compounding barriers: the distance from production areas to registered abattoirs, delays in payments, the poor body condition and quality of animals, high and unaccounted-for transportation costs, and the impracticality of selling only one or two animals (Mkhize *et al.*, 2026; Hlatshwayo *et al.*, 2021; NAMC, 2024).

Nkosi and Kirsten (1993) stated that livestock auctions are the most important marketing channel for livestock. However, low marketable livestock numbers, especially cattle, pose a significant challenge for auction agents in developing areas. Smallholder farmers usually consume a larger proportion of their produce and/or sell the surplus to local communities (Mkuna & Wale, 2022). The importance of this study rests on its ability to demonstrate the untapped potential of transitioning smallholder beef cattle farmers in uMgungundlovu District from subsistence-oriented production towards greater market participation, a transition that is critical for improving rural household incomes and reducing poverty. However, the extent to which they can penetrate varies across local areas of study and depends on the availability of infrastructure and market information. According to Oduniyi *et al.* (2021), smallholder farmers are excluded from one of the most lucrative channels, such as direct sales to supermarkets and exports, mainly due to a lack of management skills, small quantities produced, low quality of the produce, lack of suitable storage facilities, little value added to their products, transport constraints, and insufficient dissemination of market information.

Despite growing scholarly and policy interest in smallholder beef cattle farming in South Africa, a critical knowledge gap remains in the literature. While previous studies have examined isolated aspects of smallholder livestock production, such as market access constraints (Musemwa *et al.*, 2008), management practice limitations (Khapayi & Celliers, 2016), and productivity challenges (Mapiye *et al.*, 2018), no study has simultaneously integrated management practices, productivity indicators, and market access into a unified analytical framework at the district level. This is particularly relevant for the uMgungundlovu District, KwaZulu-Natal, where smallholder beef cattle farming is a critical livelihood activity yet remains chronically underperforming. Furthermore, limited attention has been paid to how socio-economic characteristics and management behaviour interact to shape farmers' revenue outcomes. The absence of this integrated, district-level evidence constrains policymakers' and

development practitioners' ability to design targeted, evidence-based interventions. This study addresses that gap by examining the performance of smallholder beef cattle farmers in uMgungundlovu through the simultaneous analysis of management practices, productivity, and market access

1.3. Research objectives

The study aims to evaluate the performance of smallholder beef farmers in the uMgungundlovu District, focusing on their management practices, productivity, and market access.

The specific objectives of the study are as follows:

- (i) To identify smallholder farmer livestock management practices in uMgungundlovu District.
- (ii) To characterise beef markets available to smallholder farmers and determine factors that influence smallholder beef cattle farmers' market choice in uMgungundlovu District.
- (iii) To determine the profitability of the smallholder beef cattle enterprise in uMgungundlovu District.
- (iv) To determine factors that affect the performance of smallholder farmers' beef cattle enterprise in uMgungundlovu District.
- (v) To make recommendations for improving the performance of the smallholder beef sector in the district.

1.4. Research questions

The overarching research question guiding this study is: What factors determine the performance of smallholder beef cattle farmers in uMgungundlovu District, and how do management practices and market access constraints interact to shape enterprise outcomes? This consolidated question is addressed through the following specific sub-questions:

- (i) What are the livestock management practices employed by smallholder cattle farmers? To what extent do these compare with the recommended standards?
- (ii) How profitable are smallholder beef cattle enterprises?

- (iii) To what extent do smallholder beef management practices affect the performance of their beef enterprise?
- (iv) What are the levels of farmers' participation in the beef markets? What determines the level of their market participation?

1.5. Hypothesis

The following hypotheses were tested in the study:

- (i) H_{01} : Socio-economic and management factors do not significantly influence the market choice decisions of smallholder beef cattle farmers in uMgungundlovu District.
- (ii) H_{11} : Socio-economic and management factors significantly influence the market choice decisions of smallholder beef cattle farmers in uMgungundlovu District.
- (iii) H_{02} : Socio-economic and management factors do not significantly influence the revenue outcomes of smallholder beef cattle farmers in uMgungundlovu District.
- (iv) H_{12} : Socio-economic and management factors significantly influence the revenue outcomes of smallholder beef cattle farmers in uMgungundlovu District.

1.6. Contribution of the study

The study makes various contributions to the body of knowledge, including empirical, methodological, and theoretical. Empirically, it has already been established that smallholder cattle farmers face constraints in management, in productivity, and in market access. Each of these constraints has been documented largely on the evidence from the Eastern Cape and Limpopo. What was not already known before this study is the relative contribution of these sets of constraints. This is mainly because the three had not been measured on the same households. Thus, this study's empirical contribution is the measurement of all three among 397 households in uMgungundlovu and the joint modeling of these variables. The specific new finding is that the two dimensions of enterprise performance (market channel and revenue outcomes) have different determinants. While the market channel choice is determined by human capital and by institutional support, namely education level,

extension service quality, access to quality bulls and breeding knowledge, revenue is determined by price and cost structure, namely the realised cattle price category and the labour cost band. Market distance is not a significant determinant of either. There is no previous South African study that has shown this separation.

The theoretical contribution is based on the two frameworks (the Sustainable Livelihoods Framework and Household Production Theory), which have been used to derive the conceptual framework of this study. Thus, the study's two important findings make it necessary to modify these two source frameworks. The first concern regards the Sustainable Livelihoods Framework, which treats transforming structures as a contextual layer that mediates the effect of assets on outcomes. The results show that the quality of the extension service is a significant determinant of the market channel, while physical access to the market is not. This shows that in this setting, the institution is not mediating the effect of the asset position but acting as a binding constraint independently of it. Thus, this requires refining the framework so that, in situations where the transforming structures fall below a certain threshold of functionality, they cease to mediate and begin to bind. Thus, the framework should treat institutional quality as a constraint variable rather than as context.

The second concern is regarding Household Production Theory, which specifies labour as a continuously variable input with a positive and diminishing marginal product. The result of the ordinal model gives a significant negative coefficient on the middle labour cost band, while the highest band is not significant. There is no monotonic input relationship that can generate this pattern. The interpretation advanced is that labour in these systems switches regime rather than scaling, moving from unpaid family labour to hired herding at a discrete point, and that the fixed cost of the switch is incurred in full before the herd reaches the scale at which it is recovered. The contribution is the identification of a labour threshold effect in smallholder cattle systems, which the standard specification does not predict and cannot detect, since a continuous specification would average the two regimes and return a null result.

The study also makes some methodological and policy contributions. Methodologically, the study shows that in a data-scarce environment where farm financial records are absent (where income is disclosed only within brackets, and

where non-response on sensitive items runs as high as 74.3%) a paired specification of a multinomial logit for channel and an ordinal logistic model for revenue is suitable for producing robust results. Although these are standard models, the study that demonstrated the ordinal banding of revenue succeeds where continuous income measurement fails, which makes district-level econometric work feasible in settings where it is usually abandoned. On policy, the study establishes for uMgungundlovu that the operative institutional variable is the quality of extension rather than access to it, and it identifies two thresholds, a cattle price above R4 000 per head and a labour cost band of R1 500 to R2 000 per month, at which revenue outcomes change.

1.7. Delineation of the study

This study is geographically confined to four local municipalities within the uMgungundlovu District Municipality of KwaZulu-Natal, South Africa: uMngeni, Richmond, iMpofana, and Impendle. These municipalities were purposively selected based on their agricultural activity and the prevalence of smallholder cattle farming. The study focuses exclusively on registered smallholder beef cattle farmers who own between 1 and 50 head of cattle. It does not extend to commercial cattle enterprises, other livestock types (such as dairy, poultry, or small stock), or municipalities outside the selected district. Data were collected during the 2023/2024 agricultural season using a structured questionnaire administered through face-to-face interviews. The study does not assess the full value chain beyond the farm gate; specifically, abattoir operations, processing, and retail are outside the scope of this research.

1.8. Definition of keywords

Smallholder farmers: small-scale farmers, pastoralists, forest keepers, and fishers who manage areas ranging from less than 1 hectare to 10 hectares. Smallholders are characterized by family-focused motives such as favouring the stability of the farm household system, using mainly family labour for production, and using part of the produce for family consumption (FAO, 2009). Thus, in this study, a smallholder beef cattle farmer is defined as a farmer who owns between 1 and 50 head of cattle, produces primarily for household consumption and occasional market sales, relies mainly on family labour and traditional management practices, and operates within the communal or small-scale farming sector

Commercialization: following Pingali and Rosegrant (1995), is defined as the process by which subsistence-oriented farm households progressively increase market orientation, producing a larger share of output for sale and increasingly aligning production decisions with market price signals. In the smallholder livestock context, commercialization is not viewed as a binary state but a continuum ranging from fully subsistence-oriented production (all cattle retained for household use and social purposes) to semi-commercial production (surplus cattle sold through informal channels) to commercial production (systematic cattle sales through formal auction or abattoir channels to maximise income). This study examines factors influencing the position of smallholder farmers along this commercialisation continuum, recognising that most farmers in uMgungundlovu fall within the subsistence-to-semi-commercial range.

Subsistence farmers: Subsistence farming is a form of farming in which nearly all of the crops or livestock raised are used to maintain the farmer's family, leaving little, if any, surplus for sale or trade.

Farm performance: In this study, enterprise performance refers to the measurable outcomes of smallholder beef cattle farming. Following Reardon, Crawford, and Kelly (1994), performance is conceptualised as encompassing three interrelated dimensions such as productivity, revenue generation and market participation. Productivity is defined as the efficiency with which inputs (land, labour, capital) are converted into outputs (cattle, revenue). Revenue generation refers to the gross income realised from cattle sales. Market participation is the degree to which an enterprise engages with formal or informal beef markets. This multidimensional conceptualisation of performance is appropriate for smallholder systems where profitability alone does not capture the full range of enterprise outcomes, and where subsistence and commercially oriented farmers coexist within the same geographic area.

Profitability: Profit is the difference between the revenue that an economic entity has received from its outputs and the total costs of its inputs (Arnold, 2001).

Market access: Market access is the process that ensures new technology has fast, sustained market access at the right price for the right patients who would gain a major benefit from it (Mantovani *et al.*, 2018).

Livestock management practices: Livestock management is a program that applies biological and chemical principles to the production and management of livestock, and to the production and handling of meat and other products (Kaasschieter *et al.*, 1992). It involves beef management practices, in which cattle producers need good handling facilities to perform recommended practices, including vaccinating, identifying, castrating, dehorning, implanting, deworming, and checking for pregnancy (Lakshmi, 2023).

Auction: According to Nkosi and Kirsten (1993), livestock auctions are marketplaces where producers bring their livestock to sell through public bidding to buyers who offer the highest price per animal. Those auction places are organized at regular times and are open to all individuals, whether they are producers selling or buyers, such as another farmer, a speculator, a butcher, or anyone buying for personal use (NDA, 2005).

Abattoirs: It is a place where animals are slaughtered.

1.9. Chapter summary

Chapter 1 establishes the rationale and context for the study. It opens by situating smallholder beef cattle farming within South Africa's rural development agenda, documenting its contribution to household income, food security, and socio-economic stability in communal areas. The chapter draws on national and global statistics to demonstrate the growing importance of the livestock sector, while simultaneously identifying the persistent performance gap between the commercial and smallholder sectors. It documents the structural constraints facing smallholder farmers, including inadequate management practices, low market off-take rates, poor access to extension services, and limited market participation. It also establishes why uMgungundlovu District, KwaZulu-Natal, was selected as the study site.

The chapter proceeds to outline the overarching research question, what factors determine the performance of smallholder beef cattle farmers in uMgungundlovu, and

how do management practices and market access constraints interact to shape enterprise outcomes? Moreover, it outlines five specific objectives covering management practices, profitability, market characterisation, performance determinants, and policy recommendations. Testable null and alternative hypotheses are stated for both market choice and revenue outcomes. The study's original contribution to knowledge is declared across three dimensions. Empirically it focuses on district-level integrated analysis in uMgungundlovu. Methodologically it combines multinomial logit and ordinal logistic regression. The chapter concludes with key term definitions and a structured overview of the thesis.

1.10. Outline of the study

This thesis is structured into seven chapters, from contextualisation through empirical analysis to conclusions and recommendations. Chapter 1 introduces the study by establishing the background, problem statement, research objectives, hypotheses, justification, scope, and thesis structure. Chapter 2 presents a critical review of the relevant literature, organised under sub-sections that cover market participation and commercialisation, characteristics of smallholder farmers, market access constraints, marketing channels, livestock management and production constraints, and the KwaZulu-Natal livestock context. The chapter concludes by identifying the theoretical and conceptual frameworks guiding the study and the key gaps in the literature that this research addresses. Chapter 3 describes the research paradigm, design, study area, sampling procedure, data collection instrument, and analytical methods. Chapter 4 presents the descriptive socio-economic results, characterising the farming population in uMgungundlovu. Chapter 5 reports on breeding management practices, production and herd management, market dynamics, and performance measurement methods. Chapter 6 presents the econometric results of the multinomial logit and ordinal logistic regression models. Chapter 7 provides the summary, conclusions, recommendations, theoretical and methodological contributions, limitations, and directions for future research.

Chapter 2: Literature Review

2.1 Introduction

This chapter reviews the relevant literature for the study. It covers the global and South African context of smallholder beef cattle farming, characteristics of smallholder farmers, management practices and productivity, market access and market choice, and profitability determinants. The chapter concludes by identifying the key research gaps that this study seeks to address and presenting the theoretical and conceptual frameworks that guide the analysis. Overview of smallholder farming context in South Africa

2.2 Overview of smallholder farming context in South Africa

The literature indicates that the participation of South African emerging beef farmers in high-value agricultural markets is unsatisfactory (Oduniyi *et al.*, 2021; Hlatshwayo *et al.*, 2021; Nkadimeng, 2019; DALRRD, 2021; Nyamazana, 2023). It may be easy to access the market, but retaining one's position in the market is more difficult, particularly for South African emerging beef farmers (Ohen *et al.*, 2014; Maiyo *et al.*, 2016). The authors have identified two types of markets, informal and formal. Informal markets embrace unofficial transactions among farmers and from farmers directly to consumers. On the other hand, Hlatshwayo *et al.* (2021) state that formal markets have clearly defined grades, quality standards, and safety regulations, and that prices are set formally. Smallholder farmers find it difficult to access these formal markets.

However, access to markets is essential for poor farmers in rural areas if they are to benefit from agricultural growth. Rural people in many parts of the world, including South Africa, often report that they cannot improve their living standards because they cannot access markets (Nyamamu *et al.*, 2025). They struggle to secure high-value agricultural markets due to their lack of understanding of market structures and channels (Mkhize *et al.*, 2026). Smallholder farmers are constrained by high transaction costs, high risks, missing markets, and a lack of collective action in the marketing environment. The development and support of smallholder farmers are imperative for addressing high levels of rural poverty in many developing countries, including South Africa (Mkhize *et al.*, 2026). A major challenge for sustainable

agricultural development in South Africa is the limited ability of previously disadvantaged farmers, e.g., emerging farmers, to access both viable local and international markets for their produce (Zantsi *et al.*, 2021).

Mudhara, (2010) stated that the South African government liberalized the marketing environment when it introduced the Marketing of Agricultural Products Act of 1996. Satgar (2011) argues that although market liberalization was intended to create equal opportunities for all players in the agricultural industry, this goal was never realized. Monopolistic businesses that operated under the guise of farmers' cooperatives increased in structural power after markets were liberalised. Another development resulting from market liberalisation was that farmers' cooperatives converted into private and public companies. An example given by Satgar (2011) is the National Cooperative Dairies (NCD), which was founded in 1898. After market liberalisation, the NCD became more powerful by forming joint ventures with companies such as Danone and Fonterra.

In South Africa, market liberalisation was a major drawback for smallholder farmers, as the inexperienced farmers found themselves competing for market share in an extremely competitive environment (Van Schalkwyk *et al.*, 2012). Smallholder farmers also found themselves incurring high transaction and transport costs to access markets after the liberalisation of the market (Van Schalkwyk *et al.*, 2012). According to the Department of Agriculture, Forestry and Fisheries (2012), smallholder farmers lack reliable markets. As a result of this development, the farmers end up selling their produce at "giveaway prices" at their farm gates or local markets.

In South Africa, a dual system exists in the livestock farming sector, with a highly commercialised and subsistence system. Cattle are the primary livestock activity in the country in both commercial and smallholder farms. Cattle production is more concentrated in the KwaZulu-Natal, Eastern Cape, Free State, and Northwest. Cattle farmers in rural areas of South Africa struggle to participate in the formal economy due to limited access to markets and other institutional challenges (DALRRD, 2022). Cattle farmers identified interrelated issues, including a lack of good infrastructure, production inputs, and extension services, poor livestock quality, and traditional norms (Coetzee *et al.*, 2005; Musemwa, 2008; Mmbengwa *et al.*, 2015).

Commercialisation of smallholder agriculture through increased participation of smallholder farmers in formal markets is a critical requirement for the economic growth and development of most developing countries relying on agriculture (Pingali, 1995). Improving productivity, profitability, and sustainability of smallholder farming is the main pathway to reducing poverty in developing countries (World Bank, 2020). Markets play an important role in rural development, employment creation, income generation, food security, technology diffusion, enhanced resource-use efficiency, and the development of rural-market linkages. Market availability and the ability of smallholder and resource-poor rural farmers to access market opportunities and diversify their market links are, therefore, prerequisites for enhancing agriculture-based economic growth and increasing rural incomes (Oparinde, 2014).

Livestock plays a significant role in the growth of state economies and sustainable food systems. The global livestock market is projected to reach USD 20 billion by 2026, increasing at an average annual rate of 0.3% since 2017. Global livestock production is projected to reach over 2 billion heads by 2026, increasing at an average annual rate of 0.5% (ReportLinker, 2022). In Africa, the livestock sector accounts for between 30 and 80 percent of the agricultural gross domestic product (GDP), depending on the country (Erdaw, 2023). Despite the sector's advancements, it receives only 5 to 10 percent of agricultural investments (Ederer, 2023). Globally, and even in the livestock-keeping regions of Eastern Africa, livestock is essential to achieving the 17 Sustainable Development Goals (SDGs) of the United Nations. Livestock and development programs directly contribute to the SDGs: No Poverty (SDG 1), Zero Hunger (SDG 2), Good Health and Well-being (SDG 3), Gender Equality (SDG 5), Decent Work and Economic Growth (SDG 8), Climate Action (SDG 13), and Partnerships to Achieve the Goals (SDG 17). Key to achieving food, economic, and nutrition security, Kenya's livestock sector provides a substantial portion of the population with a means of subsistence. This sector accounts for around 12% of the national gross domestic product (GDP) and 42% of agricultural GDP (Bahta *et al.*, 2023). Over 10 million pastoralists living in the Arid and Semi-Arid Lands (ASALs), which are home to 36% of Kenya's population, produce 70% of the country's livestock output (Martijn *et al.*, 2018).

Livestock production and marketing systems are crucial components of the growth of the livestock sector, as they facilitate the creation and communication of the value of livestock and livestock products to different market segments. Consequently, control of competition and market access variables will strengthen livestock development programming, allowing pastoral areas to sustain livestock production and marketing investments with greater flexibility (Anno *et al.*, 2023).

One of the most pronounced differences in beef from pasture versus concentrate-fed cattle is meat colour. Several reports confirm that pasture-fed cattle have darker meat (Therkildsen *et al.*, 1998; Bruce *et al.*, 2004; Mancini & Hunt, 2005). In addition, Priolo *et al.* (2001) examined 35 experiments in which the effect of pasture versus concentrate feeding on meat colour was assessed by objective and subjective methods in the same meat cuts. The results confirm that dietary components, and in particular grass feeding, affect meat colour and flavour in cattle and sheep. Meat from beef and sheep raised on pasture or extensive grazing is generally darker than meat from ruminants fed concentrates, which was confirmed by both objective (meat lightness) and subjective (meat brightness) measurements (Priolo *et al.*, 2001; Priolo *et al.*, 2002). Meat from pasture-fed animals is about 10% less bright than that from concentrate-fed animals.

2.3 Characteristics of smallholder beef cattle farmers in South Africa

Smallholder farmers are a heterogeneous group whose characteristics vary according to resource endowment, production orientation, market participation, and access to technology. Earlier studies often associated smallholder farming with subsistence production, limited access to information, low education levels, and weak managerial capacity (Mudhara, 2010; Department of Agriculture, Forestry and Fisheries- DAFF, 2012). These characteristics remain relevant for many resource-constrained and pro-poor farming households, particularly in rural areas where access to extension services, finance, infrastructure, and markets is still limited. However, contemporary evidence suggests that smallholder farming is increasingly diverse and should not be viewed as uniformly low-input or subsistence-oriented.

Many smallholder farmers are now engaged in commercially oriented, highly intensive farming systems, including hydroponics, aquaponics, aquaculture, poultry, and micro-

livestock enterprises, often operating successfully on less than 1 hectare of land. In this regard, farm size alone is no longer an adequate indicator of productivity or commercial potential. Recent developments in technology adoption, digital agriculture, contract farming, and value-chain integration have enabled some smallholders to improve productivity, profitability, and market participation despite limited land resources.

Nevertheless, a significant proportion of smallholder farmers in South Africa continue to face structural constraints, including inadequate access to finance, poor infrastructure, limited market information, climate variability, and unequal participation in formal value chains. These challenges contribute to persistent rural poverty and food insecurity among vulnerable farming households. Smallholder farmers should be understood as a diverse category comprising both subsistence-oriented producers and commercially oriented emerging farmers operating under different socio-economic and agro-ecological conditions.

Other limitations to market access include the poor condition of livestock and the low marketable livestock. Nkhori (2004) asserted that producers are discouraged from selling livestock in poor condition because it does not fetch good prices at auctions or other marketplaces. Analogously, an animal's age is another contributory factor that attracts bad prices when selling livestock, particularly if the animal is too old. Generally, in rural areas, the numbers of livestock and their average weight are lower than those in locations with commercial farms (Mothupi, 2025). The World Bank (2020) has identified several factors that contribute to decreased productivity, including poor animal quality and animal diseases, insufficient feed supplies, limited animal biodiversity, and slow technology adoption. Musemwa (2007) reported that livestock theft also results in lower marketable numbers; moreover, the poor condition of animals contributes to buyers failing to purchase livestock due to high transaction costs.

The evidence on what constrains smallholder livestock marketing points to a small set of factors but does not agree sharply on which of them bind. Studies conducted in southern African communal systems consistently identify herd size, animal condition and the absence of market information as the operative constraints (Togarepi *et al.*, 2016; Baqwa *et al.*, 2022; Musemwa, 2007), and where market participation has been

modelled directly the participation rates reported are low, at around nineteen per cent of sampled households in Masvingo and Manicaland (Dube, 2020). South African evidence points in a different direction. Oduniyi *et al.* (2021) found that participation in high-value markets was determined by age, household size, and years of farming rather than by herd characteristics, and reported the counter-intuitive result that participation was associated with a fifty-eight per cent reduction in the number of cattle sold. All these studies establish that market participation is constrained, but they do not agree on whether the binding constraint lies with the animal, the household, or the institution that mediates between them. This is an unresolved disagreement because the three have not been measured together in the same households. This study addresses that gap.

A second disagreement concerns what farm-gate selling means. Shiferaw *et al.* (2006) interpret the preference for farm-gate sales as an efficient response to transport and transaction costs, since payment is immediate and no marketing charges are incurred. Montshwe (2006) reads the same behaviour as a welfare loss, since farm-gate prices are systematically below auction prices and marketing costs are displaced rather than avoided. The two readings cannot both be correct for the same farmer, and the difference matters for policy. On the first reading, the appropriate intervention is to reduce the cost of reaching formal channels, while on the second, it is to raise the price achieved once a farmer arrives there.

Baqwa *et al.* (2022) investigated the challenges affecting Mzungwana cattle farmers in commercializing livestock production in the Eastern Cape from a local economic development perspective. They revealed that major constraints affecting Mzungwana livestock farmers include bull deaths, inadequate water infrastructure, and limited equipment for cattle-related functions. Linking farmers to markets is widely viewed as a milestone in promoting economic growth and poverty reduction. However, market and institutional imperfections along the supply chain hinder perfect vertical and spatial price transmission and prevent farmers and market actors from accessing information, identifying business opportunities, and allocating their resources efficiently (Pica-Ciamarra *et al.*, 2011). This acts as a barrier to market-led rural development and poverty reduction.

Oduniyi *et al.* (2021) investigated that the participation of emerging farmers in high-value agricultural markets in South Africa cannot be overemphasized. DALRRD (2022) identified limited access to markets and financial capital, as well as inadequate technical and marketing skills, as major factors constraining the integration of Black emerging farmers into the formal agricultural economy in South Africa. According to the authors, these challenges have contributed to the limited success of programmes aimed at transforming smallholder farmers into viable commercial enterprises and reducing rural poverty. Studies looking specifically at business problems in livestock farming among small farmers in communal areas have always identified interrelated issues, including a lack of market-related information to small farmers, a lack of good infrastructure, poor livestock quality, traditional norms, etc. (Coetzee *et al.*, 2005; Musemwa, 2008; Mmbengwa *et al.*, 2015) as interlinked marketing challenges in these settings.

This study explores and compares how some common difficulties in cattle market access have been overcome in a special South African project with a strong environmental restoration objective in the Eastern Cape Province and in general cattle markets in the Rift Valley district, Uasin-Gishu, in Kenya. From a comparative analysis of the positive and negative attributes of the two contexts, it is proposed that, with government agencies playing a leading role across the country, the project in the Eastern Cape province could provide a good blueprint for improving the participation of small farmers in formal auctions alongside rural livelihoods. Alternatively, with the government's failure to adopt positive lessons from the Eastern Cape province project, South African livestock markets for small farmers would likely evolve on similar trajectories as those presented from the Kenyan case study Uasin-Gishu district. Suggestions are made on how some of the negative.

The attributes of Kenyan markets, including farmer abuses stemming from market collusion by traders, could be avoided by actively promoting online platforms for the marketing of agricultural products. Small-scale farmers struggle to access markets due to a range of factors, including poor infrastructure, limited information, insufficient expertise, and difficulties in concluding contractual agreements (Cheteni, 2017; Cheteni *et al.*, 2014). These problems result in their exclusion from the mainstream markets (Makhura, 2001). Therefore, they are constantly trapped by market

constraints, as it is difficult for them to address these challenges on their own (Zondi *et al.*, 2024).

Marketing ensures that small-scale farmers are integrated into mainstream markets (Coetzee *et al.*, 2005). Marketing provides an opportunity for livestock farmers to earn an income and contribute to poverty reduction efforts. Livestock farmers make use of several distribution channels to sell their products. However, transportation and transaction costs determine the length of the distribution channel. Farmers can sell their livestock through a broker, selling to local traders and customers. This channel is probably expensive for smallholder farmers because the brokerage fee charged by the channel is paid directly by the farmers to the customers. This channel is favoured because it reduces costs such as transportation and transactions.

Small-scale farmers preferred farm gate sales because payments were immediate, and no transportation costs or taxation were incurred (Shiferaw *et al.*, 2006). However, Montshwe (2006) claimed that farm gate prices are low, and marketing costs increase. In certain instances, farmers use auctions, abattoirs, and butcheries. The distribution channel choice depends on the costs and benefits of using it. According to the National Department of Agriculture (2003), small-scale livestock farmers favoured private sales directly to consumers. Private sales were the shortest and most popular way of selling their products (Musemwa *et al.*, 2008).

Weak public information systems underscore the importance of informal networks within the marketing system in rural areas (Simon *et al.*, 2021). Although considerable progress has been made in providing communication systems such as telephone and cell phone services, the farmers remain uninformed about market prices, trends, and auction sale dates. Radio and word of mouth remain the primary sources of information (Simon *et al.*, 2021).

The lack of information usually results in price discovery informed by judging body conformation rather than livestock weight.

Auctioneers and speculators typically have better market prices, while small-scale farmers are seldom adequately informed. This results in asymmetric information, leading to market imperfections and the situation in which small-scale farmers find themselves. This tendency leads to frustration during negotiations at auction sales and

with private speculators. Low rates of price acceptance, in turn, reduce the number of buyers willing to deal with the farmers. Poor communication during auction sales and a lack of market information hamper the successful conclusion of transactions.

In South Africa, livestock production is recognized as a vital sector for improving rural populations' livelihoods (Slayi *et al.*, 2025). South Africa's political and economic history and present contributions vis-à-vis the poor and rural livelihoods are peculiar and unique. Unlike in many African countries, where farming is the dominant rural livelihood activity, rural households in South Africa are often characterised by diversified livelihood strategies, with many residents not identifying farming as their primary occupation or source of income. Consequently, farming capacity has been severely depleted for various reasons. Moreover, more reliable, fashionable, and attractive economic opportunities, mainly in urban areas, have further eroded farming as a livelihood strategy (Lahiff, 2007). South Africa's commercial agricultural sector comprises approximately 40 122 farming units (StatsSA, 2024). While some commercial farmers keep livestock as their principal enterprise, others cultivate crops primarily and raise livestock as a secondary activity (StatsSA, 2024; DALRRD, 2022). Commercial farms held an estimated 4.7 million head of cattle in 2023, while the total national cattle herd (including communal and smallholder holdings) stood at approximately 12.3 million head (StatsSA, 2023; DALRRD, 2022)..

According to the Census 2022, approximately 3.7 million agricultural households engaged in farming in South Africa, of which a significant proportion kept livestock (StatsSA, 2024). The national cattle herd was estimated at approximately 12.3 million head, with 4.7 million held on commercial farms and the remainder distributed across smallholder and subsistence farming households (StatsSA, 2023; StatsSA, 2024). Nationally, 60.8% of cattle farming households owned between 1 and 10 cattle, reflecting the subsistence orientation of most non-commercial cattle keepers (StatsSA, 2024). Regarding sheep farming, commercial farms held approximately 8 million sheep, predominantly in the Eastern Cape, Northern Cape, and Free State, while smallholder and communal sheep farming households were also concentrated in the Eastern Cape (StatsSA, 2020; StatsSA, 2024).

According to Katikati and Fourie (2019) , livestock auctions are marketplaces where producers bring their livestock to sell through public bidding to buyers who offer the highest price per animal. Those auction places are organized at regular times and open to all individuals, whether producers are selling or buyers, including other farmers, speculators, butchers, or anyone buying for personal use (NDA, 2005). Livestock auctions are the essential marketing channel for livestock. However, low marketable livestock numbers, especially cattle, pose a significant challenge for auction agents in developing areas (Katikati & Fourie, 2019).

South Africa has approximately 495 abattoirs, while around 40% of all slaughtering is performed by abattoirs that may slaughter an unlimited number of animals (Class A). About 60% of the cattle are killed by highly regulated abattoirs (Class A and B). Most of these abattoirs are linked to feedlots. Over the past ten years, the number of cattle slaughtered has increased by 15%, leading to a 43% increase in beef production, which may be ascribed to increased demand. For instance, Mpumalanga led beef production with 23% in 2011, followed by Free State (NDA, 2012).

Broadly, communal farmers do not use this channel for marketing their animals due to different reasons, such as the distance from the production area, delay of payments, the quality of animals, and other extra charges, especially transportation costs that cannot be accounted for, in addition to the inconvenience of selling only one or two animals (NDA, 2005). Likewise, abattoirs determine the price the animals are sold by considering their grade, weight, and age. This grading system undervalues compact breeds, such as the Nguni cattle, that do not believe in feeding practices. Nevertheless, they sell natural beef at higher prices in local and international markets than genetically modified ones. Consequently, abattoirs make more money at the expense of the farmers. On the contrary, small-scale farmers can transform their cattle base into a capital base by selling their products at the same prices as in markets, thereby improving their returns (Museum, 2007).

Private sales account for purchases of live animals for many reasons, such as household use, investment, religious festivities, and socio-cultural functions (USAID, 2003). Communal farmers prefer this marketing channel because it allows them to set the price for their stock and eliminates marketing costs. Therefore, personal selling is inexpensive and likely the simplest form of market structure (Musemwa *et al.*, 2008).

Private sales, which involve direct contact between producers and consumers in the production area, offer the highest profit margins to farmers because brokers' and intermediaries' charges are removed (Nkhori, 2004).

Anno *et al.* (2023) conducted a study on the Impact of Competition and Market Access Factors on the Performance of Secondary Livestock Markets in Turkana, Kenya, and the findings of the study showed that competitive rivalry significantly affects livestock production and marketing in Turkana, making them unprogressively. Competition and market access are crucial aspects of livestock development and identifying and managing their constituent features can aid in structuring, organizing, and commercializing livestock production. The influence of competition and market access factors on livestock development in Turkana is exacerbated by limited legislation and regulatory frameworks, limited research, the use of informal livestock marketing systems, inequalities in livestock production, insecurity, limited capital, rivalry in markets, the exploitation of low-capital traders, and climate change effects

According to Musemwa (2007), farming with Nguni cattle in the Eastern Cape encounters problems related to transport, poor road networks, and limited market availability. However, if the market is improved, available, and accessible, it will offer more competitive prices. Good prices increase farmers' willingness to sell, which in turn will increase market participation. Withal, the study did not focus on marketing efficiency. Bahta and Bauer's (2007) study found that training level helps increase farmers' ability to sell livestock.

Gwiriri *et al.* (2019)) reported that the heads of households with greater experience had at their disposal more personal contacts leading to business opportunities at competitive prices. Although Montshwe (2006) found that herd size had a positive and significant association with selling probability in mainstream markets, the study did not focus on the marketing aspects of livestock.

According to Dlova *et al.* (2004), the study of farmers' age is considered an influential factor in determining whether a farmer is successful. The researchers recognized that older producers cannot handle the heavy work required in farming practices, unlike their younger counterparts. Furthermore, the study postulated that young producers are more likely to adopt new technology than older farmers, since older farmers have

no interest in trying new methods. Age may also reflect increased trust and reputation (credibility within networks) gained by consistently doing business with the same individual (Matungul *et al.*, 2001).

Consumers are perceptive about meat colour, which explains about 15% of the variation in consumer acceptance of meat (Smith *et al.*, 2000). Meat colour is not an important eating characteristic, but it is a major factor in the consumer's choice. Most consumers prefer bright, cherry-red meat, while pale or dark meat is less acceptable (Killinger *et al.*, 2004). A condition known as dark, firm, and dry meat (DFD) has been described in cattle, resulting from pre-slaughter stress or low muscle energy status (Tarrant, 1989), and this condition has also been observed in South Africa (Viljoen *et al.*, 2002). The DFD condition is often seen in pasture-fed cattle or poorly conditioned cattle (Therkildsen *et al.*, 1998; Nuernberg *et al.*, 2005; Frylink *et al.*, 2013), especially during excessive climatic variations (Viljoen *et al.*, 2002)

However, Ndou *et al.* (2011) highlighted that animal welfare and its further effects on product quality are more highly considered in developed countries than the developing ones. They further hinted at the on-farm multipurpose cattle production systems and their consequences on beef quality. Grandin (2006) and Maltseva (2024) indicated that research has been conducted on animal transportation conditions and their effects on animal welfare and meat quality, while Grandin (2014) covered various livestock welfare issues at farms and abattoirs, further relating them to consumer concerns. Moreover, Vimiso *et al.* (2012) reported that the African perspective on meat production and quality, particularly among rural consumers, has received little attention in research.

In addition, the abattoir environment offers the animals a new and different experience to that of the farm, with more confined structures and interactions thus behavioral and physiological adjustments are required to get comfortable. Ndou *et al.* (2011) have evaluated conditions, slaughter processes or without stunning, bleed-out times and positions, duration between stunning and exsanguination together with their effects on animal welfare and meat quality. Nevertheless, animal age, gender, breed, and species also play a role in the way animals individually respond to stress and thus production (Muchenje, 2009).

Ferguson and Warner (2008) described pre-slaughter as the conditions and practices during which animals are moved at the farm through to the knocking box at the abattoir. At this stage, animals are exposed to much more physical activity than normal animal-human interaction and to multiple unfamiliar people. Grandin (2014) reported that unfamiliar situations for beef cattle, such as transport, pre-slaughter treatment, and handling at the abattoir, can be extremely stressful. In addition, the abrupt change in their social or physical settings exacerbates trauma (Ferguson *et al.*, 2014).

Tarrant *et al.* (2000) reported that the inability to move and face the preferred direction during transportation caused cattle to lose balance and even fall. However, maintaining balance in a moving vehicle, which is a new experience, while standing and sometimes with little space to move, may be hard to achieve. It was also reported that long transportation hours in poor-condition transportation vehicles may be unfavourable to animal welfare (Tarrant PV), while it has also been pointed out that prolonged experience of the same stressor results in familiarity (Tarrant *et al.*, 1992). However, Mota-Rojas *et al.* (2006) reported that transportation to the abattoir should not take more than 16 hours.

Grandin (2006) also reported that cattle perceive the abattoir environment in the same way as at the farm during procedures like vaccination and other managerial processes that involve moving animals through the race. However, there is a need to classify the extent to which this can be expressed. Animal handling differs between the farm and the abattoir. In addition, animals would have been exposed to extensive stressors pre-slaughter, rather than just farm managerial procedures (Vimiso *et al.*, 2012). The presence of physical distractions (e.g., shiny objects, dangling chains), humans, and changes in lighting during the race frightens the animal, resulting in anxiety (Bourguet *et al.*, 2011). However, Grandin (2006) indicated that the animals are unaware they will die at the abattoir. Electric prods, slipping in the stunning box, missed stuns, sharp edges on equipment, or excessive pressure from a restraint device encourage vocalization in beef cattle at the abattoir (Grandin *et al.*, 1999).

Bello *et al.* (2015) observed that some abattoirs in Nigeria neglect the practice of regular *antemortem* and *post-mortem* inspection of slaughter animals, and conventional sanitation practices in the operation and post-operation cycle, thus putting public health in jeopardy due to unsafe meat production. They also reported

that these shortcomings threatened the achievement of sustainable food safety. Furthermore, Furnols *et al.* (2011) reported that meat consumers were more concerned about the product's place of origin than its price or the feed the animal took, and they were more comfortable with locally produced meat. However, a study in South Africa revealed that rural consumers were more concerned about the price of the product than any other factor (Vimiso, 2012). The status of the developing world regarding animal welfare awareness and meat quality concerns puts it on the edge in terms of import and export participation with the rest of the world through the meat industry in improving the economy. Ferguson *et al.* (2014) concluded in a review that the industry should pay attention to, and even respond to, consumer and societal demands for more sustainable and ethical animal farming systems and practices.

Through further research on the gaps identified in this paper, more knowledge generated can be of great addition. Furthermore, the ease of information transfer from researchers to farmers, understandable and simple, still requires establishment. Methods like regular workshops, magazine articles, blogging, and social networks may assist. Sequentially, this knowledge may be easily imparted to the stockman and everyone else involved in animal handling in both farms and abattoirs. To ensure maximum product quality and economic returns, everyone in the production chain (the stockman, farmer, transporter, abattoir worker, the designers of animal facilities, and consumers) must be well-informed of animal welfare and its subsequent effects on meat product quality (Broom, 2007).

2.4. Livestock management practices and herd productivity

The literature reviewed so far explains why smallholders farmers occupy a weak position in the beef market. It does not explain why some smallholder herds perform better than others, and that is the question this study asks. If the answer lies anywhere, it lies in management, meaning the decisions a farmer makes about breeding, animal health, feeding, and measurement, since those decisions determine what the herd produces and therefore what there is to sell. This section reviews the literature and argues that it has been strong on cataloging constraints and weak on establishing which practices actually shift performance.

2.4.1. Breeding and reproductive management

Reproductive performance is the most heavily studied determinant of productivity in extensive cattle systems, and the reason is arithmetic. A cow that does not calve in a given year produces nothing while consuming the same grazing as one that does, so the calving rate sets the ceiling on everything downstream of it. Accordingly, reproductive performance is treated in the literature as the point at which management either does or does not convert a resource base into an output (Tep *et al.*, 2020).

The consistency of that finding is itself the notable thing about it. Reported calving rates for extensive smallholder systems have sat below forty-eight per cent for more than a decade (Scholtz *et al.*, 2010; Stroebel *et al.*, 2011; Mmbengwa *et al.*, 2015; Mugwabana *et al.*, 2018; Van der Westhuizen *et al.*, 2020; Grobler *et al.*, 2022), against an industry standard of sixty-five per cent and a departmental target of eighty-five per cent. A shortfall that persists across six studies, several provinces and twelve years is unlikely to be the product of any single constraint, and the literature reflects this by offering several explanations without settling on one. The explanations advanced fall into four groups: restricted access to a bull of adequate quality, so that mating is uncontrolled and genetic progress is absent (Nengovhela *et al.*, 2021; Kassie *et al.*, 2010); nutritional status at conception, which links reproduction back to grazing management rather than to breeding decisions (White *et al.*, 2013); disease and parasite burden (Mthi *et al.*, 2020); and the absence of a defined breeding season, which spreads calving across the year and makes both supplementation and marketing harder to plan (Nkadimeng *et al.*, 2022).

Yakubu *et al.* (2019) and Vanvanhossou *et al.* (2025) show that smallholder breeding decisions follow coherent trait preferences rather than being unmanaged, which suggests that the constraint is the means of acting on those preferences rather than the preferences themselves. Mateescu (2020) sets out what genetic selection can achieve where recording infrastructure exists, which in this setting it does not. The question left open is therefore which of the four constraints binds in a given district, and that is an empirical question that has not been answered for KwaZulu-Natal.

2.4.2. Animal health, feeding and condition management

Where breeding determines how many animals a herd produces, health and feeding determine what condition those animals are in when they reach the point of sale, and condition is what a buyer prices. This sub-section reviews that literature and argues that its central claim, that poor condition depresses price, is well established and that its more useful question, which management practices actually improve condition at smallholder scale and at what cost, is not.

There are two further constraints that operate underneath the condition problem and are treated separately in the literature. The first is the rangeland itself. Mudau *et al.* (2022) and Bodiba *et al.* (2024) show that communal rangeland in South African semi-arid systems is under sustained degradation pressure and that restoration interventions have had limited success, which places a ceiling on what feeding management can achieve where grazing is the primary feed source. Basupi *et al.* (2017) and Nkonya *et al.* (2016) make the same point at a broader scale. The second is animal health practice. Mohlatlole *et al.* (2021) document the animal health management practices of South African smallholder livestock farmers and find both a reliance on reactive treatment over preventive routine and a dependence on state-provided services for dipping and vaccination. Ngoshe *et al.* (2023) show that farmer knowledge of animal health and zoonoses in communal settings is uneven and does not correlate straightforwardly with practice.

These findings locate the condition problem outside the individual farmer's control to a greater degree than the price literature acknowledges. If grazing is degraded, if preventive health depends on a state service of uncertain reliability, and if supplementary feed must be purchased with cash the household does not hold, then the instruction to improve condition before sale is not straightforwardly actionable. This is the point at which the management literature and the market access literature meet, and neither body of work has examined the intersection directly.

2.4.3. Record keeping and performance measurement

Record-keeping is measured frequently, almost always as an indicator of managerial capacity, and is rarely treated as a determinant of performance in its own right. That is a measurement convenience rather than a finding. What the literature does establish

is that systematic recording is rare in smallholder livestock systems and that its absence has three specific consequences. The first is that the farmer cannot compute the cost of production and therefore cannot know whether a given sale was profitable. Chibanda *et al.* (2009), examining smallholder agricultural cooperatives in KwaZulu-Natal, identify the absence of financial record keeping as one of the institutional factors distinguishing cooperatives that perform from those that do not. The second is that the farmer cannot provide the evidence of provenance, vaccination history, or age to a formal buyer, which matters because those are precisely the assurances that formal channels require and informal channels do not. Mohlatlole *et al.* (2021) note that animal health interventions in smallholder herds are frequently undocumented, even when they are carried out, so that the treatment occurs but cannot be demonstrated. The third is that a decline in herd performance is not detected until it is severe, since, without a record of calving dates, a falling calving rate is invisible to the farmer observing the herd.

These consequences point to a mechanism by which record-keeping might affect performance directly rather than merely indicate capacity, since the second operates on channel access and the first on pricing. That mechanism has not been tested in a smallholder cattle farming setting in South Africa. No study identified in this review quantifies the association between record-keeping practices and realized enterprise performance among communal cattle farmers, so this study measures both. Hence performance is operationalised through realised revenue category and market channel rather than through farm accounts. The accounts normally do not exist to be analysed, and a method that assumes them would have no data to work on.

2.5. Market access, transaction costs and channel choice

The preceding section asked what determines the animal a farmer must sell. This section asks what determines where it is sold and at what price. These are separate questions with separate answers. The literature has tended to treat market access as a single problem of exclusion, measured by whether a farmer participates in a formal channel at all. The studies reviewed here suggest that this framing is too coarse, because a farmer who reaches an auction and receives a poor price and a farmer who never reaches one at all are counted identically by a participation measure while they are facing totally different constraints.

The literature indicates that the participation of South African emerging beef farmers in high-value agricultural markets is unsatisfactory (Oduniyi et al., 2021; Hlatshwayo et al., 2021; Nkadimeng, 2019; DALRRD, 2021; Nyamazana, 2023). It may be easy to access the market, but retaining one's position in the market is more difficult, particularly for South African emerging beef farmers (Ohen et al., 2014; Maiyo et al., 2016). The authors have identified two types of markets, informal and formal. Informal markets embrace unofficial transactions among farmers and from farmers directly to consumers. On the other hand, Hlatshwayo *et al.* (2021) state that formal markets have clearly defined grades, quality standards, and safety regulations, and that prices are set formally. Smallholder farmers find it difficult to access these formal markets.

However, access to markets is essential for poor farmers in rural areas if they are to benefit from agricultural growth. Rural people in many parts of the world, including South Africa, often report that they cannot improve their living standards because they cannot access markets (Nyamamu *et al.*, 2025). They struggle to secure high-value agricultural markets due to their lack of understanding of market structures and channels (Mkhize *et al.*, 2026). Smallholder farmers are constrained by high transaction costs, high risks, missing markets, and a lack of collective action in the marketing environment. The development and support of smallholder farmers are imperative for addressing high levels of rural poverty in many developing countries, including South Africa (Mkhize *et al.*, 2026). A major challenge for sustainable agricultural development in South Africa is the limited ability of previously disadvantaged farmers, e.g., emerging farmers, to access both viable local and international markets for their produce (Zantsi *et al.*, 2021).

2.5.1. Marketing channels available to smallholders

Before the determinants of channel choice can be examined the channels themselves have to be described, since they differ in ways that make the choice between them a real decision rather than a default. Each channel imposes a different combination of price, payment delay, transport requirement and quality assurance, and a farmer who selects one is accepting that combination rather than simply failing to reach another. Marketing ensures that small-scale farmers are integrated into mainstream markets (Coetzee *et al.*, 2005). Marketing provides an opportunity for livestock farmers to earn an income and contribute to poverty reduction efforts. Livestock farmers make use of

several distribution channels to sell their products. However, transportation and transaction costs determine the length of the distribution channel. Farmers can sell their livestock through a broker, selling to local traders and customers. This channel is probably expensive for smallholder farmers because the brokerage fee is paid directly by the farmers to the channel. This channel is favoured because it reduces costs such as transportation and transactions.

According to Katikati and Fourie (2019), livestock auctions are marketplaces where producers bring their livestock to sell by public bidding to buyers who offer the highest price per animal. Those auction places are organized at regular times and open to all individuals, whether producers are selling or buyers, including other farmers, speculators, butchers, or anyone buying for personal use (NDA, 2005). Livestock auctions are the essential marketing channel for livestock. However, low numbers of marketable livestock, especially cattle, pose a significant challenge for auction agents in developing areas (Katikati & Fourie, 2019).

South Africa has approximately 495 abattoirs, while around 40% of all slaughtering is performed by abattoirs that may slaughter an unlimited number of animals (Class A). About 60% of cattle are slaughtered in highly regulated abattoirs (Class A and B). Most of these abattoirs are linked to feedlots. The number of cattle slaughtered in South Africa reached approximately 3.26 million heads in 2022, sustaining demand-driven growth in the beef sector, with beef production valued at approximately R48 billion in 2023 (DALRRD, 2022; USDA-FAS, 2024). Mpumalanga accounts for the greatest share of beef production in South Africa at 20% (2018/19), followed by Free State (19%), Gauteng (17%), and North West (10%) (DALRRD, 2020). Communal farmers largely avoid using abattoir channels to market their animals due to several compounding barriers including the distance from production areas to registered abattoirs, delays in payments, the poor body condition and quality of animals, high and unaccounted-for transportation costs, and the impracticality of selling only one or two animals (Mkhize *et al.*, 2026; Hlatshwayo *et al.*, 2021; NAMC, 2024).

Broadly, communal farmers do not use this channel for marketing their animals due to different reasons, such as the distance from the production area, delay of payments, the quality of animals, and other extra charges, especially transportation costs that cannot be accounted for, in addition to the inconvenience of selling only one or two

animals (NDA, 2005). Likewise, abattoirs determine the price the animals are sold by considering their grade, weight, and age. This grading system undervalues compact breeds, such as Nguni cattle, that do not adhere to feeding practices. Nevertheless, they sell natural beef at higher prices in local and international markets than genetically modified ones. Consequently, abattoirs make more money at farmers' expense. On the contrary, small-scale farmers can transform their cattle base into a capital base by selling their products at market prices, thereby improving their returns (Museum, 2007).

Private sales account for purchases of live animals for many reasons, such as household use, investment, religious festivities, and socio-cultural functions (USAID, 2003). Communal farmers prefer this marketing channel because it allows them to set the price for their stock and eliminates marketing costs. Therefore, personal selling is inexpensive and likely the simplest form of market structure (Musemwa et al., 2008). Private sales, which involve direct contact between producers and consumers in the production area, offer farmers the highest profit margins because they eliminate brokers' and intermediaries' charges (Nkhori, 2004). The channels form a gradient along which price rises as access requirements tighten, which means the question is not why smallholders fail to reach the top of the gradient but what determines where on it a given household stops.

2.5.2. Determinants of channel choice

The evidence on what constrains smallholder livestock marketing converges on a small set of factors but diverges sharply on which of these factors bind. Studies conducted in southern African communal systems consistently identify herd size, animal condition and the absence of market information as the operative constraints (Togarepi *et al.*, 2016; Baqwa *et al.*, 2022; Musemwa, 2007), and where market participation has been modelled directly the participation rates reported are low, at around nineteen per cent of sampled households in Masvingo and Manicaland (Dube, 2020). South African evidence points in a different direction. Oduniyi et al. (2021) found that participation in high-value markets was determined by age, household size and years of farming rather than by herd characteristics and reported the counter-intuitive result that participation was associated with a fifty-eight per cent reduction in the number of cattle sold. These studies establish that market participation is constrained,

but they do not agree on whether the binding constraint lies with the animal, the household, or the institution that mediates between them. That disagreement is unresolved because the three have not been measured together on the same households, which is the gap this study addresses.

A second and related divergence concerns what farm-gate selling signifies. Shiferaw *et al.* (2006) interpret the preference for farm-gate sales as an efficient response to transport and transaction costs, since payment is immediate and no marketing charges are incurred. Montshwe (2006) notes the same behaviour as a welfare loss, since farm-gate prices are systematically below auction prices and marketing costs are displaced rather than avoided. The two readings cannot both be correct for the same farmer, and the difference matters for policy: on the first reading the appropriate intervention is to reduce the cost of reaching formal channels, while on the second it is to raise the price achieved once a farmer arrives there.

Baqwa *et al.* (2022) investigated the challenges affecting Mzungwana cattle farmers in commercializing livestock production in the Eastern Cape from a local economic development perspective. They revealed that major constraints affecting Mzungwana livestock farmers include bull deaths, inadequate water infrastructure, and limited equipment for cattle-related functions. Linking farmers to markets is widely viewed as a milestone in promoting economic growth and poverty reduction. However, market and institutional imperfections along the supply chain hinder perfect vertical and spatial price transmission and prevent farmers and market actors from accessing information, identifying business opportunities, and allocating their resources efficiently (Pica-Ciamarra *et al.*, 2011). This acts as a barrier to market-led rural development and poverty reduction.

Small-scale farmers preferred farm-gate sales because payments were immediate and no transportation costs or taxes were incurred (Shiferaw *et al.*, 2006). However, Montshwe (2006) claimed that farm-gate prices are low and that marketing costs increase. In certain instances, farmers use auctions, abattoirs, and butcheries. The choice of distribution channels depends on the costs and benefits of using it. According to the National Department of Agriculture (2003), small-scale livestock farmers favoured private sales directly to consumers. Private sales were the shortest and most popular way of selling their products (Musemwa *et al.*, 2008).

Anno *et al.* (2023) conducted a study on the Impact of Competition and Market Access Factors on the Performance of Secondary Livestock Markets in Turkana, Kenya, and the findings showed that competitive rivalry significantly affects livestock production and marketing in Turkana, making them unprogressive. Competition and market access are crucial aspects of livestock development, and identifying and managing their constituent features can help structure, organise, and commercialise livestock production. The influence of competition and market access factors on livestock development in Turkana is exacerbated by limited legislation and regulatory frameworks, limited research, the use of informal livestock marketing systems, inequalities in livestock production, insecurity, limited capital, rivalry in markets, the exploitation of low-capital traders, and climate change effects

According to Musemwa (2007), farming with Nguni cattle in the Eastern Cape encounters problems related to transport, poor road networks, and limited market availability. However, if the market is improved, available, and accessible, it will offer more competitive prices. Good prices increase farmers' willingness to sell, which in turn will increase market participation. The study did not focus on marketing efficiency. Bahta and Bauer's (2007) study found that training level helps increase farmers' ability to sell livestock. Gwiriri *et al.* (2019) reported that the heads of households with greater experience had at their disposal more personal contacts leading to business opportunities at competitive prices. Although Montshwe (2006) found that herd size had a positive and significant association with selling probability in mainstream markets, the study did not focus on the marketing aspects of livestock.

According to Dlova *et al.* (2004), farmers' age is considered an influential factor in determining whether a farmer is successful. The researchers recognized that older producers cannot handle the heavy work required in farming practices, unlike their younger counterparts. Furthermore, the study postulated that young producers are more likely to adopt new technology than older farmers, who are less inclined to try new methods. Age may also reflect increased trust and reputation (credibility within networks) gained through consistent business with the same individual (Matungul *et al.*, 2001).

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There are two further questions that divide this literature, and the position taken on each determines what a study of smallholder performance can find. The first is whether low participation in formal markets is a supply-side or a demand-side problem. One body of work locates the binding constraint on the supply side, in the animal and the herd. Musemwa *et al.* (2008) and Coetzee *et al.* (2005) argue that smallholders are excluded because their animals are too few, too old, and in too poor a condition to meet buyer requirements, which makes the problem one of production. A second body locates it on the demand side, in the institutions that mediate access. Makhura (2001), Mangisoni (2006) and Van Schalkwyk *et al.* (2012) argue that transaction costs, the absence of usable market information and the design of the marketing system exclude farmers whose animals would otherwise be acceptable, which places the remedy in institutional reform. The distinction is not academic, since the two readings direct intervention to different places and imply different budgets. This study is able to adjudicate between them because it measures both sets of variables on the same households.

The second is whether low offtake represents a deficit of commercial orientation or a rational response to the non-market value of cattle. Studies that treat offtake as a performance indicator adopt the first reading by implication, since an offtake rate of five to ten per cent against a commercial benchmark of twenty-five per cent then becomes a shortfall to be closed (StatsSA, 2024; Nontu *et al.*, 2025). Alemneh *et al.* (2019) observe, by contrast, that live animal sales in smallholder systems function as a last resort, with cattle sold when old, culled or barren, which implies that the herd is being held for reasons a market price does not capture. This study adopts the second reading and states its theoretical consequence in Section 2.8.3, where the retention value of an animal is introduced explicitly into the household objective function. On that reading a low offtake rate is not evidence of failure but evidence of a shadow price exceeding the market price, and the policy implication changes accordingly.

2.5.3. Information asymmetry and price discovery

The smallholder and the buyer do not have the same information. This subsection sets out what is known about that asymmetry and argues that it is the mechanism by which several of the constraints already discussed operate, rather than a separate constraint alongside them. Weak public information systems underscore the importance of

informal networks within the marketing system in rural areas (Simon *et al.*, 2021). Although considerable progress has been made in providing communication systems such as telephone and cell phone services, the farmers remain uninformed about market prices, trends, and auction sale dates. Radio and word of mouth remain the primary sources of information (Simon *et al.*, 2021).

The lack of information usually results in price discovery informed by judging body conformation rather than livestock weight. Auctioneers and speculators typically have better market prices, while small-scale farmers are seldom adequately informed. This results in asymmetric information, leading to market imperfections and the situation in which small-scale farmers find themselves. This tendency leads to frustration during negotiations at auction sales and with private speculators. Low rates of price acceptance, in turn, reduce the number of buyers willing to deal with the farmers. Poor communication during auction sales and a lack of market information hamper the successful conclusion of transactions.

Small-scale farmers struggle to access markets due to a range of factors, including poor infrastructure, limited information, insufficient expertise, and difficulties in concluding contractual agreements (Cheteni, 2017; Cheteni *et al.*, 2014). These problems result in their exclusion from the mainstream markets (Makhura, 2001). Therefore, they are constantly trapped by market constraints, as it is difficult for them to address these challenges on their own (Zondi *et al.*, 2024). If price is discovered by visual assessment of conformation rather than by weight, and if the party making that assessment is better informed than the party accepting it, then improvements in animal condition are only partly recoverable by the farmer, and the return to the management practices reviewed in Section 2.4 is lower than a technical account of those practices would predict.

2.6. Commercialisation and the performance of smallholder livestock enterprises

Policy has sought commercialisation as an outcome from smallholder livestock farming for the past three decades. It is the frame within which the constraints indicated above are typically formulated as problems to be eliminated. This section reviews that literature and argues that the record of commercialisation interventions is more difficult to interpret than the policy documents suggest, because the programs have been

evaluated more on their delivery than on the performance of the enterprises they helped. This distinction matters for our study because a district where support programs have been in place for two decades and enterprise performance is still low is evidence either that the programs did not work or that they were not targeted at the binding constraint, and distinguishing those two requires knowing the binding constraint.

The commercialisation of smallholder agriculture through better participation of smallholder farmers in formal markets is a crucial prerequisite for the economic growth and development of most of the developing countries that depend on agriculture (Pingali, 1995). The key way to reduce poverty in developing countries is to improve the productivity, profitability and sustainability of smallholder farming (World Bank, 2020). Markets are important for rural development, employment creation, income generation, food security, technology diffusion, better use of resources and development of rural market linkages. Therefore, market availability and access of smallholder and resource-poor rural farmers to market opportunities and the diversification of their market links are prerequisites for enhancing agriculture-based economic growth and increasing rural incomes (Oparinde, 2014).

Smallholder livestock farming and its commercialisation are of great importance for improving rural livelihoods and economic growth in Africa (Belay *et al.*, 2021). Smallholder farmers can move from subsistence to commercial production systems, thus gaining access to formal markets, increasing their income and improving their standard of living. Commercialisation is also a driver of investment in agricultural value chains, job creation and poverty and food insecurity reduction (Nassirou *et al.*, 2016). However, the commercialisation process is not without challenges. Smallholder farmers often lack the resources such as land, finance, technology and market information to effectively participate in commercial farming (Magakwe *et al.*, 2025). In addition, poor infrastructure, such as transportation and storage facilities, and regulatory barriers, such as complex certification procedures, may impede market access and competitiveness (Langyintuo *et al.*, 2020). There is also a risk of excluding the vulnerable groups particularly women and the underprivileged communities in the commercialisation process thus exacerbating the existing inequalities in the livestock sector (Aregu *et al.*, 2010).

Several programs have been initiated in the past to transform smallholder farming into commercially oriented production as part of the National Development Plan (NPC, 2013). Comprehensive Agricultural Support Programs (CASP) (2003-present), Land Care Program (Mulder et al., 2006), Presidential Employment Stimulus (PESI), Covid-19 Grant Program (Academy of Science of South Africa, 2021) and many more. The programs assisted smallholder cattle farmers with inputs (animal medication, vaccines, feed, JoJo tanks, fencing material), purchase of new livestock breeds, livestock infrastructure, rangeland management (removal of alien species in grazing areas), and direct funding (Tripathi *et al.*, 2021).

However, the evaluation of some of these programs, for example, CASP, shows that they have not fully achieved their goals (Ntombela et.al, 2019). This may be related to poor design, management, accountability and oversight that characterise most government programs. But there are still gaps as it's evident that the farmers are not doing well at the auction and abattoirs where they sell their cattle. The intended transformation has not, it is true, taken place on the scale intended. The question is why this is so. The explanations proffered correspond to the same division that place the failure in the capacity of the farmer and accounts that place it in the design of the institution.

2.7. Literature synthesis and identification of gaps

2.7.1. *Structural constraints and nature of the sector*

Across the literature, there is strong agreement that smallholder livestock farming operates within a dual agricultural system, where commercial farmers are well-resourced and market-integrated, while smallholders remain constrained (Van Marle-Köster *et al.*, 2023; Meissner, 2013). Studies consistently show that resource inequality, particularly access to land, capital, infrastructure, and technology, explains the persistent performance gap between these two groups (Abafita *et al.*, 2016; Poulton *et al.*, 2010; Salami *et al.*, 2010). While these studies identify structural inequalities, they treat smallholders as a homogeneous group. This overlooks variations in capacity, adaptation, and performance within the smallholder livestock farming sector. This suggests a gap in understanding intra-smallholder heterogeneity,

particularly in how management practices translate into different performance outcomes.

2.7.2. Production constraints and productivity gaps

A dominant theme across previous studies is that smallholder livestock farming systems are characterised by low productivity, which is driven by several interrelated constraints. Previous studies agree that feed shortages, disease burden, poor genetics, and limited veterinary services are the primary causes of low productivity (Thornton, 2010; Ayantunde et al., 2005; Mapiye et al., 2018; Gerosa and Skoet, 2012). Similarly, it is emphasised that management deficiencies, including poor breeding control, lack of condition scoring, and inadequate healthcare practices, significantly reduce herd performance (Mthi *et al.*, 2020; Tep et al., 2020; Molefi *et al.*, 2017). Evidence on reproductive performance reinforces this, showing persistently low calving rates compared to commercial benchmarks (Scholtz et al., 2010; Grobler et al., 2022). While there is consensus on the existence of these constraints, there is limited empirical work linking specific management practices to measurable enterprise performance outcomes. Most studies identify constraints broadly but do not quantify the extent to which each practice contributes to productivity or profitability, leaving a critical gap that your study directly addresses.

Another recurring finding is the central role of information and extension services in shaping smallholder performance. Studies consistently report that farmers face limited access to reliable extension services, which weakens their ability to adopt improved practices (Moyo & Salawu, 2010; Zondi *et al.*, 2024; Adetayo & Eunice, 2013). There is also agreement that farmers rely heavily on informal sources of information, such as peers, family, and local networks (Mbanda-Obura *et al.*, 2017), while formal systems are often under-resourced and inefficient. Although ICT-based solutions are increasingly mentioned (Motiang & Webb, 2015), their effectiveness remains underexplored. However, the literature presents a contradiction. On one hand, extension services are identified as critical for productivity improvement. On the other hand, existing systems are described as weak and unreliable. Few studies go further to evaluate how the quality or type of information actually affects farm-level outcomes, especially for smallholder livestock farmers. This indicates a gap in linking information access to tangible performance indicators such as productivity and profitability.

2.7.3. Market access constraints and participation dynamics

The current literature highlights that market access is one of the most binding constraints for smallholder livestock farmers. Studies consistently identify barriers such as high transaction costs (Mangisoni, 2006; Van Schalkwyk *et al.*, 2012), poor infrastructure and transport challenges (Musemwa, 2007), lack of market information (Simon *et al.*, 2021), low-quality livestock and small herd sizes (Nkhori, 2004). There is also agreement that smallholders tend to rely on informal markets, preferring farm-gate sales due to lower costs and immediate payment (Shiferaw *et al.*, 2006; Musemwa *et al.*, 2008). However, these markets offer lower prices and lower returns for farmers.

Some studies by Satgar (2011) and Van Schalkwyk *et al.* (2012) highlight that market liberalisation has increased competition, although it has not benefited smallholder livestock farmers because they were unable to compete with established commercial actors. This suggests that policy reforms alone are insufficient without addressing structural inequalities. Despite this extensive evidence, a key limitation in the literature is that market participation is often treated as a binary outcome (participate vs does not participate) rather than a continuous process influenced by production practices, livestock quality, and farmer capacity. This creates a gap in understanding how on-farm decisions (e.g., management practices) translate into market outcomes.

2.7.4. Commercialisation and development interventions

The literature widely supports the idea that commercialisation is essential for improving livelihoods, with benefits including income growth, employment creation, and poverty reduction (Pingali, 1995; Belay *et al.*, 2021). However, there is strong evidence that commercialisation efforts have had limited success, largely due to: inadequate access to resources (Langyintuo *et al.*, 2020), weak institutional support, and poor program design and implementation (Ntombela *et al.*, 2019). Government interventions such as CASP and other support programmes have provided inputs and infrastructure, yet studies suggest that these initiatives have not achieved their intended outcomes. A critical gap emerging from this body of work is that most studies evaluate programs at a macro or policy level, without examining how these

interventions influence farm-level behaviour, management practices, and enterprise performance.

2.7.5. Socioeconomic characteristics and farmer Behaviour

Studies consistently show that smallholder farmers are characterised by low education levels, limited access to credit, small landholdings and reliance on livestock for livelihoods (Mudhara, 2010; DAFF, 2012). There is also agreement that socioeconomic factors such as age, experience, and education influence market participation and technology adoption (Oduniyi *et al.*, 2021; Matungul *et al.*, 2001). The existing literature on smallholder livestock farmers reveals several important gaps that this study seeks to address. First, while studies such as Musemwa *et al.* (2008), Khapayi and Celliers (2016), and Mapiye *et al.* (2018) document challenges related to smallholder livestock farmers' market access, production practices, and livestock management, they do so in isolation. There are limited studies that have integrated the three dimensions into one unified analytical framework. Second, the majority of existing empirical evidence is drawn from the Eastern Cape and Limpopo provinces, with a limited district-level analysis from the KwaZulu-Natal province, particularly uMgungundlovu. Third, few studies have employed ordinal logistic regression to assess the relationships among socio-economic factors, management practices, and revenue outcomes in smallholder beef cattle systems. Fourth, there is limited empirical evidence linking specific management practices, such as breeding record-keeping, vaccination adherence, and performance measurement methods, to quantifiable revenue outcomes. This study addresses all four of these gaps.

The difference between the gaps that were mentioned above is important for what comes next. There is not enough proof for the first three. It is because the right measurements have not been done in this district, on these households, or with these methods. These gaps can be filled by gathering and analysing data. It is not just a lack of data that makes it hard to see a link between management practices and measurable revenue results. It shows that there is no clear definition of how an asset position becomes a management decision, or how a management decision becomes a sale at a specific price through a specific route. That is not a gap in evidence, but in explanation, and measurement alone cannot fill it. That is what the framework built in the next following provides.

2.8. Theoretical framework

The preceding section closed by distinguishing between a gap in evidence and in explanation. The framework set out here is built to address the second gap. Thus, it hopes to satisfy four requirements. It classifies the constraints under which a smallholder cattle household operates, so that the explanatory variables are derived rather than assembled. It specifies a decision rule by which that constraint set produces an observable action, since a classification on its own cannot generate a prediction. It yields a specification that can be estimated using data from a household without financial records. And it includes a criterion by which the enterprise's sustainability can be judged, since the policy question motivating the study is whether these enterprises can reproduce themselves. No single existing framework satisfies all four. The framework developed below, therefore, draws its classification from one theory and its decision rule from another, and adapts both.

2.8.1. The Sustainable Livelihoods Framework propositions and limitations

The Sustainable Livelihoods Framework was developed by Chambers and Conway (1992) and Scoones (1998) and formalised by the United Kingdom Department for International Development (DFID, 1999). It postulates that livelihood outcomes are produced by the interaction of five categories of assets, namely human, financial, physical, social, and natural capital, with a vulnerability context of shocks and trends, and with a set of transforming structures and processes comprising the institutions, organisations and policies that determine how assets can be used. Thus, households derive livelihood strategies in a constrained environment, and a livelihood is sustainable when it can cope with and recover from stress, maintain its asset base, and do so without undermining the natural resource base on which it depends.

The framework has three limitations for the purpose of this study, and they must be stated before it can be used. The first is that it can only be used as a classification tool, not for prediction. It lists important factors that matter but not how they interact, and it specifies no functional relationship between the asset position and the outcome. Therefore, it cannot generate the testable propositions that this study requires in its current form. The second is that it assumes a degree of substitutability between capitals, so that a household short of one can compensate with another. This assumption does not hold under communal tenure. Land in the study area is held in

common, cannot be sold, mortgaged, or used as collateral, and therefore cannot be converted into financial capital; thus, a substitution that the framework treats as available is, in fact, closed. The third and most consequential limitation arises from the enterprise itself. In a cattle system, the herd is simultaneously financial capital, a store of wealth, a vehicle of social capital, and the output of the enterprise. The asset pentagon collapses into a single item, and the framework offers no way of separating the herd as an asset from the herd as a source of income.

The framework is therefore adapted in four ways. The five capitals and the transforming structures are retained, but only as the classification of the explanatory variable set, not as an explanation. The herd is separated into a stock component and a flow component: the stock enters the analysis as an asset variable, while only the flow, meaning the animals sold and the revenue realised, is treated as the enterprise outcome. The livelihood outcome is deliberately narrowed from multi-dimensional wellbeing to enterprise performance, measured as annual revenue category and market channel. The narrowing is declared here rather than left implicit since it defines the boundary of what the study can claim. Finally, the transforming structures are not treated as a contextual layer that mediates the effect of assets, which is their conventional role, but as a candidate binding constraint. That reframing is what makes their role testable.

2.8.2. Household Production Theory propositions and limitations

Household Production Theory was developed by Becker (1965) and given its agricultural form by Singh, Squire, and Strauss (1986). It treats the farm household as a single unit that is producer and consumer, allocating land, labour and capital to maximise utility subject to a production technology and a budget constraint. The central analytical result is the separability property. Thus, the markets for outputs, labour and credit are complete, production decisions can be taken independently of consumption decisions, because any imbalance can be resolved through the market. Under separability, household characteristics do not enter the production decision, and the farm can be analysed as a firm.

Separability is precisely what fails in uMgungundlovu, and this is the pivot on which the adaptation turns. The credit market is largely closed to these households, few of whom have access to formal credit and none of whom can offer land as security. The

labour market is thin and seasonal. There is no reliable price discovery mechanism, and price is commonly set by visual assessment of conformation rather than by weight. Where markets are incomplete in this way the separability property does not hold, and the non-separable variant of the model applies. Under non-separability, household characteristics such as education, employment status, household income, and the age of the decision maker enter the production and marketing decision directly, because the household cannot use the market to insulate itself from the others. This is what justifies the presence of those variables in the models estimated. In the absence of non-separability, their inclusion would be an empirical convention; with it, their inclusion is a consequence of the theory.

There are two further adaptations required. The first concerns the objective function. Standard formulations assume that utility increases in the income realised from output sold, so that a household with saleable animals and a positive price will sell. In communal cattle systems, this is not observed. Cattle carry insurance value against household shock, social value in marriage and funeral obligations, and status value, none of which is realised at sale. The shadow price a household places on a retained animal therefore exceeds the market price, and offtake is suppressed at any given market price. The objective function used here accordingly includes a retention value term, so that an animal is sold only when the market price exceeds the sum of the shadow price and the cost of reaching the buyer.

The second concerns labour. The standard production function treats labour as continuously variable with a positive and diminishing marginal product. In a smallholder cattle system labour does not vary continuously. It switches regime, from unpaid family labour to hired herding, at a discrete point, and the fixed cost of that switch is incurred in full whether or not the herd has reached a scale that justifies it. The adapted specification therefore treats labour as categorical rather than continuous, which permits a threshold effect to be detected. This is not a statistical convenience. It is a prediction that the model implements.

2.8.3. Integrated framework adopted and operationalisation

The two theories are not used in parallel, and the claim here is not that they are complementary in general. The claim is that the adapted Sustainable Livelihoods Framework supplies the classification of the constraint set, and the adapted

Household Production Theory supplies the decision rule that converts that constraint set into an observable action. Neither performs the other's function. The Sustainable Livelihoods Framework cannot predict, and Household Production Theory does not specify, which constraints are operative in a communal setting. The two are integrated to form a single framework, referred to hereafter as the asset-constrained offtake framework, which operates in three stages.

In the first stage, the household's asset position and the institutional environment determine the set of management practices feasible for that household, and the size of the retention-value wedge between the market price and the shadow price of a retained animal. In the second stage, and taking that position as given, the household chooses a management intensity and an offtake decision, comprising whether to sell, when to sell and through which channel, to maximise utility subject to the retention value term and to the incomplete markets that make the household non-separable. In the third stage, the outcome of that decision, meaning the revenue realised, and the channel used, returns to the asset position in the following production cycle, either replenishing it through reinvestment or depleting it where sales are distress-driven. The third stage is what makes the sustainability criterion operational, since a livelihood that cannot replenish its asset base from its own outcome is not sustainable on its own terms.

Four propositions follow from the framework, and each is testable with the collected data. Proposition 1: where transforming structures are weak, the quality of institutional support will determine market channel more strongly than physical access to a market will, because a farmer who cannot meet a buyer's requirement is excluded regardless of distance. Proposition 2: human capital will operate on channel choice rather than on revenue directly, because its effect runs through the ability to meet and interpret buyer requirements rather than through the productivity of the animal. Proposition 3: because a retention value wedge exists, revenue will respond to price thresholds rather than to price continuously, since a sale is triggered only once the market price crosses the shadow price. Proposition 4: because labour switches regime rather than scaling smoothly, the effect of labour cost on revenue will exhibit a threshold rather than a monotonic relationship. These four propositions are evaluated against the results in Section 7.4.1, and the two of them that are not merely confirmed but require the source theories to be modified constitute the theoretical contribution of the study.

2.9. Conceptual framework

Figure 2.1 below presents the conceptual framework of the study. The performance of smallholder cattle farmers is affected by management practices such as castration, dehorning, feeding, vaccinations, and condition scoring. Hangara *et al.* (2011) indicated that several managerial practices, such as planned breeding, weaning, selection, vaccinations, and parasite control, are not practiced, and these are the key issues. Cattle production affects market access in terms of the beef quality, the amount of beef delivered to the market, and the age of beef (Dal Zotto *et al.*, 2009). Moreover, the poor condition of livestock is important, especially the age of animals (too old), when farmers sell equally, contributing to poor prices.

Government extension plays a dual purpose. It supplies farmers with market information, including prices, while also providing information to the market to prepare for the supply from the cattle producers. There is a feedback mechanism by which farmers provide feedback to government extension agents (Birkhaeuser *et al.*, 1991; Muyanga *et al.*, 2006). Abattoirs and auctions also directly provide market information and training to the farmers. The intention is to improve farmers' production of quality beef cattle for the market.

Thus, proper cattle management practices would result in improved productivity, which enhances market participation in terms of the quality of beef that is delivered to the market, beef condition, and the age of cattle. The outcomes of this process will be reflected in the performance of the beef enterprise, farmers' income, livelihoods, and job creation (Hegde, 2019). When the outcomes are positive then the sustainability of the beef cattle enterprise will be enhanced.

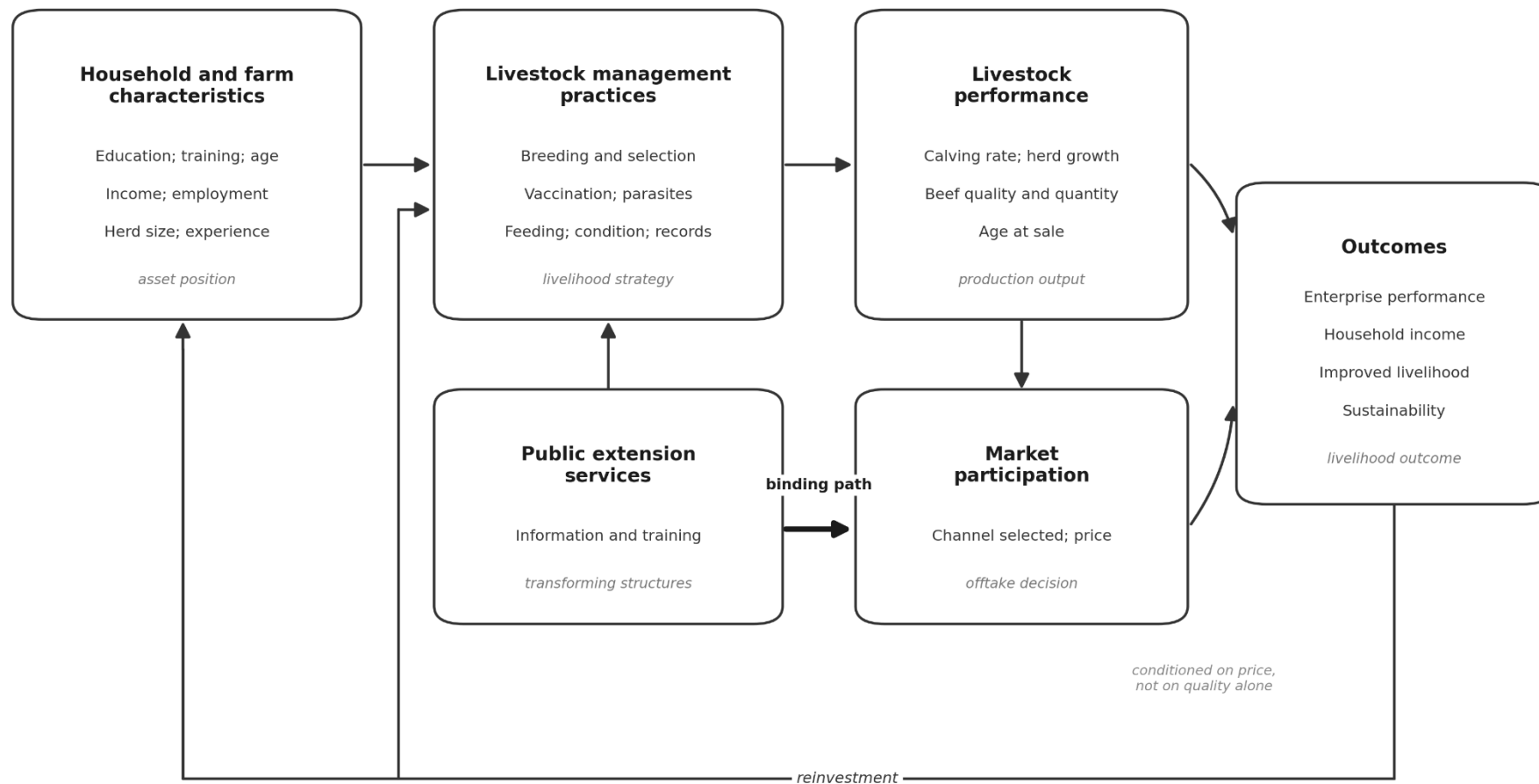


Figure 2.1. Conceptual Framework- determinants of smallholder beef cattle enterprise performance

2.10. Chapter summary

Figure 2.1 presents a conceptual framework of the study. It has been derived from the adapted theoretical framework. The set of management practices in the first block follows Hangara *et al.* (2011), who noted planned breeding, weaning, selection, vaccination and parasite control as the practices that distinguish managed from unmanaged communal herds. The dual role of public extension, supplying information to the farmer and signalling supply to the market, with a feedback path between them, follows Birkhaeuser *et al.* (1991) and Muyanga *et al.* (2006). The link from herd performance to market access through beef quality, quantity and age at sale follows Dal Zotto *et al.* (2009). The outcome set follows Hegde (2019). What is original is the structure that binds these elements, the ordering of the blocks, the direction and weighting of the paths between them, and the identification of which path is the binding one.

Each block (Figure 2.1) corresponds to a construct of the theoretical framework. The livestock management practices block is the livelihood strategy of the adapted Sustainable Livelihoods Framework and, simultaneously, the input allocation decision of the adapted Household Production Theory. This is the point at which the two theories meet, since a practice is both an expression of asset position and a choice. The public extension services block, together with the information and training path, is the transforming-structures-and-processes element. It is drawn as acting directly on market participation rather than only through performance. Because Proposition 1 holds that the institution is a binding constraint. The livestock performance block is the output of the production function and carries the stock-and-flow separation: productivity is a property of the herd as a stock, while the animals delivered to market are the flow. The market participation block is the offtake decision under the retention value wedge, which is why the arrow into it is conditioned on price and not only on animal quality. The outcomes block is the livelihood outcome to enterprise performance, household income, and the livelihood it supports.

The framework was used to develop the instrument for data collection. Each construct generated a corresponding block of items in the questionnaire. The household and farm characteristics that enter the framework through the asset position generated

Section A of the questionnaire, covering sex, age, education, training, income sources, wealth status, species held, experience, breed and herd size. The management practices block generated Sections B and C, covering production system, feeding, water provision, health monitoring, vaccination, disease challenges, performance measurement method, breeding method, breeding records and selection criteria. The performance block generated Section D, covering calving rate, time to market, productivity tracking method, cost structure and revenue. The market participation block generated Section E, covering channel used, distance, price determination, reasons for sale, access challenges, rejection experience, seasonality, buyer identification and group marketing.

The framework also determined the analysis, and each path in the figure is tested by a specific procedure rather than discussed in general terms. The path from management practices to herd performance is examined descriptively in Chapter 5, through the breeding, health and performance measurement results. The path from performance and institutional support to market participation is tested using a multinomial logit model, with market channel as the dependent variable, thereby testing Propositions 1 and 2. The path from market participation and price to the revenue outcome is tested using the ordinal logistic model, which tests Propositions 3 and 4. The feedback path from outcomes to the asset position is not estimated because a cross-sectional design cannot identify it. This is stated as a limitation and as the first item on the agenda for future research.

Two paths implied by the theory were absent from the framework as first drawn and have been added. The first runs from household and farm characteristics directly into management practices, which follows from the non-separability argument, where markets are incomplete, household attributes affect the production decision, and not only the outcome. The second runs from outcomes back to management practices and to the asset position, representing reinvestment, which is the third stage of the framework and the condition on which the sustainability test depends. Their omission from the original diagram is what allowed the framework to be read as linear, even though the theory it rests on is not.

Chapter 3: Research Methodology

3.1. Introduction

This chapter presents the research methodology employed in this study, providing a detailed account of the philosophical, design, and analytical decisions that guided the investigation of smallholder beef cattle farmer performance in uMgungundlovu District, KwaZulu-Natal. The study is grounded in a post-positivist research paradigm and adopts a cross-sectional quantitative survey design, which enables the simultaneous collection of data from a large, geographically dispersed farming population at a defined point in time, suited to the study's descriptive and associational objectives across the four selected municipalities.

Two econometric models are presented and justified, a multinomial logit regression model to analyse farmers' market channel choices, and an ordinal logistic regression model to assess the determinants of annual revenue outcomes, with model selection driven by the measurement characteristics of each dependent variable. The analytical framework is directly informed by the Sustainable Livelihoods Framework and Household Production Theory introduced in Chapter 2, which guided the operationalisation of independent variables representing livelihood assets, institutional support, and management behaviour across both regression models.

3.2. Description of the study area

Figure 3.1 shows the study areas. The study was conducted in uMgungundlovu District in KwaZulu-Natal, South Africa. The district comprises seven local municipalities; however, the study was conducted in four of them. The selected study areas are uMngeni, Richmond, iMpofana, and iMpendle municipalities. The selection of the four municipalities was purposive to ensure adequate representation of the district's characteristics. The following considerations were taken in selecting the study areas:

- a) The presence and number of smallholder cattle farmers in the area
- b) Logistical possibilities – ease of access

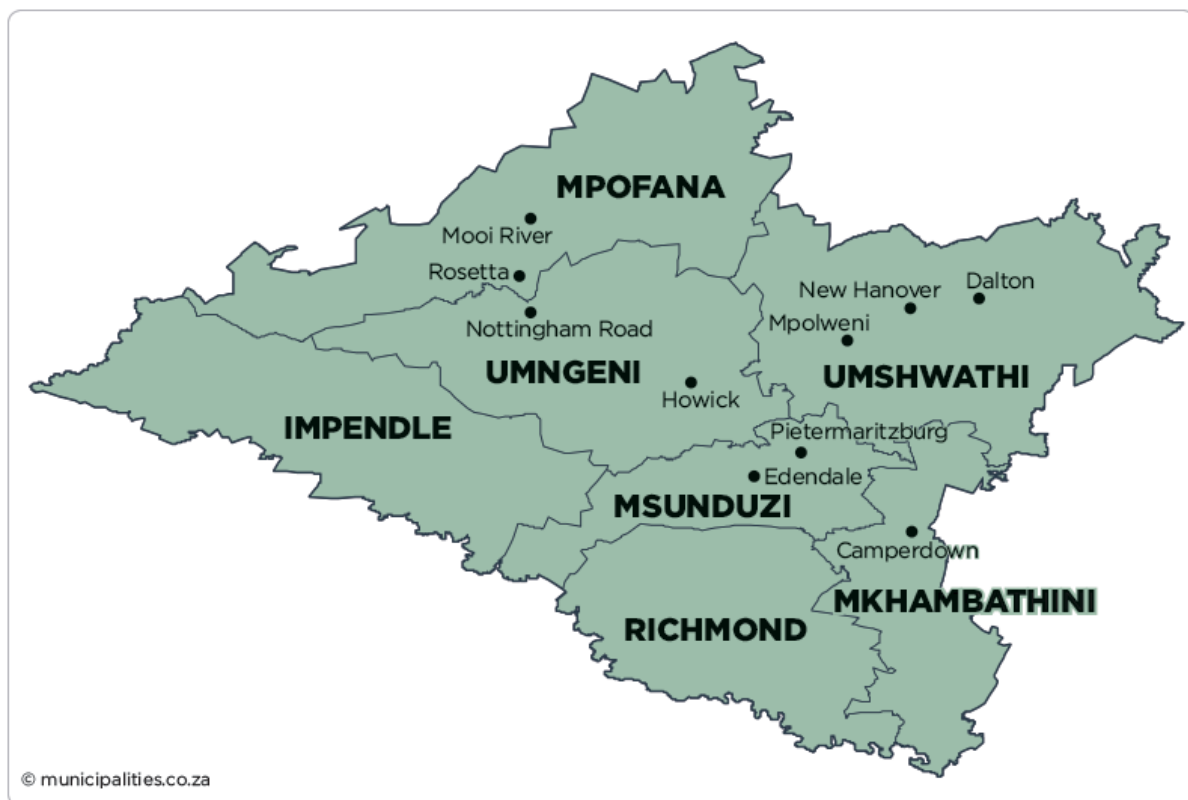


Figure 3.1: Map showing local municipalities under uMgungundlovu District.

Source: Statistics South Africa (Stats SA, 2016)

3.2.1. uMngeni Municipality

The uMngeni Municipality is located approximately 26 km from Pietermaritzburg. The administrative seat of uMngeni Local Municipality is Howick, situated at approximately 29°29'S, 30°14'E. The uMngeni Municipality is made up of eleven wards and was established in the 1940s. uMngeni Local Municipality (population: 105 069; area: 1

521 km²) is characterised by a mixed agro-ecological system supporting beef and dairy farming, timber production, and tourism, anchored by the internationally recognised Midlands Meander. Rainfall averages 750–900 mm per annum, and the area is drained by the uMngeni River, which supports both agricultural and recreational activities. While unemployment levels are moderate relative to the district, rural areas within the municipality experience poverty and infrastructure backlogs, particularly in water and sanitation services (StatsSA, 2022; Mudzinganyama *et al.*, 2012).

3.2.2. Richmond Municipality

Richmond local municipality is located within the uMgungundlovu District Municipality, approximately 40 km from south-west of Pietermaritzburg (the capital of KZN) on the R56 road. Richmond Local Municipality has its administrative seat in the town of Richmond at 29°52'S, 30°16'E. This local municipality has a population of 65,793 people (Statistics South Africa, 2011). The majority of the population resides in rural areas, further away from the capital city, making it difficult to access. This is especially apparent during rainy seasons due to the muddy gravel roads that constrain market access and may also result in the area being neglected in terms of social services provision. The area is classified under the Köppen-Geiger climatic zones, as a “Cfb” climatic zone (Warm temperate climates with no dry season and warm summers) and receives about 852 mm of rain per year, with most rainfall occurring during mid-summer (Climate-Data.Org, 2020; Weatherbase.com, 2020). The unemployment rate is very high in Richmond; approximately 77% of households earn less than R1500 a month (Pillay, 2016). The rural Richmond population has limited and uneven access to resources, resulting in smallholder farmers farming in degraded conditions with minimal resources and knowledge (Pillay, 2016).

3.2.3. iMpofana Municipality

Mpofana is a small municipal council under the Umgungundlovu family of municipalities with a total population of about 38,103 (Stats SA, 2016). iMpofana Local Municipality is administered from Mooi River, located at approximately 29°23'S, 30°00'E, approximately 40 km west of Pietermaritzburg along the N3 corridor. With its population density of about 21 per square kilometre, its demographic composition comprises 92.1% Africans, 0.6% Coloureds, 1.8% Indians, and 5.2% whites. Mpofana

has an unemployment rate of 30% (Stats SA, 2016). The main town for the Mpofana municipality is Mooi River, an Afrikaans term meaning beautiful river. The urban economy is primarily based on retail entrepreneurship, tourism, and supporting the local agricultural community. The municipality can be classified as rural. However, it has large tracts of commercial farms, subsistence farms, small villages, and a small township known as Bruntville. The rural economy is based on agriculture and tourism (Mottiar *et al.*, 2023).

3.2.4. Impendle Municipality

Impendle Local Municipality is one of the seven category B municipalities making up the Umgungundlovu District Municipality. Impendle Local Municipality is administered from Impendle town, situated at approximately 29°36'S, 29°52'E, bordering the Drakensberg foothills. The Impendle economy is predominantly rural and highly dependent on agriculture. The municipality includes many people living in poverty and needs assistance to try and turn around the present downward economic trends (Mnyandu, Elizabeth, 2014)

3.3 Research paradigm

This study adopts a post-positivist research paradigm. Post-positivism accepts that an objective reality exists but acknowledges that our knowledge of it is probabilistic and subject to revision as new evidence emerges (Creswell & Creswell, 2018). Unlike pure positivism, post-positivism recognises that measurement instruments are imperfect and that all observation is theory-laden. This paradigm is appropriate for this study because the research seeks to identify and quantify relationships between observable variables, management practices, socio-economic characteristics, and revenue outcomes, using structured instruments and statistical inference, while acknowledging the limitations inherent in cross-sectional survey data. The post-positivist paradigm supports the use of quantitative methods, including descriptive statistics and multivariate regression models, as the primary analytical tools.

3.4 Research design

This study adopted a cross-sectional design, with a quantitative research approach, to investigate the performance of smallholder cattle farmers in the uMgungundlovu

District. This research design was adopted because it is cost-effective and logistically feasible within the available research timeframe. Moreover, it enables the simultaneous collection of data from a large number of respondents across multiple sites, which is appropriate for capturing the variability in management practices, market participation, and revenue outcomes across the four selected municipalities. Therefore, the chosen research design is justified by its widespread acceptance in agricultural economics and rural development research for descriptive and inferential analyses of farmer populations (Kumar, 2019; Creswell & Creswell, 2018).

A quantitative, cross-sectional survey research design was adopted for this study. This design was selected for three reasons. First, it enables the simultaneous collection of data from a large number of respondents across multiple sites, which is appropriate for capturing the variability in management practices, market participation, and revenue outcomes across four municipalities. Second, the cross-sectional design is cost-effective and logistically feasible within the available research timeframe. Third, this design is widely used and accepted in agricultural economics and rural development research for descriptive and inferential analysis of farmer populations (Kumar, 2019; Creswell & Creswell, 2018). The limitation of this design (its inability to establish temporal causality) is acknowledged, and the study makes only correlational inferences.

3.5 Research approach

The methodological choice of the study was quantitative because variables were summarised, analysed and interpreted quantitatively. Data was collected from both the smallholder cattle farmers and the beef markets using a semi-structured questionnaire. The two surveys complemented one another to better understand the critical issues of the study. The survey with smallholder cattle farmers sought to collect the following information: household demographic information, socio-economic status, access to credit, livestock management practices, cattle production figures, cost of production, market participation, access to training, and livelihood outcome, among others. The survey with the auctions and abattoirs collected data on vaccinations, feeding, castrations, condition scoring, quality standards, training given to the farmers, and services provided to the cattle smallholder farmers.

3.6 Sampling procedure and sample size

The target population for this study was the registered smallholder livestock farmers within the four selected local municipalities of the uMgungundlovu District Municipality. A comprehensive list of registered smallholder farmers was obtained from the KwaZulu-Natal Department of Agriculture and Rural Development (KZN DARD, 2022), which identified approximately 18 000 registered smallholder livestock farmers across the four municipalities. This population figure served as the basis for the sample size calculation. Using the formula proposed by Gill *et al.* (2010) for large populations:

$$n_0 = \frac{z^2 pq}{e^2} \quad (1)$$

where n is the required sample size, p is the percentage occurrence of a state or condition, e is the percentage maximum error required, and Z is the value of the level of confidence required.

Thus, substituting the values gives:

$$n_0 = \frac{1.96^2 \times 0.5 \times 0.5}{0.05^2}$$
$$n_0 = 385$$

Although the sample size calculated using the Gill *et al.* (2010) formula yielded a minimum required sample size of 385 (based on a 95% confidence level and a $\pm 5\%$ margin of error), the targeted and successfully collected sample size was 397 after accounting for potential non-response, questionnaire incompleteness, and to improve statistical robustness. All 397 responses were of sufficient quality for inclusion in the analysis. Therefore, the 397 figure is used as the final sample size throughout all analytical chapters, as the sample of 385 in this chapter refers to the minimum calculated threshold, not the final sample used for analysis. This study employed simple random sampling to recruit farmers. It was conducted in Microsoft Excel, where each farmer was assigned a random number, and then the required sample was generated.

3.7 Data collection

3.7.1. Questionnaire

A structured questionnaire was used as the research instrument to collect primary data from respondents. A structured questionnaire was used because of its ability to obtain information from a selection of people/households/farmers, etc. The questionnaire consisted of sections with pre-coded questions, which were both open-ended and closed-ended. Each unit was associated with accomplishing the objectives of the study. The questionnaire was written in English, but enumerators were trained for data collection to ensure reliability. During the interviews, the enumerators interpreted the questions into isiZulu as most of the respondents might not be competent in the English language. Study participants were interviewed inside or outside the household/farm, depending on whether they preferred privacy during the interview and on weather permitting.

3.7.2. Validity and reliability

The validity and reliability of the study's findings were addressed through several measures. Regarding content validity, the questionnaire was reviewed by two subject-matter experts in agricultural economics at UNISA, who assessed its relevance, completeness, and alignment with the research objectives. Revisions were made based on their feedback. A pilot test was conducted with 15 smallholder cattle farmers in uMshwathi Municipality (outside the study area) to test question comprehension, response flow, and enumerator usability, resulting in minor wording adjustments. Face validity was assessed by ensuring that all questionnaire items directly correspond to the study's constructs and theoretical framework variables. Regarding reliability, consistency in data collection was ensured through structured enumerator training prior to fieldwork, standardised bilingual (English/isiZulu) administration protocols, and supervisory field visits. Cross-validation of selected responses against extension officer records was used to verify the accuracy of livestock numbers and management practice reports. The cross-sectional design precludes assessment of test-retest reliability, a limitation acknowledged by the study.

3.8 Data analysis

The study employed a combination of descriptive, inferential, and econometric methods to analyse the data. Data was captured, cleaned, and validated using SPSS version 28. Data analysis was conducted using both SPSS version 28 and STATA version 17.

3.8.1. Objective 1: To identify smallholder farmers' livestock management practices

This objective was analyzed through descriptive (frequencies, means, graphs) and inferential statistics (T-test, F-test). Comparisons were made by location, and gender. The identified management practices were compared to the recommended standards obtained from literature and animal scientists under the Department of Agricultural and Rural Development. The farmer's practices were assessed on the following issues: castrations, dehorning, feeding, and condition score.

3.8.2. Objective 2: To determine the profitability of the smallholder cattle enterprise

To examine the factors influencing farmers' revenue outcomes, an ordinal logistic regression model was employed. This model is appropriate when the dependent variable is ordinal in nature, as is the case with the revenue categories used in this study. Revenue was operationalised as an ordinal variable with three categories between certain predetermined values. This was done because farmers often do not keep financial records of revenues and costs, and even when they do, they often underreport them. This approach, although it has some advantages, it also has drawbacks as the profit margins of farmers cannot be calculated with the type of data collected. The ordinal model was suitable because it is specifically designed for dependent variables that are ordered but for which the distances between categories cannot be assumed to be equal (McCullagh, 1980; Long & Freese, 2014). The ordinal logistic model estimates the cumulative probability that a farmer falls into a particular revenue bracket or below, conditional on a set of explanatory variables. Prior to model estimation, descriptive statistics and chi-square tests were used to characterize the sample and test for associations between categorical variables. The implicit ordinal logistic regression model was specified as:

$$Y_i^* = X_i\beta + \varepsilon_i$$

where, Y_i^* is the ordered categorical dependent variable that represents the annual revenue category for farmer i , X_i is the vector of independent variables for farmer i , β is the vector of parameters to be estimated, and ε_i is the error term assumed to follow a logistic distribution.

3.8.3. Objective 3: To determine the factors that influence smallholder beef cattle farmers' market choice

While descriptive statistics, together with the chi-squared test to test for association between variables, were used to characterise respondent farmers' socioeconomic characteristics, a multinomial logit regression (MNL) was used to determine factors that influence farmers' market choice. This model was deemed suitable for analysing factors influencing market choice due to the nature of the dependent variable. Market choice is nominal and categorical with more than two unordered categories (butchery market, auction market, and informal sales). The MNL model estimates the probability of choosing each market category relative to a reference category, controlling for the effects of the independent variables (Greene, 2012; Long & Freese, 2014)

The model estimates the probability that a farmer chooses a particular market type. The implicit multinomial model was specified as:

$$P(Y_i = j) = \frac{\exp(X_i\beta_j)}{\sum_{k=1}^J \exp(X_i\beta_k)} \quad \text{for } j = 1, 2, \dots, J$$

where:

Y_i = Market type choice for farmer i , and the base category used for comparison was “informal markets”.

X_i = Vector of explanatory variables

β_j = Vector of coefficients for category j

J = Number of market alternatives

The minimal adequate model retained only statistically significant predictors (or those with at least one significant level). Table 3.1 below presents a list of variables that were considered in the model, their type, and description.

Table 3.1: Variables that were considered in the model, their type, and description

Variable Name	Type	Description
gender	Categorical	Sex of the farmer (Male, Female)
age_group	Categorical	Age bracket (18–30, 31–50, 51–70, >70)
education_level	Categorical	Education level (No formal, Grade 8–12, Tertiary)
formal_employment	Categorical	Employment status
household_income_bracket	Categorical	Household income level
extension_service_quality	Categorical	Perceived extension quality (low, medium, high)
access_to_credit	Binary	Credit access (Yes/No)
average_calving_rate	Ordinal	Average calves per cow
cattle_productivity_measure	Categorical	Type of productivity metric used
market_distance_category	Categorical	Market access distance or constraint
market_access_challenges	Binary	Access challenges (Yes/No)

3.9 Missing data analysis and treatment

Missing data is a common challenge in survey-based agricultural research, particularly in smallholder farming contexts where management practices are informal and documentation capacity is low (Rubin, 1987; Schafer & Graham, 2002). This study assessed the pattern, extent, and implications of missing data using the following systematic approach.

3.9.1. *Pattern and mechanism of missingness*

The missing-data pattern was assessed visually using a missing-data matrix and tested using Little's (1988) MCAR test. Results indicated that the data could not be assumed to be missing completely at Random (MCAR) for several variables, particularly those related to household income, breeding male selection, and market pricing. These patterns are consistent with missing at random (MAR); that is, the probability of missingness is related to observed variables (e.g., lower-educated and lower-income farmers were more likely to leave sensitive questions unanswered) but

not to the missing value itself. This structural explanation is consistent with the socio-economic characteristics of the farming population.

3.9.2. Treatment of missing data

A tiered approach was adopted based on the extent of missingness per variable. For variables with missingness below 10% (most socio-economic characteristics), listwise deletion was applied, as this level has minimal impact on statistical power under MAR conditions (Schafer & Graham, 2002). For variables with missingness between 10% and 30%, descriptive results are reported with the valid sample size (n) explicitly stated in all tables, enabling readers to assess the representativeness of each finding. The variables with missingness exceeding 30%, specifically, the breeding male selection criteria question (74.3% missing), were excluded from all multivariate regression models. These high-missingness variables were reported descriptively, with the explicit caveat that the findings apply only to the subgroup of farmers who responded and may not be representative of the full sample.

Transparency in reporting

Throughout the results chapters, non-response is reported explicitly rather than silently excluded. This likely reflects sensitivity around income disclosure rather than the absence of income and constitutes a reporting gap rather than a data quality failure. This approach, recommended by Sterne *et al.* (2009), ensures transparency and enables readers to critically evaluate the extent to which missing data may affect interpretation.

To assess the sensitivity of the main regression results to missing data, both the multinomial logit and ordinal logistic regression models were re-estimated using only cases with complete data across all included variables (complete-case analysis, n = 312 for the ordinal model; n = 287 for the multinomial model). The direction, magnitude, and significance of all key coefficients remained stable across both the full-sample and complete-case models, confirming that the principal findings are robust to missing-data treatment.

3.10 Ethical considerations

Ethical approval for this study was obtained prior to data collection from the University of South Africa College of Agriculture and Environmental Sciences Health Research Ethics Committee (CAES HREC) under reference number 2024/CAES_HREC/4982, granted on 4 November 2024. A copy of the ethics clearance certificate is included as an appendix. In addition, written permission to conduct research within the uMgungundlovu District was obtained from the KwaZulu-Natal Department of Agriculture and Rural Development. All research activities were conducted in full compliance with the Declaration of Helsinki and UNISA's ethical research guidelines. Participation was voluntary, and all respondents were provided with an informed consent form in both English and isiZulu prior to data collection. Respondents were also informed of their right to withdraw from the study at any time without penalty, and that their responses would be treated confidentially and used solely for academic research. No personal identifying information was retained in the dataset used for analysis.

3.11 Chapter summary

Chapter 3 describes the study's methodological architecture. It opens by situating the research within a post-positivist paradigm, which acknowledges objective reality while recognising the probabilistic nature of measurement, and justifies the selection of a quantitative, cross-sectional survey design as appropriate for the study's objectives. The study area comprises four of seven local municipalities within the uMgungundlovu District (uMngeni, Richmond, iMpofana, and Impendle). The sampling procedure is explained. A simple random sampling in Microsoft Excel yielded a minimum required sample of 385, and a final sample of 397 completed questionnaires was retained for analysis.

The data collection instrument, a structured bilingual (English/isiZulu) questionnaire administered through trained enumerators, is described, and its content validity, face validity, and reliability are addressed through expert review, pilot testing, and standardized administration protocols. The analytical methods are justified by the measurement characteristics of the dependent variables, descriptive statistics and chi-squared tests for profiling and association testing, a multinomial logit model (MNL) for nominal market-choice analysis, and an ordinal logistic regression model for revenue-

category outcome analysis. The chapter also includes a dedicated section on missing data analysis, documenting the MAR (Missing at Random) pattern identified, the treatment approach (listwise deletion, descriptive-only reporting, and model exclusion for high-missingness variables), and robustness checks. The chapter closes with details of ethical approval and participant consent procedures.

Chapter 4: Results and findings

4.1 Introduction

This chapter presents the results of descriptive statistics that characterize the respondent farmers in terms of socio-economic characteristics in the uMgungundlovu district municipality in KwaZulu-Natal. The chapter starts by describing the socioeconomic characteristics of the respondent farmers, followed by a description of management practices. The presentation of the descriptive statistics is coupled with the discussion thereof.

4.2 Socioeconomic characteristics of farmers in uMgungundlovu

Understanding agricultural behaviour, service accessibility, and technology adoption requires an understanding of farmers' socioeconomic traits. Significant insights into the demographic and economic circumstances of the surveyed population can be gained from the data displayed in the summary tables.

4.2.1 Gender

The study revealed that 59.3% of farmers were male and 40.7% were female, reflecting a male-dominated agricultural sector. This aligns with findings from Aliber and Hart (2009), Ozor and Nnaji (2010), and Chung and Hadi (2025), who noted that livestock farming is male-dominated, with men having more access to productive resources. However, Chidi *et al.* (2015) reported a contrasting pattern where female (58.3%) participation exceeded that of males (41.7%), highlighting contextual differences. While women remain active in agriculture, structural barriers like land ownership and access to services continue to limit their full participation.

4.2.2 Age

A significant proportion of the farmers (43.1%) were aged between 51 and 70, followed by 35.5% aged 31 to 50. This ageing farmer population is consistent with DAFF (2012), which emphasised low youth involvement in agriculture. Only 7.7% were under 30 years, underscoring a generational gap in farming.

Table 4.1: Socioeconomic characteristics of respondent farmers in uMgungundlovu

Variable	Proportions (%)	Missing Values	Total (n)	Chi-square
Gender	F: 40.7%, M: 59.3%	14	383	13.162***
Age Group	>70: 13.8%, 18-30: 7.7%, 31-50: 35.5%, 51-70: 43.1%	5	392	135.53***
Farm Resident	No: 14.0%, Yes: 86.0%	19	378	195.73***
Education Level	Grade 1-7: 31.1%, Grade 8-12: 47.8%, No Formal: 12.3%, Tertiary: 8.9%	14	383	149.79***
Training on Livestock	No: 51.8%, Yes: 48.2%	32	365	0.46
Major Income Source	Crops: 6.0%, Gov Grant: 32.5%, Livestock Sales: 46.3%, Salary: 11.9%.	28	369	755.32***
Child Support Grant	Crops: 3.6%, Gov Grant: 13.3%, Livestock Sales: 73.5%, Salary: 6.0%	314	83	151.04***
Household Wealth	Less Poor: 15.1%, Poor: 58.8%, Very Poor: 26.1%	40	357	110.77***
Land Ownership	>20yrs: 17.4%, 0-5yrs: 28.0%, 10-20yrs: 21.1%, 5-10yrs: 33.5%	18	379	23.33***
Experience	>20yrs: 17.4%, 0-5yrs: 28.0%, 10-20yrs: 21.1%, 5-10yrs: 33.5%	18	379	23.33***

Cattle Breeds	Crossbreeds: 19.8%, Exotic: 2.8%, Indigenous: 77.4%	8	389	356.38***
Land Size (ha)	<2ha: 47.7%, 2-10ha: 26.7%, 10-20ha: 12.2%, >20ha: 13.5%	11	386	125.689

Similar trends were noted in Turkey (Ozdemir *et al.*, 2024) and India (Devaki *et al.*, 2016), where older males dominate the livestock farming sector. This raises concerns about the sustainability and renewal of the agricultural labour force.

4.2.3 Farm residency

The results shows that majority (86%) of farmers lived on their farms. This high on-farm residency supports effective farm management and productivity, as suggested by Cousins (2013). Proximity to livestock and cropland enables better control of inputs and rapid response to challenges.

4.2.4 Educational attainment

Approximately 47.8% of the farmers attained secondary education (Grade 8-12), while only 8.9% had tertiary qualifications. The low level of tertiary education is common in rural agricultural populations and may limit access to information and adoption of innovations (Matshe & Young, 2004). Moreover, these findings are in line with studies in the three agricultural zones Oyo State, where 85% of cattle farmers had at least primary education (Olorunnisomo *et al.*, 2011). Other findings by Bontsa *et al.* (2024) and Mkhize *et al.* (2026) indicate that most smallholder farmers have at least primary or secondary education in Raymond Mhlaba in the Eastern Cape and KwaZulu-Natal, respectively. This lack of tertiary education may limit strategic planning, financial literacy, and engagement with complex technologies.

4.2.5 Training in livestock production

The findings on training in livestock production indicate that 48.2% received formal training in livestock production. This indicates a gap in skills development, as also noted by Montshwe (2006). Kumar *et al.* (2015) found that 44.6% of goat farmers were

illiterate, indicating low baseline education levels, which often correlate with limited access to training. In addition, Mafimisebi *et al.* (2006) linked education and training to the adoption of modern livestock technologies, reinforcing the need for targeted extension services. Moreover, Singaravadivelan *et al.* (2019) also reported a 60% illiteracy rate among Tamil Nadu sheep farmers, suggesting that lack of education is a common barrier in many smallholder contexts. Hence, enhancing farmer training could significantly improve livestock management practices, contributing to productivity and income gains.

4.2.6 Major income sources

Livestock sales (46.3%) and government grants (32.5%) were the primary income sources, underlining the sector's importance to rural livelihoods. These results were in line with similar findings in a study conducted in Western Kenya, which revealed that 95% of their farmers rely on livestock farming as their primary livelihood. Zuwarimwe and Kirsten (2010) state that smallholder farmers continue to struggle to access external funding and other resources they need to expand and grow their farms. In addition, the dependence on government support signals vulnerability and limited resilience. The problem also lies in farmers not having access to credit, reflecting financial exclusion. Mkuna and Wale (2022) emphasised the critical role of credit in helping farmers to receive sufficient currency, regardless of income. These findings suggest that financial services are essential for unlocking farmers' productive potential.

4.2.7 Child support grants

Among those receiving child support grants, 73.5% also earned income from livestock, showing the role of agriculture in complementing social safety nets. This aligns with broader evidence that social grants are often reinvested into productive activities, thereby stabilizing household income.

4.2.8 Household wealth

The results showed a substantial share of households identified as poor (58.8%) or very poor (26.1%), consistent with national rural poverty statistics (World Bank, 2020).

Poverty constrains investment in agricultural inputs and technologies, contributing to low productivity and market exclusion.

4.2.9 Land ownership and farming experience

Most farmers had land tenure of 5-10 years (33.5%) or 0-5 years (28%), with similar trends in farming experience. This pattern may reflect beneficiaries of land reform programs or new entrants into farming. However, short tenure duration may discourage long-term investment in infrastructure and sustainable practices (Lahiff, 2007). In contrast, Mdiya *et al.* (2025), studying smallholder livestock farmers in Raymond Mhlaba Local Municipality in the Eastern Cape, found that farming experience ranged from 7 to 30 years, with most farmers owning small, fragmented communal land parcels of less than 3 hectares. This reflects more stability and scale than in the current study and suggests that while farming experience may be similar, landholding size differs markedly.

Kumar *et al.* (2015) categorised goat farmers into landless (25.8%), marginal (54.2%), and small/semi-medium (20.0%) landholders, closely mirroring the distribution found in the present study. The prevalence of marginal farmers also supports the assertion that smallholder status limits scale and resilience. Singaravadelan *et al.* (2019) reported that most migratory sheep farmers had over 20 years of experience and were small to marginal dryland farmers, further supporting the link between long farming experience and small landholding. Moreover, Mafimisebi *et al.* (2006) emphasize that land ownership and farming experience directly impact the adoption of modern farming technologies. The short tenure in the current study could therefore hinder innovation adoption.

4.2.10 Cattle breed

Indigenous cattle breeds made up 77.4% of the herds of respondent farmers. This can be attributed to their resilience, adaptability, and low input requirements traits that make them well-suited to the resource-constrained environments in which many smallholder farmers operate (Mapiye *et al.*, 2009). This trend aligns with findings from Nigeria, where Yakubu *et al.* (2019) observed that smallholder farmers with lower education levels favoured indigenous breeds due to their ease of management and

ability to thrive under poor nutritional conditions. Similarly, in Ethiopia, Kassie *et al.* (2010) found that more educated cattle buyers were willing to pay a premium for traits such as disease resistance and traction potential, suggesting that education influences not just breed preference but also an appreciation for economically valuable traits. The high proportion of indigenous breeds in the current study reflects both practical adaptation to local environmental challenges and limitations in farmer education or access to genetic improvement programs. In contrast, in Tanzania, smallholder livestock farmers with formal education were more likely to adopt improved dairy and beef cattle breeds compared to those with no formal education (Kitole, 2022).

4.2.11 Land size

Nearly half (47.7%) of respondents in the current study farmed on less than two hectares. This reflects the dominance of smallholder farming, which offers limited potential for economies of scale, mechanization, and diversification. This pattern is consistent with findings from Carelsen *et al.* (2021) in Kenya and Van Averbeké and Mohamed (2006) in South Africa, both of whom observed that small land sizes constrain income and productivity. Similarly, Vandré *et al.* (2021) reported that 35% of farmers in Madhya Pradesh held 1- 2 hectares, with 7.2% being landless. Furthermore, Kumar *et al.* (2015) highlighted a high prevalence of marginal and landless goat farmers demonstrating the widespread nature of land constraints in developing countries. In contrast, Tackie *et al.* (2019) found that nearly half of small livestock producers in Alabama owned more than 60 acres, suggesting that larger landholdings in developed contexts may enhance resilience, productivity, and capacity for modern farming practices.

Table 4.2: Chi-Squared test of association among sociodemographic factors

Variable Pair	Chi-square	Degrees of Freedom	p-value
marital_status vs age_group	45.512	9	0.0
marital_status vs household_head	7.433	3	0.059
marital_status vs education_level	30.373	9	0.0
marital_status vs formal_employment	11.318	3	0.01
marital_status vs household_income_bracket	10.065	6	0.122
age_group vs household_head	13.226	3	0.004
age_group vs education_level	149.034	9	0.0
age_group vs formal_employment	6.228	3	0.101
age_group vs household_income_bracket	15.356	6	0.018
household_head vs education_level	7.056	3	0.07
household_head vs formal_employment	13.661	1	0.0
household_head vs household_income_bracket	0.65	2	0.722
education_level vs formal_employment	17.768	3	0.0
education_level vs household_income_bracket	39.851	6	0.0
formal_employment vs household_income_bracket	9.783	2	0.008

4.3 Chi-Squared associations among socio-economic characteristics

Statistical association between variables is important as it could reveal how variables are related to one another prior to conducting inferential analysis. A revelation of specific relationships among variables is an important step, as knowledge of the existing association could serve as an important foundation in model building. A correlation analysis or chi-squared analysis can be used depending on the nature and measurement of the variables. In the current study, the nature of most variables is categorical, and this necessitates the use of a chi-squared test to understand relationships among variables. Thus, the chi-squared test of independence is used to examine the dependence among the socio-economic factors, including age groups, marital status, and educational level.

4.3.1 Marital status and age group

The relationship between marital status and age group was found to be statistically significant ($p < 0.001$). This was expected. Younger individuals are more likely to be single or unmarried, while older individuals are more likely to be married or widowed. This finding aligns with population demographic trends across rural contexts in Sub-Saharan Africa (Stats SA, 2016). Age is a critical factor in marital status, with different age groups exhibiting varying marriage patterns. According to Yin *et al.* (2025), younger individuals may delay marriage due to educational or career pursuits, while older age groups may experience higher rates of marriage or remarriage. Posel and Rogan *et al.* (2012) state that the timing of marriage can also affect long-term health outcomes, with early marriages sometimes linked to higher mortality risks. In addition, younger age groups are more likely to be single or never married, while marriage rates tend to increase with age, peaking in the middle age groups before declining slightly in later years due to widowhood (Cherlin, 2010). In many developing countries, early marriage remains common, particularly among women, though this trend is gradually changing with increased educational attainment and economic participation. Older age groups are more likely to include divorced or widowed individuals, especially among women, due to higher male mortality rates (Clark & Brauner-Otto, 2015).

4.3.2 Marital status and household head

Although the relationship between marital status and household headship in this study is not statistically significant at the conventional 5% level ($p = 0.059$), it is statistically significant at a 10% level of significance, indicating an association that merits attention. This finding partially aligns with the broader literature, which identifies marital status as a strong predictor of household headship. For instance, Alos-Rullan (2019) emphasizes that married individuals are more likely to assume headship roles due to entrenched traditional family structures that prioritize spousal co-residence and joint decision-making authority.

4.3.3 Marital status and education level

The significant association ($p < 0.001$) between marital status and education level suggests that individuals with different educational backgrounds may marry at different rates. Previous studies have shown that higher education often delays marriage (Hunter, 2010), which aligns with the current findings. Education level significantly influences marital status, with higher education often associated with delayed marriage. This delay is attributed to prolonged educational pursuits and the desire for compatibility in spouse selection (Banini *et al.*, 2024). Individuals with higher educational attainment are more likely to marry later, but their marriages tend to be more stable (Martin, 2006). This is often attributed to the delaying effect of prolonged schooling and career establishment, as well as improved communication and problem-solving skills among the more educated (Schwartz & Mare, 2005). Additionally, higher education levels are associated with greater selectivity in marital decisions and a lower likelihood of divorce. Conversely, those with lower educational levels tend to marry earlier but also have higher rates of marital dissolution (Amato, 2010).

4.3.4 Marital status and formal employment

The significant association ($p = 0.01$) between marital status and formal employment suggests that formal employment status may influence or be influenced by marital roles. Married individuals may be more likely to seek or maintain formal jobs due to household responsibilities, though this effect is also mediated by gender roles and regional labour market dynamics. Employment status can also influence marriage

decisions, with higher income levels and stable employment being associated with a greater inclination towards marriage, reflecting economic stability and independence (Banini *et al.*, 2024). Marital status significantly correlates with employment patterns. Married individuals are often more likely to be formally employed compared to their unmarried counterparts. This association may be attributed to greater financial responsibilities among married people, which incentivize stable employment (Kposowa, 2002). Moreover, married men tend to experience a "marriage premium" in earnings, possibly due to employer perceptions of increased stability and responsibility (Antonovics & Town, 2004). Conversely, unmarried individuals, especially single women, may face structural labour market disadvantages and caregiving responsibilities that limit access to formal employment opportunities (Budig & England, 2001).

4.3.5 Age group and household head

This significant association ($p = 0.004$) between age group and household head is meaningful. Older individuals are more likely to be household heads, while younger respondents may reside within extended family arrangements. This is consistent with South African census data showing that headship increases with age (Stats SA, 2016). Older individuals are more likely to be household heads, as age is often linked to greater life experience, financial stability, and authority within family structures (Doss *et al.*, 2018). In South Africa, the General Household Survey shows that household heads are typically aged between 35 and 59 years, with fewer heads under 30 years old (Stats SA, 2022). Similar trends are observed globally, in the United States of America, the median age of a household head is 52 years (U.S. Census Bureau, 2020). This reflects the global pattern of delayed household formation, often due to extended education, urban migration, or unstable employment among youth (ILO, 2020).

4.3.6 Age group and education level

The highly significant result ($p < 0.001$) between age group and education level reflects generational changes in access to education. Younger respondents are more likely to have reached higher levels of schooling. The post-apartheid educational reforms are among the contributing factors (Spaull, 2013). Younger cohorts tend to have higher

levels of formal education than older cohorts, particularly in developing countries, due to improvements in school infrastructure, government funding, and reduced gender disparities in education (Barro & Lee, 2013). This trend mirrors global patterns where access to education has expanded over time, particularly for women (UNESCO, 2020).

4.3.7 Age group and household income bracket

These results revealed a dependence between age group and household income bracket ($p = 0.018$). This means that there is an association between age and income differences. Older individuals may have more assets or income sources over time, or may qualify for pensions or grants, while younger farmers may have more limited economic capacity. Younger individuals normally earn less due to limited work experience and entry-level job positions (Friedline *et al.*, 2020). Moreover, younger groups normally have limited work experience and occupy entry-level job positions, limiting their earning potential (Friedline *et al.*, 2020). However, this is not likely to hold for women. Older women in rural areas may earn less despite their age, due to cumulative disadvantages in labour markets and limited access to pensions (Posel & Rogan, 2012).

4.3.8 Household head and formal employment

There was a strong association ($p < 0.001$) between household heads and formal employment. This means that formal income sources could elevate individuals to household leadership roles. This is particularly relevant in rural settings where income diversity is limited. The level of education is a moderator. Higher education levels are associated with better employment opportunities and reduced risk of poverty. For example, in Turkey, households with heads who have higher education levels are less likely to be poor, and vocational or technical education can be more beneficial than general high school education in certain regions (Bilenkisi *et al.*, 2015). Similarly, in Vietnam, results revealed that formal employment is more accessible to those with higher education, reducing poverty risk (Duc, n.d.).

4.3.9 Education level and formal employment

There was a significant relationship ($p < 0.001$) between education and formal employment. This confirms long-standing findings that higher educational attainment is linked to better access to the formal labour market (Bhorat *et al.*, 2014). Formal education significantly enhances the likelihood of securing formal employment. A study conducted in Nepal, revealed that individuals with tertiary education are more likely to be employed in the formal sector compared to those with only primary or secondary education (Bolli *et al.*, 2019). This trend is consistent over time, although the strength of the relationship between lower levels of education and formal employment has decreased (Bolli *et al.*, 2019). In addition, a study conducted in Gorontalo Province, Indonesia, revealed that education level positively influences income in both formal and informal sectors, highlighting the importance of education across different types of employment (Banini *et al.*, 2024).

4.3.10 Education level and household income bracket

The level of education and household income were strongly associated ($p < 0.001$). This provides more evidence on the central role of education in income determination. Better-educated individuals typically earn and diversify income sources more than less educated individuals. This is consistent with economic theory on human capital and findings from South African labour market analyses (Van der Berg, 2015). The

education level within a household, particularly the highest educational attainment, is positively correlated with household income. This is supported by studies from China, which show that higher family education levels lead to increased household income (Li, 2023). The education of the household head is a significant determinant of household income, with higher education levels leading to better financial decision-making and income growth (Chen, 2024).

4.3.11 Formal employment and household income bracket

A significant relationship ($p = 0.008$) existed between formal employment and income. Formal jobs are more stable and offer higher incomes than informal or subsistence-based livelihoods, enhancing household economic outcomes. The results are consistent with a study conducted in Sukabumi, which revealed that individuals in formal employment earn more than those in informal sectors, highlighting the income disparity between these sectors (Tjahyadi *et al.*, 2023). The results also concur with the findings of Bolli *et al.* (2019) that there is a relationship between formal employment and income.

4.4 Chapter summary

The livestock farming population in uMgungundlovu is mainly middle-aged, male, semi-educated, and resource-poor, and they rely significantly on traditional farming methods and government assistance. Small landholdings and poor technical agricultural training hamper the productivity and income diversification of farmers, highlighting the pressing need for focused policy changes. Specifically, policy considerations should include expansion of extension services to enhance knowledge transfer, youth-focused agricultural initiatives to draw and keep younger generations, and land reform laws that guarantee long-term tenure to encourage investment. Furthermore, livestock development strategies should prioritize increasing productivity within indigenous systems and educational programs that increase awareness of the economic potential of livestock. Strategies that ultimately improve the livelihoods of farmers will comprise strategies that improve market and credit access and the financial literacy of farmers.

The findings also highlight the interconnected nature of socioeconomic characteristics, and this has significant consequences for policy and development planning. This

underscores the necessity of ongoing investments in easily accessible, high-quality education as well as responsiveness of policy interventions to age, because different age groups face different opportunities and challenges in the labour market. Development initiatives aimed at households must consider the complex ways that household headship, marital status, and educational attainment influence socioeconomic well-being. Furthermore, taking gender into account is crucial, especially when figuring out how women's participation in formal employment and leadership is impacted by marital status and household duties.

Chapter 5:

Breeding management practices, market dynamics, and performance of farmers in uMgungundlovu District

5.1 Introduction

This chapter presents an integrated analysis of livestock management strategies, marketing dynamics, and performance assessment methods employed by smallholder farmers in uMgungundlovu District. The discussion begins with an examination of breeding management practices, highlighting the extent to which farmers adopt selective breeding, their criteria for breeding cattle selection, and the challenges encountered in these decisions. The chapter then explores herd management, focusing on feeding practices and animal health monitoring approaches. Market access and participation are subsequently analysed, including barriers to formal market entry and the nature of market rejections. Finally, the chapter assesses how farmers measure livestock performance and concludes by reflecting on implications for policy, extension support, and future interventions aimed at improving smallholder livestock productivity and commercialisation.

5.2 Breeding management practices

5.2.1 *Selective breeding*

The results revealed that 59.4% of respondents practice selective breeding (Figure 5.1). However, the remaining 40.6% represent a missed opportunity as farmers who do not apply selective breeding criteria continue to use unimproved bulls, resulting in slower genetic gain, lower calving rates, reduced growth performance, and ultimately lower revenue outcomes. Selective breeding, even when based on simple observable traits, has been shown to yield measurable gains in productivity (Kosgey & Okeyo, 2007). However, comparative studies showed regional variation, where Tada *et al.* (2013) found only 40% adoption in the Eastern Cape, whereas Haile *et al.* (2011) reported higher rates (more than 60%) in Ethiopia, driven by national programs. In addition, Mateescu (2020) and Rowan (2022) note that while advanced techniques (e.g., selection indices) are effective, they remain underutilized in smallholder systems due to complexity and cost.

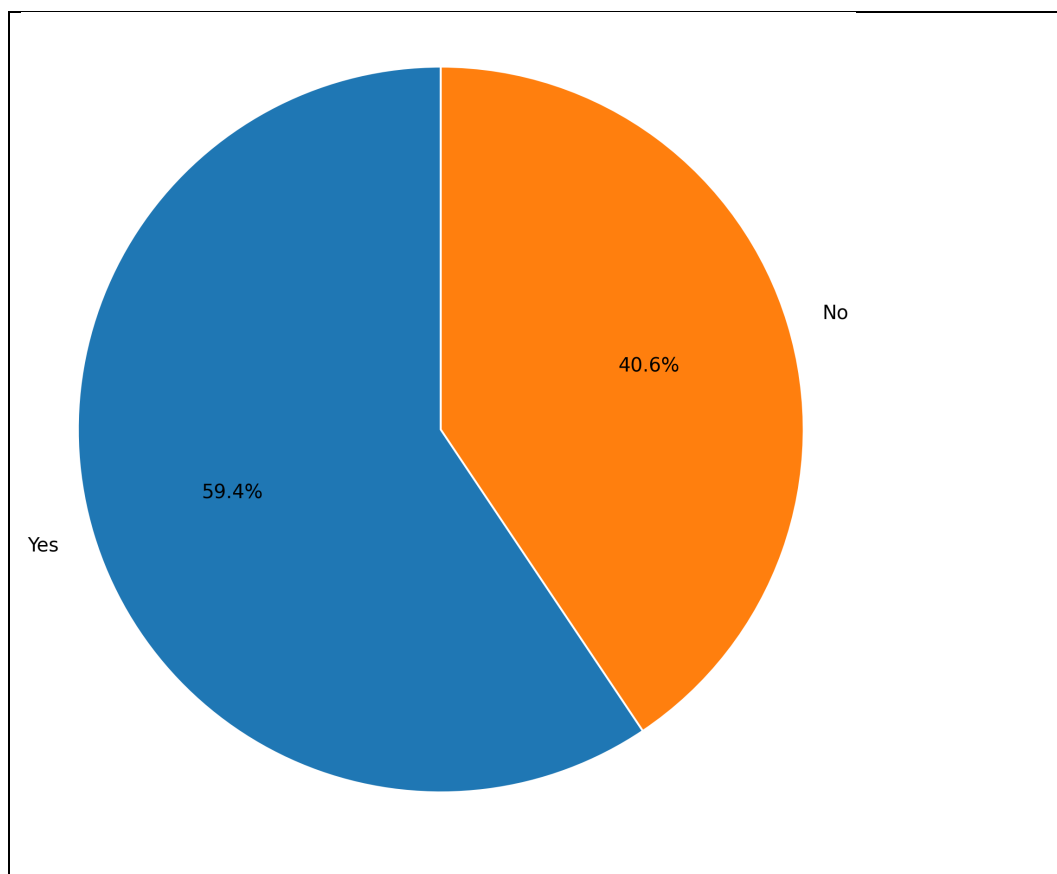


Figure 5.1: Distribution of practice selective breeding

5.2.2 Type of selective breeding practiced

Figure 3 presents the results of the distribution of types of selective breeding. The results revealed that the most reported methods used by farmers were natural Oestrus observation (53.5%) and visual cues (38.3%) (Figure 5.2). These techniques, while accessible, lack precision and leave room for error. Low adoption of technologies like heat detection pads (1.0%) signals a missed opportunity for improving reproductive timing and efficiency.

As reported by Mashiloane and Chimonyo (2016), visual evaluation based on body size and behaviour is prevalent. In contrast, Tanzanian farmers (Chawala *et al.*, 2018) emphasised traits like milk yield and disease resistance, suggesting that where awareness of economic traits is stronger, breeding decisions are more strategic.

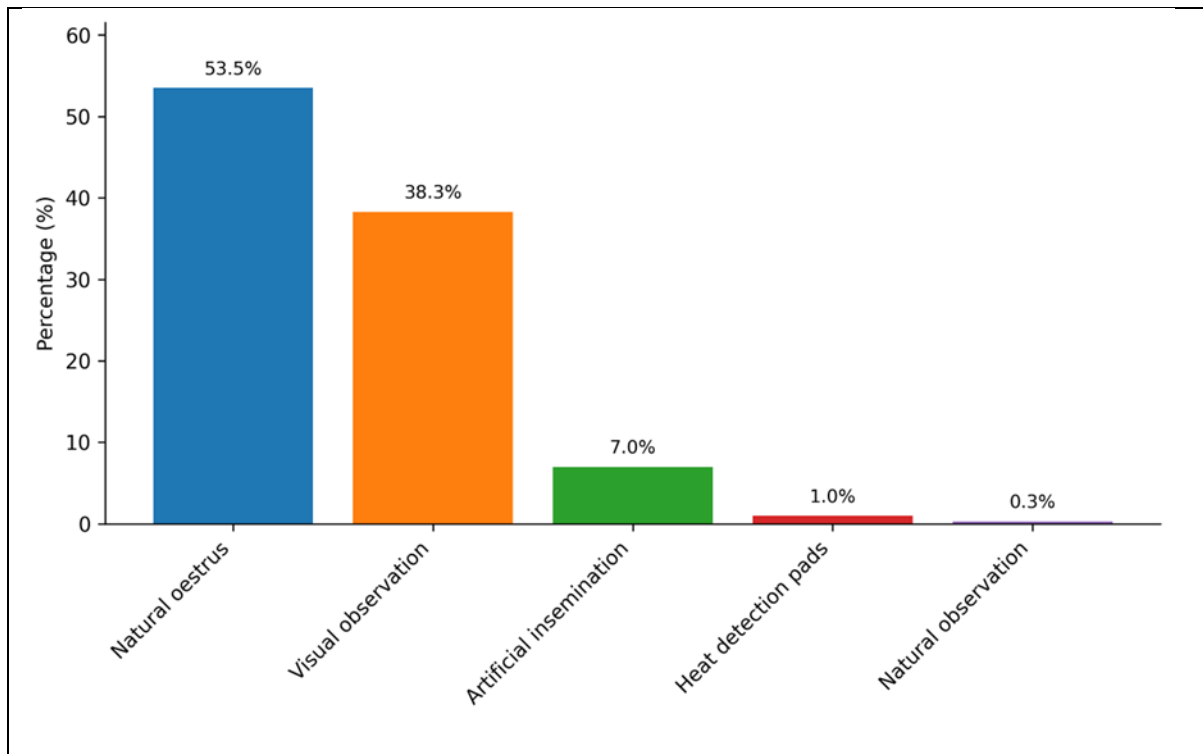


Figure 5.2: Distribution of types of selective breeding practices

5.2.3 Breeding female selection criteria

Figure 5.3 presents the results of the distribution of criteria for selecting breeding females. The results revealed that farmers primarily use visual traits like body condition (39.7%) and age (15.7%) to select breeding females. This practical approach aligns with low-resource contexts but underrepresents genetic and reproductive traits such as fertility (9.3%) and longevity (10.8%). This indicates a need for increased awareness of economically valuable traits. In contrast, Zander and Drucker (2008) found that selection in West Africa was often culturally motivated. Ngeno *et al.* (2011) similarly reported reliance on visual assessments, highlighting a widespread gap in structured genetic evaluation.

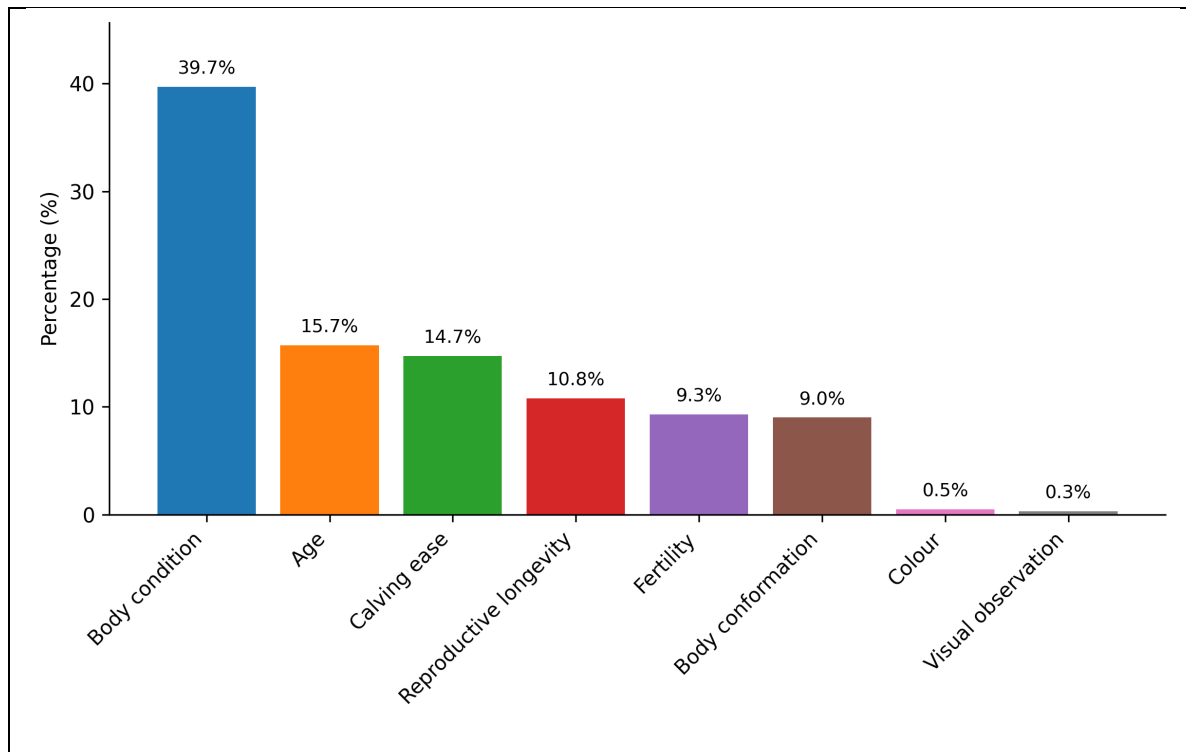


Figure 5.3: Distribution of criteria for selecting breeding females

However, there was a high non-response rate (74.31%) for the criteria for selecting breeding males (Figure 5.4). This means that the selection of breeding males is either neglected or not well understood. Where data exists, age and body conformation dominate selection decisions. Moyo *et al.* (2012) and Mdladla *et al.* (2016) observed that farmers often select bulls based on maternal productivity and size, rather than objective fertility or pedigree data. Nqeno *et al.* (2011) also concur that some farmers used observable traits like size and calving intervals. In addition, Zander and Drucker (2008) found that in West Africa, selection was more culturally based (e.g., colour, horn shape).

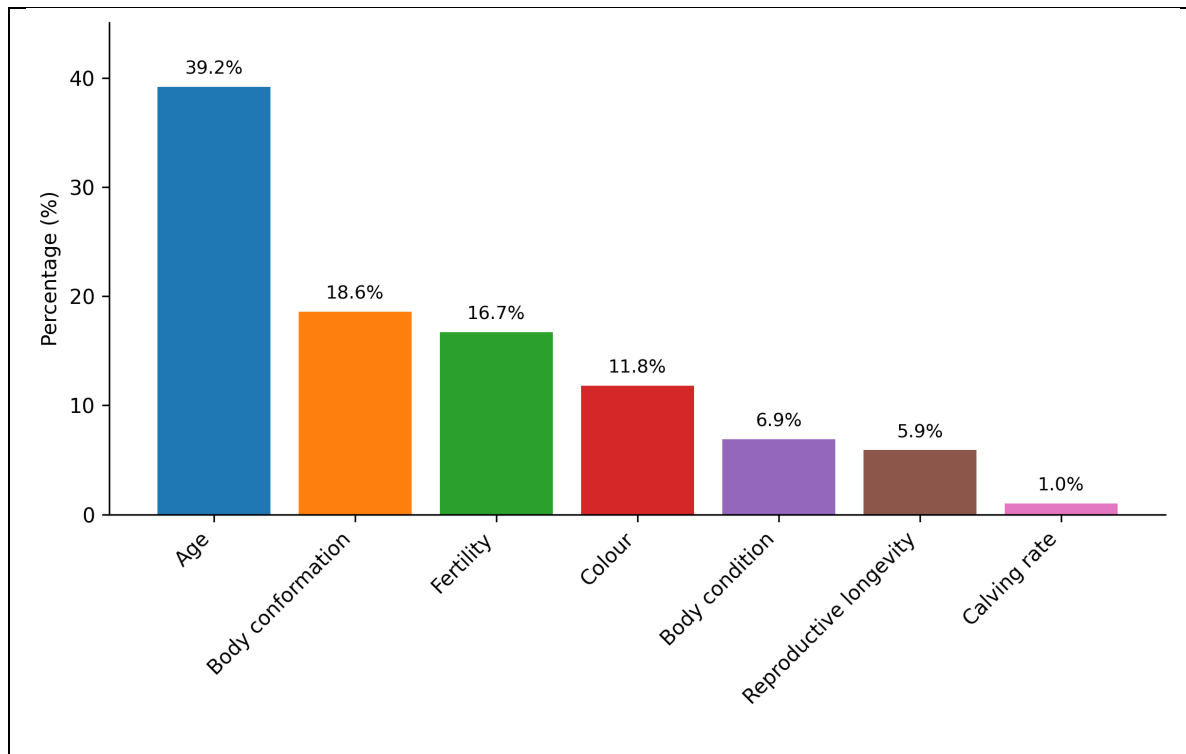


Figure 5.4: Distribution of criteria for selecting breeding males

5.2.4 Breeding marketing challenge

These results showed a high rate of missing responses (95.72%), which suggests farmers may not distinguish breeding-specific marketing challenges from general livestock marketing issues. Musemwa *et al.* (2008) and Randolph *et al.* (2007) both underlined weak market integration and poor infrastructure as key constraints. These issues limit the viability of breeding enterprises and may explain the limited focus on marketing breeding stock. In addition, Rowan (2022) notes that evolving market demands require farmers to align breeding goals with buyer preferences. Furthermore, according to Mateescu (2020) and Maltseva (2024), environmental sustainability and animal welfare are emerging considerations influencing market access.

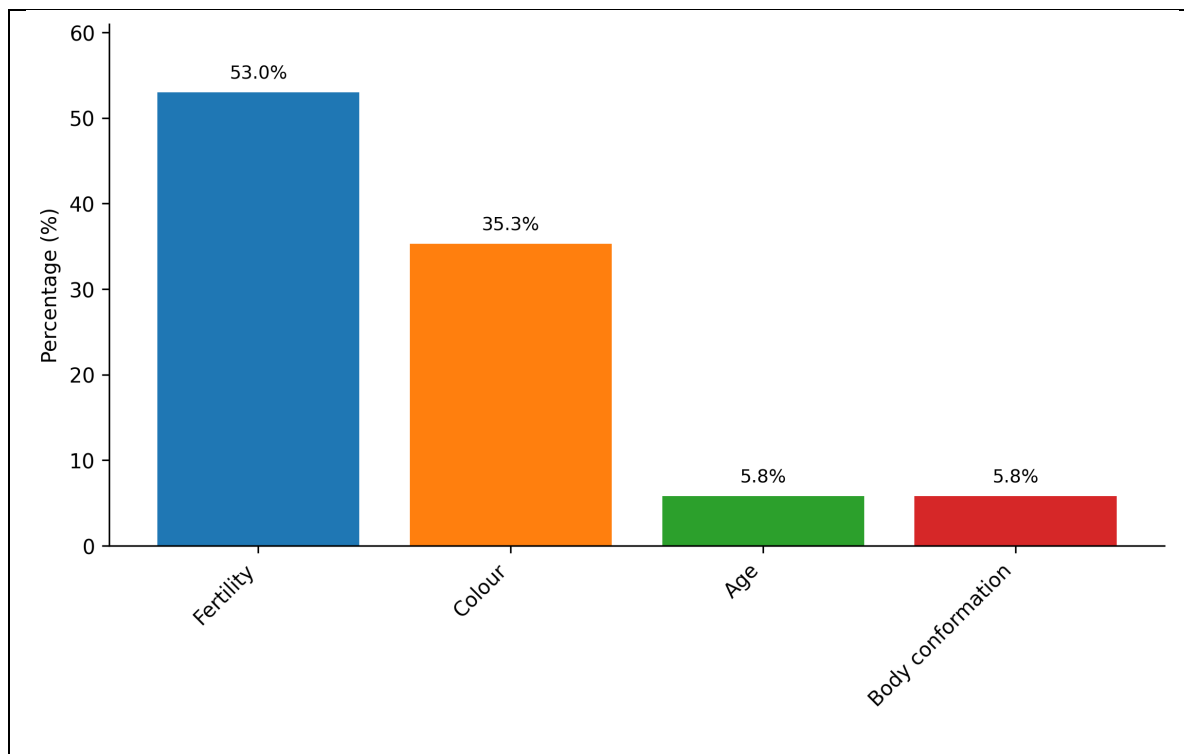


Figure 5.5: Distribution of marketing challenges

5.2.5 *Breeding cattle selection challenges*

The results show that most farmers frequently cited body condition (37.4%), libido (17.2%), and age (16.7%) when identifying challenges in selecting breeding cattle. These are sensible criteria, but the neglect of temperament (1.3%) and disease resistance (12.2%) is concerning. This is consistent with findings from Tada *et al.* (2013), who noted poor access to structured breeding programs, and Bester *et al.* (2003), who emphasized knowledge gaps in trait prioritization. A shift toward multi-trait selection informed by both performance and adaptability would better support herd sustainability.

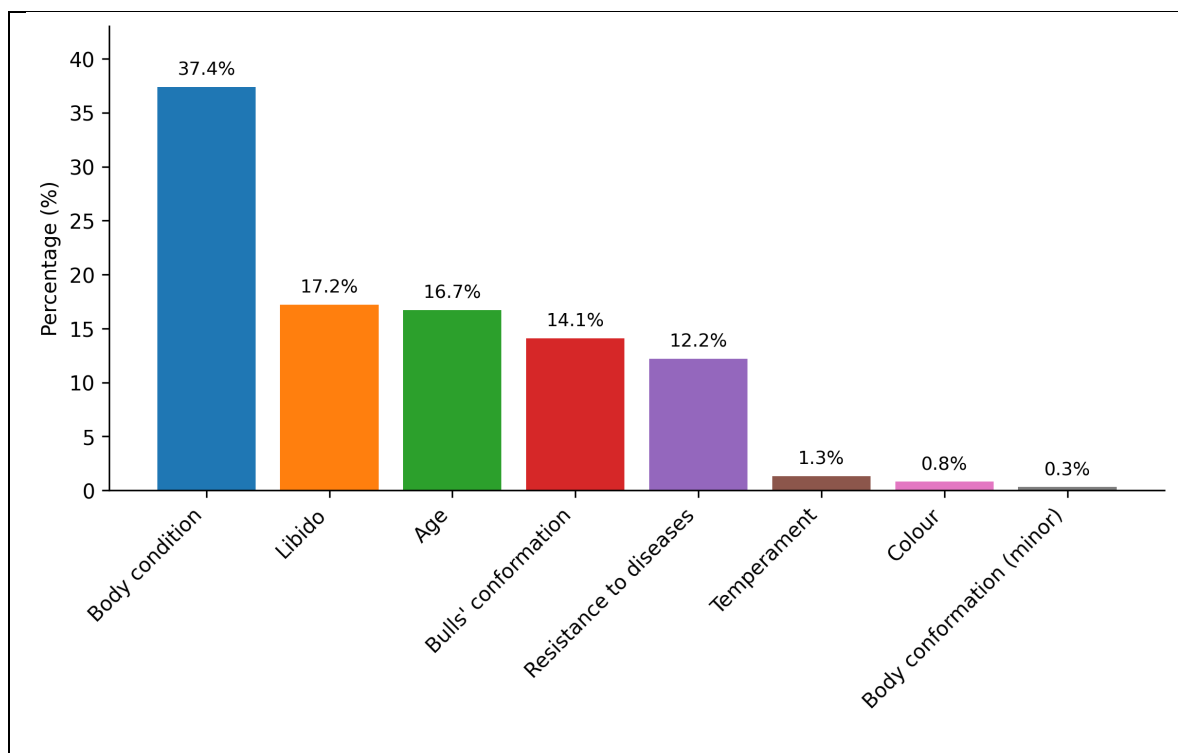


Figure 5.6: Distribution of challenges in selecting cattle breeding

5.3 Production and herd management practices

5.3.1 Primary feed sources

The findings of this study reveal a strong dependence on natural resources for livestock production among the respondent smallholder farmers. Natural grazing (87.5%) and river water (91%) were the dominant feed and water sources, respectively. This heavy reliance on the environment echoes the observations of Musemwa *et al.* (2008), who reported that communal farmers in the Eastern Cape predominantly utilise unimproved grazing systems. While these resources are accessible and cost-effective, such dependence heightens vulnerability to climatic shocks, particularly droughts, which severely compromise forage availability and overall livestock productivity.

Table 5.1: Primary source of feed and water

Category	Frequency	Proportion (%)	Total
Primary source of feed			
grazing	335	87.47	397
purchased feed	33	8.62	397
crop residues	15	3.92	397
Primary source of feed			
river	355	91.03	397
water tank	20	5.13	397
streams	11	2.82	397
ponds	4	1.03	397

To compensate for nutritional gaps inherent in natural grazing systems, a significant proportion of farmers (81% reported the use of feed supplements, especially vitamins and minerals (55.2%). This suggests an awareness of the limitations of natural pastures and a proactive attempt to address nutritional deficiencies. The trend aligns with findings by Khapayi and Celliers (2016), who observed increasing, though uneven, adoption of improved feeding strategies among smallholder farmers. These efforts demonstrate an evolving approach to livestock nutrition management, although resource constraints may still limit uniform uptake across farming communities.

Table 5.2: Supplemental feeding and type of supplement

Category	Frequency	Percentage (%)	Total
Supplemental feeding			
yes	311	80.99	397
no	73	19.01	397
Type of supplement			
minerals & vitamins	191	55.2	397
licks	95	27.46	397
grains	41	11.85	397
hay and silage	19	5.49	397

5.3.2 Health monitoring

Despite the efforts to enhance nutrition, the study highlights persistent challenges in animal health management. The widespread use of personal observation methods, coupled with limited access to veterinary services (12%), mirrors the findings of Ngoshe *et al.* (2023), who reported that smallholder farmers often lack the technical knowledge required to effectively manage livestock diseases. This is further complicated by the low levels of regular vaccination, with only one-third of respondents adhering to consistent vaccination practices. These gaps in animal healthcare align with observations by Khapayi and Celliers (2016) and Silayi *et al.* (2025), who both emphasised the inadequacy of veterinary extension support and the resultant shift toward reactive, rather than preventative, disease management approaches. Such shortcomings increase livestock susceptibility to diseases such as foot and mouth disease (FMD) and lumpy skin disease (LSD).

Table 5.3: Health monitoring methods

Variable	Category	Frequency	Percentage (%)	Total
health_monitoring_method	personal observation	309	79.03	397
health_monitoring_method	veterinary services	48	12.28	397
health_monitoring_method	extension services	34	8.7	397

Health monitoring practices also reflect the limitations in formal veterinary oversight. Approximately 79% of farmers rely on personal observation to detect animal illness, a method that, while accessible, is often unreliable without adequate training. This pattern is common in resource-poor settings. Ngoshe *et al.* (2023) noted similar tendencies in the Eastern Cape, where observable symptoms were often used in place of professional diagnostics due to cost and access barriers. The high prevalence of diseases such as diarrhoea 71.68%, external parasites 14.3%, and black quarter 4.08% further underscores the impact of insufficient veterinary outreach and inadequate farmer training. Moyo and Masika (2009) similarly reported that parasite infestations remain widespread in communal areas due to poorly coordinated control programs.

Table 5.4: Common disease challenges

Category	Frequency	Percentage (%)	Total
diarrhea	281	71.68	397
external parasites	55	14.03	397
black quarter	16	4.08	397
Lumpy skin disease	10	2.55	397
blue tongue	10	2.55	397
foot and mouth disease	9	2.3	397
heart water	6	1.53	397
mastitis	2	0.51	397
blue quarter	1	0.26	397
babesiosis	1	0.26	397
lumpy	1	0.26	397

5.4 Characterisation of beef markets used by farmers

These results revealed that informal markets dominate (59.3%) livestock sales. Moreover, the willingness to use group marketing was limited (38.8%), alongside with high proportion of farmers unwilling to participate in collective sales (67.8%). This is consistent with broader trends observed among smallholder farmers across Sub-Saharan Africa. Alene *et al.* (2008) and Barrett (2010) attribute this reliance on informal markets to lower transaction costs, greater flexibility, and minimal entry requirements. Similarly, in the South African context, Randela *et al.* (2008) found that communal livestock farmers often preferred informal channels due to proximity, established social networks, and the use of cash-based transactions.

Table 5.5: Market type and group marketing

Category	Frequency	Percentage
Market types		
informal markets	235	59.31%
auctions	146	36.70%
direct to butcheries	12	2.93%
abattoirs	4	1.06%
Group marketing		
no	243	61.17%
yes	154	38.83%

The limited participation in group marketing confirms the findings by Ortmann and King (2007), who emphasized that mistrust, lack of cohesion, and weak institutional support are major barriers to cooperative arrangements. These observations are further supported by the findings of Lemke *et al.* (2009), which emphasised the role of social capital and trust in determining the success of group marketing initiatives.

There were approximately 85% of the respondents who reported market access-related challenges, with about 23% farmers citing transport difficulties. Some of the key market barriers included limited market information, poor infrastructure, and low prices. These findings resonate with studies by Musemwa *et al.* (2007) and Hlongwane *et al.* (2014), which documented similar impediments constraining smallholder commercialization in South Africa. Inadequate infrastructure, particularly in remote rural areas, contributes to a spatial mismatch between producers and markets, thereby reinforcing smallholders' dependence on informal buyers. This dependency results in unfavourable terms of trade, and middlemen exploit the information asymmetries and weak bargaining power (Chawatama *et al.*, 2005).

The results also revealed that about 78% farmers face market rejections. This is largely due to uncastrated males, disease, and missing documentation, which reflects significant quality and compliance issues that often characterize low-input livestock systems. These results align with findings from Namibia and Botswana by Mmbengwa *et al.* (2015), where deficiencies in animal health management and lack of traceability systems restricted smallholder access to formal beef markets. In South Africa, Montshwe (2006) associated market rejections with weak veterinary support, inadequate regulatory knowledge, and poor extension service delivery. The persistence of such challenges underscores the critical need for targeted veterinary

services and farmer training to enhance compliance with formal market standards (FAO, 2011).

Table 5.6: Market rejections and frequency of marketing

Category		Percentage
Market rejections		
yes	310	78.13%
no	87	21.87%
Frequency of marketing		
annually	220	55.58%
emergencies	165	41.56%
monthly	7	1.82%
weekly	4	1.04%

The sales behaviour of more than half of the farmers (56%) was unstructured, with livestock sales made annually or during emergencies (42%). This suggests a non-strategic, reactive engagement with the market. This finding is indicative of “distress sales,” a concept well-documented in the literature, where livestock serve primarily as a form of savings or insurance rather than a commercial asset (Boughton *et al.*, 2007). The fact that 83% of sales were driven by household income needs, rather than by favourable market conditions, further supports this subsistence-oriented livelihood strategy. Comparable behaviour has been observed in Ethiopia and Kenya, where livestock sales are often liquidity-motivated and disconnected from market signals (Jabbar *et al.*, 2007), ultimately limiting farmers' ability to take advantage of price seasonality and resulting in low profitability.

The expressed need for financial access (35%), along with requests for training and government support, highlights the demand for enabling interventions that can facilitate livestock commercialization. These priorities reflect calls in the literature for inclusive livestock development strategies that provide smallholders with access to credit, inputs, and extension services. According to Zantsi *et al.* (2021), without such support, smallholders remain locked in low-productivity cycles. In line with this, the Department of Agriculture, Forestry and Fisheries (DAFF, 2013) emphasized the importance of integrating emerging farmers into formal markets through policy support and financial inclusion.

Moreover, the preference for informal markets and the high rate of market rejections reflects broader structural challenges. As Nkhori (2004) argues, many smallholder

farmers are effectively excluded from formal markets due to stringent quality requirements, high transaction costs, and insufficient institutional support. Informal markets, therefore, often present the most accessible for resource-constrained producers.

The management practices identified among farmers in uMgungundlovu reflect a predominantly traditional, low-input farming system with limited integration of modern husbandry practices. The near-exclusive reliance on natural mating (85.6%), combined with limited breeding record-keeping (50.1% of farmers), constrains opportunities for systematic genetic improvement and herd performance monitoring. These practices have direct implications for productivity. Farmers cannot plan mating cycles effectively, manage inbreeding risks, or track calving intervals without accurate breeding records, all of which are critical determinants of herd productivity (Rowan *et al.*, 2022). Furthermore, the low vaccination adherence rate (33%) and the reactive rather than preventative approach to disease management observed in this study are associated with elevated mortality risks and reduced marketable output, thereby directly depressing revenue.

5.5 Performance measurement methods

The findings reveal that communal livestock farmers predominantly assess cattle performance based on weight gain (38.4%) and market price (33.0%). Less frequently used indicators include calving rate (15.7%) and mortality rate (12.9%), highlighting a focus on immediate physical and financial outcomes rather than on reproductive efficiency or herd health management. The reliance on these indicators occurs within an informal, experience-based system, with minimal use of structured, digital, or paper-based record-keeping tools. This informality aligns with Ndlovu and Silayi *et al.* (2025), who found that smallholder and communal farmers in Southern Africa often depend on visual appraisal and experience when evaluating livestock performance. These subjective approaches, while valuable in traditional contexts, lack the precision and traceability required in formal and export markets (Musemwa *et al.*, 2008). Consequently, farmers are at a disadvantage when trying to access premium or regulated markets that demand verifiable animal histories, vaccination records, and performance documentation (DAFF, 2012).

Comparable trends have been observed across Southern Africa. For example, Chagunda *et al.* (2013) noted that in Malawi, most smallholder cattle farmers lacked basic production records, limiting their ability to manage reproduction, plan sales, or monitor disease trends effectively. Similarly, Nkosi and Kirsten (1993) found that in South Africa, the absence of structured performance tracking was a key factor constraining the commercialisation of emerging beef producers.

The informal performance assessment is compounded by significant gaps in animal health management, particularly in access to vaccination and veterinary services. This study's findings support broader evidence indicating that veterinary coverage in rural areas is often fragmented and under-resourced. Mapiye *et al.* (2009) and Stroebe *et al.* (2023) emphasize that public veterinary services are stretched thin, with mobile clinics either unavailable or inconsistently deployed. Furthermore, Mohlatlole *et al.* (2021) report that emerging farmers often lack knowledge of disease symptoms, appropriate treatment protocols, and the timing of vaccinations, which exacerbates herd vulnerability.

Studies by Swanepoel *et al.* (2008) also stress that animal health constraints are not merely technical but are also shaped by institutional and policy failures such as the lack of coordinated extension support, poor disease surveillance infrastructure, and underfunded veterinary networks. Without improved access to health services and record-keeping training, many communal farmers will remain locked out of more lucrative livestock value chains.

5.6 Chapter summary

The findings indicate that breeding practices among smallholder farmers in uMgungundlovu are mainly traditional, relying mostly on natural mating with limited integration of modern technologies and systematic record-keeping. This highlights various areas that are critical for intervention including capacity building through extension, appropriate technology adoption, strengthening of record keeping systems, and bull schemes and male selection support.

When performance tracking, market readiness, and livestock health monitoring are not integrated, problems like cattle rejection and low farmer returns are frequently the result. Strengthening veterinary services, especially through mobile units, should be a top priority for policy in order to address this, along with encouraging appropriate record-keeping and traceability to satisfy market standards. Using collective marketing models to build trust can improve access to resources and bargaining power. To enhance livestock quality and commercial success, farmer training should also emphasize disease control, strategic supplement feeding, and comprehension of market demands.

Chapter 6:

Factors influencing farmers' market choice of cattle farmers in uMgungundlovu

6.1 Introduction

This chapter presents the results of econometric models developed to examine the key determinants influencing market participation and revenue outcomes among smallholder beef cattle farmers in uMgungundlovu District. It builds on the descriptive insights from the previous chapter by applying quantitative techniques to rigorously assess the significance and direction of associations between selected socioeconomic, technical, and institutional variables and farmers' marketing and income decisions. Two main models are presented: a multinomial logit model to evaluate the factors shaping market choice, and an ordinal logistic regression to assess the determinants of farmers' annual revenue categories. The analyses aim to reveal critical leverage points for improving farmers' integration into formal markets and enhancing their profitability, thereby informing policy and extension support strategies for inclusive livestock development.

6.2 Determinants of farmers' market choice in uMgungundlovu

Table 7 below presents the results of a multinomial logit model. The model assessed factors affecting the market choice of beef cattle smallholder farmers. The dependent variable, market type, was modelled against various socioeconomic factors, which were selected based on the literature. The informal market type was used as a reference category. Thus, the model compared the likelihood of choosing to sell in informal markets relative to selling in the auction market and selling to butchereries.

The variables that were statistically significant in predicting the market choice by farmers were education, lack of access to quality bulls, limited breeding knowledge, and extension service quality. Grade 8-12 and tertiary education level reduced the likelihood of participating in auction markets (Table 7). This means that farmers who had obtained these qualifications were likely to participate in auction markets compared to farmers who did not have formal education. This finding contrasts with general findings, as Makhura (2001) and Omiti *et al.* (2009) find that education generally enhances access to formal markets due to improved literacy, market

knowledge, and decision-making. However, Martey *et al.* (2012) argued that higher education may shift the interest of farmers towards non-agricultural income sources or more direct marketing avenues, potentially reducing auction market participation. Thus, the current findings align with this argument.

Moreover, farmers with a lack of access to quality bulls and limited breeding knowledge had a lower likelihood of participating in auctions compared to farmers with access to quality bulls. This means that not having access to quality bulls and having limited breeding knowledge reduces the chance of participating in auction markets. This aligns with the findings that link technical capacity and animal quality with entry into competitive markets. According to Jabbar *et al.* (2007) and Musemwa *et al.* (2008), livestock quality and breeding knowledge are crucial for auction market requirements due to the high valuation of physical traits and genetic potential. Auction markets are competitive and based on certain traits. Thus, breeding knowledge is crucial to increase participation in auction markets. Moreover, poor extension services also reduce the chance of selling directly to butcherries. This means farmers who have access to poor extension services have a lower chance of selling directly to butcherries compared to farmers with quality extension services. This supports literature on the role that extension officers play in connecting farmers to high-value markets. For example, Hlongwane *et al.* (2014) and Nengovhela *et al.* (2021) demonstrated the role played by extension officers in improving farmers' technical knowledge, market orientation, and ability to meet quality standards demanded by formal buyers. Thus, poor extension services increase the likelihood of participating in informal markets.

Table 6.1: Multinomial regression results of factors influencing participation in markets

Variable	Coefficient	Exp (β)
Factors influencing participation in auctions (vs informal markets)		
Education: Grade 8 - 12	-1.38***	0.25
Education: Tertiary	-2.41***	0.09
Market Distance: Lack of access to quality bulls	-2.17***	0.11
Market Distance: Limited knowledge on breeding	-1.55***	0.21
Factors influencing participation in direct to butcheries (vs informal markets)		
Extension Service Quality: medium	-2.57**	0.08

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Therefore, education level, distance-related challenges, and extension service quality significantly influence market participation. While a higher level of education is related to a preference for informal markets over formal markets, poor extension service support also discourages participation in formal channels such as auctions and butcheries.

The table below presents full multinomial logit regression model results with the raw coefficients, standard errors, z-values, p-values, and confidence intervals. The asterisks (*) indicate statistically significant variables ($p < 0.05$). The following were reference(base) categories for categorical predictors: Education Level: Grade 1 – 7, Extension Service Quality (low), Gender: F, Market Distance Category: inbreeding, Age Group: 18 – 30.

Table 6.2: Full multinomial logit regression model results of the factors influencing market participation

Equation	Coef.	Std.Err.	z	P-value
Intercept (auctions)	1.48	0.93	1.59	0.11
education_level[Grade 8 - 12]	-1.38	0.34	-4.01	0.0
education_level[No Formal Education]	-0.25	0.45	-0.55	0.58
education_level[Tertiary]	-2.41	0.72	-3.33	0.0
extension_service_quality[medium]	0.33	0.64	0.52	0.6
extension_service_quality[high]	1.5	1.27	1.18	0.24
gender[Male]	0.37	0.29	1.29	0.2
market_distance_category[lack of access to quality bulls]	-2.17	0.48	-4.5	0.0
market_distance_category[limited knowledge on breeding practices]	-1.55	0.44	-3.49	0.0
market_distance_category[low conception rates]	-0.83	0.79	-1.05	0.29
market_distance_category[resistance to diseases]	-21.69	27630.77	-0.0	1.0
age_group[31 - 50]	0.22	0.58	0.37	0.71
age_group[51 - 70]	-0.1	0.6	-0.17	0.86
age_group[>70]	-0.34	0.73	-0.47	0.64
Equation (Butcherries)				

Intercept	1.50	0.955	1.57	0.12
education_level[Grade 8 - 12]	-1.38	1.00	-1.38	0.17
education_level[No Formal Education]	-0.36	0.33	-1.09	0.28
education_level[Tertiary]	-2.41	2.54	-0.95	0.34
extension_service_quality[medium]	2.57	0.13	19.76	0.00
extension_service_quality[high]	1.2	1.45	0.83	0.41
gender[Male]	0.43	0.40	1.07	0.28
market_distance_category[lack of access to quality bulls]	-2.17	2.50	-0.87	0.38
market_distance_category[limited knowledge on breeding practices]	-1.24	1.44	-0.86	0.39
market_distance_category[low conception rates]	-0.83	0.79	-1.05	0.29
market_distance_category[resistance to diseases]	-21.69	276.77	-0.08	0.94
age_group[31 - 50]	0.11	0.25	0.44	0.66
age_group[51 - 70]	-0.54	0.44	-1.23	0.22
age_group[>70]	-0.45	0.65	-0.69	0.49

6.3 Factors influencing revenue of farmers: the role of cattle price and costs

Table 6.3 presents the results of the ordinal logistic regression model, which was used to examine the effect of average beef cattle prices and cost-related variables (labour and veterinary costs) on the likelihood of farmers falling into higher annual revenue categories. Smallholder beef cattle enterprise performance was operationalised through the use of annual revenue from cattle sales, classified into three ordinal categories: low (< R15 000), medium (R15 000–R50 000), and high (> R50 000). This operationalisation reflects the reality that most smallholder farmers do not maintain formal financial records sufficient for continuous revenue measurement, and that revenue categories capture the broad commercialisation gradient from subsistence to semi-commercial production. The ordinal logistic regression model was applied to assess which socio-economic and management factors significantly predict membership in higher revenue categories, controlling for farm-level characteristics.

The full model considered various socio-economic factors. However, the variables that were statistically significant were only price and labour costs. Thus, variables that were not statistically significant dropped from the model, leaving only significant variables for interpretation and discussion. Veterinary costs and perceived major cost drivers such as feed did not statistically significantly influence revenue. This indicates that perceptions may not always align with actual cost impacts, or that farmers may misallocate resources based on perceived rather than measured cost burdens. Nkosi and Kirsten (1993) have noted that misperceptions in communal livestock budgeting, where feed and labour were overestimated relative to their revenue contribution. Thus, there is a need to bridge the gap between farmer perceptions and real cost-revenue relationships in training interventions, helping them make evidence-based financial decisions.

Although the way profitability due to data availability was measured presented some drawbacks for rigorous analysis. Examination of the profitability of smallholder farmers remains important for evidence-based policy planning and interventions. However, the development and analysis of robust profit function models is hampered by poor farm records. Smallholder farmers and beef cattle farmers in remote areas rarely keep data on sales prices and input costs for planning and decision-making purposes due to poor data collection, storage, and analytical techniques.

Table 6.3: Ordinal logit regression results of the factors that influence profitability

Variable	Coefficient	P-value
price_category_>R4000	2.22***	0.00025
price_category_R2000 - R4000	0.92**	0.067
labour_costs_>R3000	0.74	0.3456
labour_costs_R1500 - R2000	-0.96***	0.000042
vet_costs_>R3000	-0.44	0.14523
vet_costs_R1000 - R2000	-0.57*	0.0632
vet_costs_R3000	-11.21	0.3332
major_costs_for_managing_Feed costs	-0.75	0.4564
major_costs_for_managing_Labour	0.512	0.2321
major_costs_for_managing_Transportation	0.32	0.13432
major_costs_for_managing_Veterinary services	-0.58	0.1332
1/2	-0.66***	
2/3	1.45***	

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The results showed that the likelihood of farmers who received a price that was over R4000 per head of cattle was significantly higher than that of those with less than R1500 revenue per head, with a very strong positive effect ($p < 0.001$). Moreover, there was also a positive and significant association between higher revenue and farmers with an average price per head that is between R2000–R4000. This means that farmers who receive medium to higher prices are more likely to belong to higher revenue brackets. This result is consistent with findings by Lubungu *et al.* (2012) that better pricing is associated with improved farm-level revenue outcomes and market participation in beef value chains in Zambia and South Africa. Government interventions should aim at improving marketing strategies and access to high-value chains for better farm-gate prices and smallholder incomes.

However, mid-range labour costs (R1500–R2000) affected higher revenue negatively ($p = 0.004$). This suggests inefficient labour management practices at that expenditure level. Strangely, there was no significant association between high labour costs (>R3000) and veterinary costs (>R3000) and revenue outcomes. Therefore, the significant driver of revenue is average price of cattle is the average cattle price. Mid-range labour costs negatively affect profitability. This is similar to the observation by

Nkonya *et al.* (2016) that inefficient labour allocation among semi-commercial farmers constrains income generation. This calls for further examination of labour efficiency and training programmes that emphasise the importance of labour planning and control measures.

Chapter 7

Summary, Conclusion, and Recommendations

7.1. Summary of chapters

This study examined the management practices, market dynamics, and performance of smallholder beef cattle farmers in the uMgungundlovu District of KwaZulu-Natal, South Africa. Smallholder cattle farming was presented not only as a source of livelihood and socio-cultural capital but also as a potential driver for rural development. Chapter 1 also highlighted the dualistic nature of the livestock sector in South Africa and the persistent poor performance of smallholder farmers despite several supporting efforts. Thus, Chapter 1's focus was on poor performance in terms of productivity and profitability despite numerous interventions from the public and private institutions. Livestock management, breeding practices, access to veterinary and extension services, and integration into formal markets such as abattoirs and auctions were posited as the main hindrances in smallholder farming settings.

Therefore, Chapter 1 sets the objectives of the study as follows:

To describe smallholder farmer livestock management practices.

To determine the productivity and profitability of the smallholder beef cattle enterprise.

To assess the effect of livestock management on enterprise performance.

To characterize beef markets and identify the determinants of market participation.

To generate evidence-based recommendations to enhance the performance of the sector.

The chapter made its case regarding how important it is to identify and deal with various smallholder cattle farmers' challenges, which hinder their progress and participation in the market.

Chapter 2 presented a literature and organised it into a framework. The review established that smallholder farmers hold a large share of the national herd yet remain largely outside formal high-value channels. The reasons advanced are locating the binding constraint in the animal and the herd, and the other locating it in the institutions that mediate access. It also established that access to a market does not guarantee continued participation, since a farmer must meet quality standards, bear transaction costs, and align production with buyer requirements to remain in the channel.

The chapter then synthesised this evidence into four gaps and distinguished between gaps in evidence and a gap in explanation. To close the latter, it developed the asset-constrained offtake framework, in which an adapted Sustainable Livelihoods Framework supplies the classification of the constraints acting on the household and an adapted Household Production Theory supplies the decision rule that converts those constraints into an offtake and channel decision. Both source theories were subjected to critique before adoption. The most consequential adaptation is the rejection of the separability assumption, which brings household characteristics into models of production and marketing behavior. And the introduction of a retention value term, which reframes low offtake as a rational response to a shadow-price wedge rather than as a deficit of commercial orientation. Four testable propositions were derived from the framework; the conceptual framework was then derived from them.

Chapter 3 described the research design, how the data were collected, and how the data were analysed. The study employed a cross-sectional design and collected and analysed data from 385 randomly chosen smallholder cattle producers in four municipalities in the uMgungundlovu District (uMngeni, Richmond, Mpofana, and Impendle). Trained enumerators administered standardised questionnaires in isiZulu to obtain primary data, including information on socioeconomic factors, herd management procedures, input costs, productivity measures, and market involvement. Data analysis was carried out in STATA and R, combining descriptive statistics with econometric modelling techniques such as the multinomial and ordered logit models to assess the determinants of performance and market choice participation.

Chapters 4 and 5 provided the results of the study. Specifically, Chapter 4 focused on descriptive statistics, characterising farmers based on their socioeconomic factors

and management practices and revealing constraints related to resources and uptake of improved practices. Some of the main results were that there were more male farmers (59.3%) than women. Moreover, most farmers were middle-aged or older (43.1%), which suggests that there are gaps in the generations of people who work in agriculture. Only 8.9% farmers had a college degree, with the majority of farmers having no formal livestock training (48.2%).

Indigenous cattle breeds made up 77.4% of the total, and most farmers had less than two hectares of land. Most of them (86%) lived on their farms, which makes it easier to keep an eye on their animals.

Chapter 5 detailed the breeding strategies, market participation behaviour, and empirical findings on the determinants of market choice and enterprise profitability, highlighting the key interplay between production strategies and market behaviour among smallholder cattle farmers in the uMgungundlovu District. Specifically, the findings revealed that just more than half (56.4%) of farmers selectively bred their livestock, with the remaining proportion of farmers still practising natural methods such as natural oestrus detection and visual assessment. The use of advanced reproductive technologies like artificial insemination and heat detection pads was still limited, highlighting significant constraints in current breeding techniques and limitations in accessing modern breeding technologies.

Moreover, there was still heavy reliance of farmers' selection criteria for breeding females on observable traits like body condition (38.8%) and age (15.4%). However, fertility and reproductive longevity, which are related to productivity and genetic improvement, were not popular. The selection criteria for breeding males (74.3% non-response) were neglected, revealing weak emphasis on the quality of sires, which is critical for herd improvement. The findings on market participation and choice revealed insights into the extent of participation in formal markets.

Market participation patterns indicated a preference for informal markets (e.g., direct to consumers or community members), which could be attributed to convenience, immediate payment, and less stringent compliance requirements. Nevertheless, poor participation in formal markets like auctions and abattoirs demonstrated limitations in improving income opportunities. This is attributed to major constraints related to poor

animal condition at sale, long distances to formal markets, lack of knowledge of buyer requirements, and additional costs such as transport and market fees. Thus, multinomial logit model results revealed the key determinants of market choice among farmers in uMngundlovu.

The multinomial logit model results revealed significant factors influencing the market choice of farmers in uMgungundlovu. Specifically, the results showed that the level of education is a significant determinant of choosing informal markets over abattoirs or auction markets. The quality of extension service training was another significant factor of market choice, with poor extension service training quality decreasing the likelihood of selling to butcheries and auctions over informal markets. Moreover, there is a lack of quality bulls in the market and limited breeding. The determinants of market choice among farmers in uMngundlovu reveal structural constraints related to smallholder cattle farming. Thus, supply side constraints such as management skills and institutional environment, such as organizational support, are key in shaping farmers' market outlets. An ordered logit model gave insights into performance and influential factors.

The study employed an ordered logit model to assess the performance of smallholder cattle farmers in uMgungundlovu. Profitability, ranked as low, medium, or high, was regressed against socioeconomic factors to determine factors that influenced performance. The model results showed that labour costs and prices affect the performance of farmers. Specifically, while higher market prices increased the likelihood of farmers achieving high performance, higher labour costs decreased the likelihood of high performance. The ordered logit model emphasized the role of revenue and cost structures in improving the profitability of farming in smallholder settings.

The study found that smallholder farmers in uMgungundlovu predominantly rely on traditional management practices, including natural mating (85.6%), visual performance appraisal, and limited record-keeping (50.1%). These practices constrain productivity and market readiness. An ordinal logistic regression identified cattle price ($> R4\ 000$ per head, $p < 0.001$) as the primary revenue determinant, with mid-range labor costs ($R1\ 500$ – $R2\ 000$, $p = 0.004$) exerting a negative effect. The characterization of beef markets and market choice determinants showed that Informal

markets dominate (59.3%). A multinomial logit results show that education level ($p < 0.001$), extension service quality ($p < 0.05$), access to quality bulls ($p < 0.05$), and breeding knowledge significantly influence market channel choice.

7.2. Conclusions

The multinomial logit model results confirm that education level, extension service quality, access to quality bulls, and breeding knowledge are significant determinants of market choice ($p < 0.05$). Moreover, an ordinal logistic regression results confirm that cattle price category and mid-range labour costs are significant determinants of revenue category ($p < 0.001$ and $p = 0.004$ respectively). The evidence from this study shows that enterprise performance is primarily shaped by two interacting dynamics. First, market-side factors, particularly cattle price levels and the channel through which cattle are sold, are the dominant determinants of revenue outcomes, with farmers accessing formal markets and higher price categories achieving significantly better financial performance. Second, management practices, specifically deficiencies in record-keeping, breeding management, and veterinary uptake, constrain the ability of farmers to meet formal market quality requirements, thereby creating a feedback loop in which poor management practices reinforce reliance on informal markets, which in turn perpetuate low revenue outcomes.

This study underpinned that the livestock farming population is primarily middle-aged, male, semi-educated, and resource-poor, and they rely significantly on traditional farming methods and government assistance. Productivity and income diversification are hampered by most farmers' marginal landholding circumstances and lack of formal training.

There is moderate adoption of selective breeding (56.4%), with the usage of low-precision methods like visual observation and natural oestrus detection. Breeding selection criteria focus on observable traits (body condition and age), and genetic and fertility traits were not prevalent among farmers. Farmers relied on informal market outlets. There is also low participation in formal markets, which is limited by access to markets for quality bulls and breeding knowledge.

Participation in specific markets (butcheries, abattoirs, auctions) is significantly influenced by the quality of extension services, level of education, access to quality

bulls, and access to breeding information. The profitability of farmers is low and influenced by price and labour costs. The poor adoption of recommended herd management practices is directly correlated with suboptimal performance.

Moreover, breeding practices among smallholder farmers are predominantly traditional, relying heavily on natural mating with limited integration of modern technologies and systematic record-keeping. Moreover, there is heavy reliance on informal markets, subjective measurement methods, and inefficiencies in cost management that constrain the performance of smallholder beef cattle farmers in uMgungundlovu District. The predominant measures of performance are observable traits such as weight gain and market price. The use of calving or mortality rates for measuring performance is limited. Thus, farmers' ability to accurately track herd productivity, plan breeding cycles, and meet formal market requirements is reduced by the reliance on visual appraisal and experience-based judgment, coupled with minimal record-keeping. As a result, farmers are locked into informal markets, which limit their potential for improving revenue and long-term enterprise sustainability.

The set of hypotheses in Chapter 1 (Section 1.5) comprised four hypotheses in two paired sets (two null hypotheses and two alternative hypotheses). The first set concerned market choice, and the second concerned revenue outcomes. The alternative hypothesis that socio-economic and management factors significantly influence the market choice decisions of smallholder beef cattle farmers in uMgungundlovu District was supported (with education, extension service quality, access to quality bulls, and breeding knowledge statistically significant). Moreover, the alternative hypothesis that socio-economic and management factors significantly influence the revenue outcomes of smallholder beef cattle farmers in uMgungundlovu District was supported (with cattle price above R4 000 per head; price category R2 000 to R4 000; labour costs statistically significant).

There are two features of the results that go beyond the hypotheses. The first is that the significant determinants of market choice and of revenue outcomes are almost entirely different variables. While the channel choice is determined by human capital and institutional support, revenue is determined by price and cost structure. Thus, the two performance dimensions have distinct determinants. This suggests different interventions to influence these performance outcomes. The second feature is that the

labour cost influence is not a monotonic one. While the middle band of labour cost is significant and negative, the highest band is not. Although this is inconsistent with the monotonic assumption of labour entering the production relationship as a continuous input, It is consistent with Proposition 4 made in the theoretical framework of this study.

Therefore, economic factors remain important in shaping the profitability outcomes of smallholder farmers in uMgungundlovu, as highlighted by ordinal logistic regression results. The strong and positive relationship between cattle prices and revenue highlights the importance of market access and fair pricing in achieving profitability. Nevertheless, there are labour management inefficiencies as mid-range labour costs exerted a negative effect on revenue. This reflects the broader challenge of limited financial literacy and poor record-keeping, which hampers evidence-based decision-making.

7.3 Recommendations for farmers, policymakers, and future research

Farmers should adopt various breeding methods. They should not only rely on observable physical traits but also attend specific training related to fertility, calving ease, and disease resistance in selection criteria. There should be a specific focus on herd management improvement. Vaccinations, castration, strategic feeding (including supplementation), and routine castration should be conducted regularly for animal condition and market price improvement. Department of Agriculture Land Reform and Rural Development (DALRRD), through agricultural cooperatives, should improve access to quality breeding stock. Given that poor access to quality bulls is one of the primary breeding challenges, community bull-exchange schemes and structured bull-leasing programs should be established in each of the four municipalities. DALRRD should fund and facilitate bull quality certification.

There should be a strengthening of recordkeeping and benchmarking procedures. DALRRD should deploy mobile extension units in uMgungundlovu to deliver quarterly training workshops on record-keeping, reproductive management, and market compliance. Moreover, there should be an improvement in extension officer-farmer ratios. Extension officers should encourage farmers to keep accurate and up-to-date performance indicators, including calving rate, mortality, and feeding costs, for improved decision-making. Although it is necessary for farmers to implement these

suggestions, they need to be complemented by good political will. The findings directly inform the decisions an individual farmer can make. The first concerns the timing and conditioning of sales. The revenue category shifts significantly only once the price realised exceeds R4 000 per head, and the effect at that threshold is large. A farmer who sells more animals below the threshold does not change their income category, but a farmer who sells more animals above it does. This puts a general order to make things better into a clear, measurable goal, and this is how the finding should be sent to farmers.

The second concerns one is about work. If you hire herding workers for R1,500 to R2,000, you'll probably not make as much money in the next level, unless the herd has grown big enough to cover the cost. For an individual farmer, the rule is that hiring workers should follow herd growth, not precede it. Also, when the herd is small, joint herding is the most cost-effective way to get the same results. The third one is about records. About half of the respondents do not keep many records, and approximately 74.3%, could not name a breeding-male selection factor. In order to get access to the channel, farmers must first meet the needs of buyers, and those needs must be backed up by some evidence. For each farmer, this means keeping a minimum record set that includes the date of birth, the name of the sire, the date of vaccination, the weight of the sale, and the price received. This is five entries per animal per year, which is not easy for a family member who has not had any official training to do. This is the input that all the other decisions above are based on.

Policymakers should increase investments in extension services. Specifically, there should be increased implementation of advisory services that strongly focus on breeding, market preparation, and animal health. Furthermore, resources should be increased for the facilitation of access to formal markets. Alternative formal markets should be explored, such as providing support for the development of community-based transport schemes and local auctions, and incentivising buyers to source from smallholders to reduce transaction costs. Moreover, there should be a strengthening of breeding support programs. Implement farmer-led community bull schemes and subsidise artificial insemination to improve genetic stock. Policy is important for the development of smallholder farmers in South Africa. However, research should drive policy development and implementation for improved effectiveness and efficiency.

Research development should guide policymaking through the production of location-specific breeding knowledge. There should be a specific focus on co-development, with local institutions, of research outputs on breed performance and adaptability. Moreover, there should be an extensive evaluation of existing market programs such as CASP or PESI for improved targeting, efficiency, and sustainability. There should be improved support for digital innovation for market access. Specifically, there should be collaboration with tech developers to design and roll out mobile platforms for market information, animal traceability, and price transparency.

Since higher cattle prices are among the strongest predictors of higher revenue, local municipalities should implement interventions to improve price discovery and farmers' bargaining power. Moreover, these municipalities should facilitate smallholder access to certified livestock auction markets, including the subsidising of transport costs for qualifying farmers. Labour efficiency Interventions, led by DALRRD, will also help reduce the pressure on revenue from mid-range labour costs. Specifically, training programmes should include modules on labour scheduling, rotational grazing, and shared herding arrangements to reduce per-unit labour costs without compromising herd management intensity. Moreover, development finance institutions should help smallholder livestock farmers access investment capital. Specifically, the Land Bank and other development finance institutions should develop micro-credit products tailored specifically to smallholder cattle farmers with fewer than 25 head of cattle, using livestock as acceptable collateral.

Both the provincial extension service and the Department of Agriculture, Land Reform, and Rural Development run the service. The main conclusion is that extension quality determines channel, but extension presence does not. Because of this, performance indicators for extension must change from coverage indicators, like the number of farmers visited and sessions held, to content and outcome indicators, like the percentage of clients who keep at least a minimal record set and the percentage of clients whose animals meet the requirements of a formal buyer. This is a change in how the organisation measures itself, and it does not cost any extra money. It does require that the extension curriculum include the things that the results show are important, like price limits and condition goals, work scheduling, keeping records, and choosing sires. These things are not currently at the centre of the curriculum. The

system of auctions and slaughterhouses. There are buyer needs, but they are not sent to smallholders in a way that they can use. This is how a quality problem turns into an access problem.

There should be a list of what an animal must meet that should be made public through all official channels and be available in isiZulu at the point of sale. This means that the person who has the information pays for the translation, not the person who does not. Institutions that finance development. The households studied have livestock as their main asset, which cannot be used as collateral. Animal condition affects the amount of money that can be made. The valuation basis is the animal's certified condition rather than the head count. This way, the lending decision is based on the variable that determines the ability to repay. The provincial list of animals. There is a register of small-scale livestock farmers that made this study possible, but it was limited by the register's incompleteness. The district-level targeting, like this one, depends on keeping the register up to date, which should be seen as research infrastructure rather than an administrative task.

7.4 Future research

The study has identified several specific areas for future empirical investigation. These include panel studies. Specifically, future research should employ longitudinal panel designs to track how changes in management practices and market participation affect revenue outcomes over time, enabling causal inference beyond the correlational findings of this cross-sectional study. Moreover, climate-productivity interactions would yield rich insights. There is a need for future studies that integrate farm-level climate exposure variables, especially drought frequency and rainfall variability, as mediating factors in the relationship between management practices and smallholder beef cattle profitability in uMgungundlovu. Future research should also consider the full value chain and integrate value chain analysis from farm gate to consumer to identify at which stages smallholder farmers lose bargaining power and where targeted interventions would yield the greatest profitability gains.

7.5 Limitations

This study was limited by the absence of systematic record-keeping among respondents, resulting in a high rate of missing responses for certain variables. These

gaps reflect broader structural challenges in smallholder beef cattle farming settings, where management practices are informal and documentation capacity is low. However, certain mitigation strategies were implemented to reduce bias. These included cross-validation of the farmers' responses with extension officers and spot verification visits by enumerators during the survey to confirm the number of livestock. Moreover, there was a lack of farm-level climate exposure variables (e.g., drought episodes), which may mediate the relationship between productivity and revenue. These variables should also be considered in future studies to contextualize profitability outcomes.

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APPENDIXES

Appendix 1	Research Questionnaire for farmers
Appendix 2	Participant Information Sheet
Appendix 3	Unisa Ethics Approval letter
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Appendix 1: Research questionnaire for farmers

PhD Agriculture

In the

DEPARTMENT OF AGRICULTURE



University of South Africa: Rachael Sizakele Mkhize, Student number 38680637

Department of Agriculture and Animal Health Supervisors: Dr. U Chipfupa; Dr. O Loki and Prof G Mokolopi

1. INSTRUCTIONS

- Please use a ball-point pen or a thin felt tip. This form will be processed automatically.
- Do not mark against each statement more than once.
- Please follow the instructions written in each question of this questionnaire. If you are getting confused by the question, feel free to call the person doing this research for clarity.
- Questions require your honesty, and it will be very assisting if you answer according to what you know, not what others think. Some of the questions have follow-up questions; please go through a question before answering it.
- Questionnaires need to be returned to the researcher as they still need to be analysed and interpreted. Your loyalty in answering questions will assist in correcting research findings that will be helpful to others in the future.

Assessing the performance of smallholder cattle farmers in uMgungundlovu District, KwaZulu-Natal, South Africa: Management practices, productivity, and market access

Questionnaire Number..... Village name..... Local Municipality..... Ward Number.....

SECTION A: Socio-demographic information

A1. Sex of household: 1. M ☐ 2. F ☐

A2. Marital status: 1. Married ☐ 2. Single ☐ 3. Divorced ☐ 4. Widowed ☐

A3. Age: 1. 18-30 ☐ 2. 31-50 ☐ 3. >50 – 65 ☐ 4. > 70 ☐

A4. Is the head of the household resident on the farm? 1. Yes ☐ 2. No ☐

A5. Highest education level: 1. No formal education ☐ 2. Grade 1-7 ☐ 3. Grade 8-12 ☐ 4. Tertiary ☐

A6. Have you ever received any training on livestock production? 1. Yes ☐ 2. No ☐

A7. What are the major sources of income? 1. Crops ☐ 2. Livestock sales ☐ 3. Livestock products ☐ 4. Salary ☐ 5. Government grant ☐ 6. Other ☐, specify

A8. What is the household's wealth status? 1. Very poor ☐ 2. Poor ☐ 3. Less poor ☐

A9. What type of livestock species do you keep? (Rank 1 as the most important species)

	Cattle	Goats	Indigenous chickens	Pigs	Donkey	Other (specify)
Number						
Rank						

A10. How many years have you been involved in beef cattle farming? 1. 0-5 Years ☐ 2. 5-10 years ☐ 3. 10-20 Years ☐ 4. > 20 years ☐

A11. What breeds of cattle do you keep? 1. Indigenous breeds ☐ 2. Exotic breeds ☐ 3. Crossbreeds ☐

A12. What is the size of your herd? 1. < 2 ha ☐ 2. 2 – 10 ha ☐ 3. 10 – 20 ha ☐ 4. > 20 ha ☐

SECTION B: Cattle Management Practices (Production System, Housing, Feeding, Diseases)

B1. Which production system do you use? 1. Intensive ☐ 2. Semi-Intensive ☐ 3. Both ☐

B2. What is the primary purpose of keeping cattle?

	Meat	Milk	Draught power	Cultural	Breeding	Other (specify)
Tick						
Rank						

B3. What is the primary source of feed for your livestock? 1. Grazing ☐ 2. Purchase feed ☐ 3. Crop residues ☐

B4. Do you provide supplemental feeding for your cattle 1? Yes ☐ 2. No ☐

- B5. Which supplement/s do you for feeding your cattle? 1. Grains ☐ 2. Licks ☐ 3. Minerals and Vitamins ☐ 4. Hay and silage ☐ 5. Other (specify) ☐
- B6. How do you ensure adequate water for your cattle? 1. River ☐ 2. Ponds ☐ 3. Streams ☐ 4. Water tank ☐
- B7. How often do you provide water for cattle? 1. Daily ☐ 2. Twice a day ☐ 3. Weekly ☐ 4. Other ☐
- B8. How often do you monitor the health status of your cattle? 1. Daily ☐ 2. Weekly ☐ 3. Monthly ☐ 4. Only during sickness ☐
- B9. How do you monitor the health of your livestock? 1. Personal observations ☐ 2. Veterinary services ☐ 3. Extension services ☐
- B10. What challenges do you face in managing livestock? 1. Disease outbreak ☐ 2. Lack of feed ☐ 3. Lack of extension services ☐ 4. Limited access to markets ☐
- B11. Are you aware of common diseases affecting livestock? 1. Yes ☐ 2. No ☐
- B12. What are common disease challenges that you encounter in your flock? 1. Diarrhoea ☐ 2. External parasites ☐ 3. Heart water ☐ 5. Babesiosis ☐ 6. Mastitis ☐ 7. Black Quarter ☐ 8. Blue tongue ☐ 9. Lumpy Skin Disease (LSD) ☐ 10. Foot-and-Mouth Disease ☐
- B13. How often do you vaccinate your cattle? 1. Annually ☐ 2. Every six months ☐ 3. Occasionally ☐ 4. Never ☐
- B14. What challenges do you face in managing cattle health? 1. Limited access to veterinary services ☐ 2. High cost of medication ☐ 3. Lack of knowledge on disease management ☐
- B15. When do you provide supplemental feeding? 1. Dry seasons ☐ 2. Winter months ☐ 3. Calving season ☐ 4. Breeding season ☐ 5. Other (specify) ☐
- B16. How do you measure the performance of your cattle enterprise? 1. Weight gain ☐ 2. Calving rate ☐ 3. Mortality rate ☐ 4. Market prices of sold cattle ☐

SECTION C: Breeding Management Practices

- C1. What breeding method do you use for your cattle? 1. Natural mating ☐ 2. Artificial insemination ☐ 3. Both ☐
- C2. Do you keep breeding records? 1. Yes ☐ 2. No ☐
- C3. What challenges do you face in breeding cattle? 1. Lack of access to quality bulls ☐ 2. Low conception rates ☐ 3. Inbreeding ☐ 4. Limited knowledge on breeding practices ☐
- C4. Do you practice selective breeding? 1. Yes ☐ 2. No ☐
- C5. What selective breeding practices do you use in your cattle operation? 1. Visual observation ☐ 2. Heat detection pads ☐ 3. Natural oestrus ☐ 4. Artificial insemination ☐ 5. Other (specify) ☐
- C6. What criteria do you use to select your cattle for breeding purposes? 1. Calving ease ☐ 2. Body condition ☐ 3. Reproductive longevity ☐ 4. Age ☐ 5. Fertility ☐ 6. Body conformation ☐ 7. Colour ☐
- C7. What criteria do you use to select breeding males? 1. Libido ☐ 2. Body condition ☐ 3. Resistance to diseases ☐ 4. Colour ☐ 5. Age ☐ 6. Temperament ☐ 7. Bull's conformation ☐

C8. What challenges do you face in breeding cattle? 1. Lack of access to quality bulls ☐ 2. Low conception rates ☐ 3. Inbreeding ☐ 4. Limited knowledge on breeding practices ☐

SECTION D: Productivity and profitability

D1. How many hectares of land do you use for cattle farming? _____

1. Less than 5 ha ☐ 2. 5–20 ha ☐ 3. 21–50 ha ☐ 4. More than 50 ha ☐

D2. How long have you been involved in cattle farming? 1. Less than 5 years ☐ 2. 5–10 years ☐ 3. 11–20 years ☐ 4. More than 20 years ☐

D3. What is the average calving rate (percentage of cows that give birth annually) for your herd? 1. < 50 ☐ 2. 50–75 ☐ 3. > 75 ☐

D2. How long do you keep cattle before selling them (average time to market)? 1. <12 months ☐ 2. 12–24 ☐ months 3. > 24 months ☐

D3. How do you measure or track the productivity of your beef cattle? 1. Weight monitoring ☐ 2. Calving intervals ☐ 3. Mortality rates ☐

D4. How frequently do you sell cattle from your herd? 1. Monthly ☐ 2. Quarterly ☐ 3. Annually ☐

D5. What are your main costs for managing beef cattle? 1. Feed costs ☐ 2. Veterinary services ☐ 3. Labour ☐ 4. Transportation ☐

D6. How much do you spend monthly on feed and supplements? 1. < R1000 ☐ 2. R1000–R2000 ☐ 3. > R3000 ☐

D7. How much do you spend annually on veterinary care? 1. < R2000 ☐ 2. R2000–R4000 ☐ 3. > R4000 ☐

D6. What is the average price for a mature beef animal in your area? 1. < R5000 ☐ 2. R5,000–R10,000 ☐ 3. R10,001–R20,000 ☐ 4. > R20 000 ☐

D7. What is your average annual revenue from beef cattle farming? 1. < R10 000 ☐ 2. R10 000–R20 000 ☐ 3. > R20 000 ☐

D8. How much do you spend on a monthly basis on labour? 1. < R1000 ☐ 2. R1500–R2000 ☐ 3. > R3000 ☐

D8. How would you describe the profitability of your cattle farming? 1. Highly profitable ☐ 2. Moderately profitable ☐ 3. Break-even ☐ 4. Loss-making ☐

D9. What are the biggest challenges affecting your profitability? 1. High feed costs ☐ 2. Water scarcity ☐ 3. Diseases ☐ 4. Market access ☐ 5. Infrastructure issues ☐

D10. Have you experienced changes in profitability over the last five years? 1. Yes, profitability increased ☐ 2. Yes, profitability decreased ☐ 3. No significant changes ☐

D11. What measures have you implemented to improve profitability? 1. Improved feeding programs ☐ 2. Disease prevention and control ☐ 3. Joining cooperatives or associations ☐ 4. Accessing better markets ☐ 5. Good record keeping ☐ 6. Government programs ☐

D12. Do you engage in any value-adding activities (e.g., processing or packaging beef products)? 1. Yes ☐ 2. No ☐

D13. Do you have selling contracts? 1. Yes ☐ 2. No ☐

D14. What sex of cattle do you normally sell? 1. Heifers ☐ 2. Steers ☐ 3. Young Bulls ☐ 4. Weaned calves ☐ 5. Yearlings (both males and females) ☐

SECTION E: MARKET ACCESS AND RESOURCES

- E1. What type of market do you sell beef cattle to? 1. Informal markets ☐ 2. Auctions ☐ 3. Abattoirs ☐ 4. Direct to butcheries ☐ 5. Other (specify) ☐
- E2. How far is the nearest market where you sell your cattle? 1. 0-20 km ☐ 2. 20–50 km ☐ 3. 50- 100 km ☐ 4. more than 100km ☐
- E3. What determines the price of cattle in the markets you use? 1. Body weight ☐ 2. Breed of cattle ☐ 3. Market demand ☐ 4. Negotiation with buyers ☐
- E4. How frequently do you sell cattle in the market? 1. Weekly ☐ 2. Monthly ☐ 3. Annually ☐ 4. When needed for Emergencies ☐
- E5. What influences your decision to sell cattle? 1. Market prices ☐ 2. Household needs for income ☐ 3. Feed Availability ☐ 4. Cattle performance ☐ 5. Age ☐ 6. Other (specify) ☐
- E6. Do you face challenges in accessing the markets 1? Yes ☐ 2. No ☐
- E7. What challenges do you face? 1. Transport ☐ 2. Long distances ☐ 3. Fuel cost ☐ 4. Poor infrastructure ☐ 5. Regulations and permits ☐ 6. Lack of market information ☐ 7. Low market prices ☐ 8. Other (specify) ☐
- E8. Have you ever experienced rejection of your cattle in the market? 1. Yes ☐ 2. No ☐
- E9. What were the reasons for rejection? 1. Diseases ☐ 2. Injuries ☐ 3. Males not castrated ☐ 4. Poor conformation ☐ 5. Type of breed ☐ 6. Age ☐ 7. Lack of stock document ☐ 8. Market prices ☐ 9. Sex ☐
- E10. Does the market vary with the season? 1. Yes ☐ 2. No ☐
- E11. How do they affect your market participation? 1. Holiday seasons ☐ 2. Summer months ☐ 3. Winter months ☐ 4. Drought season ☐ 5. Buyer's demand ☐
- E12. How do you typically find buyers for your cattle? 1. Direct contact with buyers ☐ 2. Through middlemen or brokers ☐ 3. Auctions or organized sales ☐
- E13. Have you ever participated in group marketing (e.g., selling through cooperatives)? 1. Yes ☐ 2. No ☐
- E14. Would you consider group marketing? 1. Yes ☐ 2. No ☐
- E15. What are the reasons for not selling through group marketing? 1. Lack of trust ☐ 2. Group Conflicts ☐ 3. Additional Costs ☐
- E16. What specific support, training, or policy changes do you think would improve the productivity and market success of smallholder beef farmers? 1. Finance access ☐ 2. Government programs ☐ 3. Extension services ☐ 4. Development of infrastructure ☐ 5. Training and development of beef smallholder farmers ☐ 6. Veterinary care ☐ 7. Business management training ☐ 8. Marketing training ☐ 9. Feed resources ☐
- E17. What are your views on implementing modern management practices (e.g., record-keeping, data-driven decision-making)? 1. Production increases ☐ 2. Profitability increases ☐ 3. Labour requirements ☐ 4. Technology ☐ 5. Improve animal welfare ☐

Appendix 2: Participant information sheet

PARTICIPANT INFORMATION SHEET

Ethics clearance reference number: 2024/CAES-HREC/4982

Research permission reference number: Research (permission from DARD)

29 August 2024

Title: Assessing the performance of smallholder cattle farmers in uMgungundlovu District, KwaZulu-Natal, South Africa: management practices, productivity and market access

Dear Prospective Participant

My Name is Rachael Sizakele Mkhize, and I am doing research with Professor B. Mokolopi, Dr Unity Chipfupa, and Dr Olwethu Loki in the Department of Agriculture and Environmental Sciences toward a Doctor of Philosophy in Agriculture at the University of South Africa. We have funding from the Department of Agriculture and Rural Development to assist farmers facing challenges in meeting market standards. We are inviting you to participate in a study entitled Assessing the performance of smallholder cattle farmers in uMgungundlovu District, KwaZulu-Natal, South Africa: management practices, productivity and market access

WHAT IS THE PURPOSE OF THE STUDY?

I am conducting this research to find out the performance of smallholder cattle farmers in uMgungundlovu District: management practices, productivity, and market access. This project aims to evaluate the performance of smallholder beef farmers in the uMgungundlovu District, focusing on their management practices, productivity, and market access.

WHY AM I BEING INVITED TO PARTICIPATE?

We are inviting participants because cattle stallholder farmers in the uMgungundlovu District are facing challenges in meeting the cattle market standards. The reasons for this could include poor management practices, lack of knowledge, and limited resources. However, attempts have been made in the past to improve the knowledge and practices of smallholder cattle farmers to meet market expectations. These efforts include training workshops and information support provided by government Extension Officers and Farmer Associations. Despite these efforts not much has been achieved. All uMgungundlovu municipalities keep a full database of all the groups of farmers.

WHAT IS THE NATURE OF MY PARTICIPATION IN THIS STUDY?

The study will focus on cattle smallholder farmers where we will ask each executive committee about the types of breeds they are producing, management practices, Cattle farming experiences, and cattle mortalities. Each participant will be given 15-20 minutes to respond to the questions.

CAN I WITHDRAW FROM THIS STUDY EVEN AFTER HAVING AGREED TO PARTICIPATE?

Participants will be allowed to withdraw from the study if they are not comfortable with any questions.

WHAT ARE THE POTENTIAL BENEFITS OF TAKING PART IN THIS STUDY?

The potential benefit of taking part in this study will cover cattle management practices in uMgungundlovu District including all four municipalities, productivity and profitability of the smallholder beef cattle enterprise and beef markets available to smallholder farmers and factors affecting the extent to which the farmers participate in the markets.

ARE THERE ANY NEGATIVE CONSEQUENCES FOR ME IF I PARTICIPATE IN THE RESEARCH PROJECT?

There will be no negative consequences for participating in this study.

WILL THE INFORMATION THAT I CONVEY TO THE RESEARCHER AND MY IDENTITY BE KEPT CONFIDENTIAL?

You have the right to insist that your Name will not be recorded anywhere and that no one, apart from the researcher and identified members of the research team, will know about your involvement in this research. Your answers will be given a code number or a pseudonym and you will be referred to in this way in the data, any publications, or other research reporting methods such as conference proceedings.

If relevant, identify who will have access to the data *[transcriber/external coder]* and how these individuals will maintain confidentiality *[e.g. by signing a confidentiality agreement. Please note that confidentiality agreements should be submitted to the Research Ethics Review Committee for consideration]*. Your answers may be reviewed by people responsible for making sure that research is done properly, including the transcriber, external coder, and members of the Research Ethics Review Committee. Otherwise, records that identify you will be available only to people working on the study, unless you permit for other people to see the records.

Any publication of the information *[e.g. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report]* and will be protected.

HOW WILL THE RESEARCHER(S) PROTECT THE SECURITY OF DATA?

Hard copies of your answers will be stored by the researcher for a minimum period of five years in a locked cupboard/filing cabinet at the Department of Environmental Science, University of South Africa (UNISA). *The Unisa library can be contacted for storing raw data on the Unisa repository. If you plan to share the data or to use it for*

*longitudinal research, it may not be appropriate to store it for 5 years only] for future research or academic purposes; electronic information will be stored on a password-protected computer. Future use of the stored data will be subject to further Research Ethics Review and approval if applicable such as using the data for a purpose unrelated to the initial aim and objectives of the study. *Hard copies will be shredded, and/or electronic copies will be permanently deleted from the hard drive of the computer through the use of a relevant software program.**

WILL I RECEIVE PAYMENT OR ANY INCENTIVES FOR PARTICIPATING IN THIS STUDY?

No payment or reward, financial or otherwise, will be offered for participating in this study. Any costs incurred by the participant should be explained and justified in adherence to the principle of fair procedures (justice).

HAS THE STUDY RECEIVED ETHICS APPROVAL?

This study has not received written approval from the Research Ethics Review Committee of Unisa. We are still applying for approval.

HOW WILL I BE INFORMED OF THE FINDINGS/RESULTS OF THE RESEARCH?

If you would like to be informed of the final research findings, please contact Rachael Sizakele Mkhize on 071 605 6844 or sizakele31@gmail.com. The findings will be accessible for [UNISA M&D WEBSITE. The findings are accessible for 5 years.

Should you require any further information or want to contact the researcher about any aspect of this study, please contact Prof Gloria Mokolopi (kgobebg@unisa.ac.za) at 078 066 5830

Thank you for taking the time to read this information sheet and for participating in this study.

Thank you.

RS Mkhize

Appendix 3: Unisa Ethics Approval Letter

College of Agriculture and Environmental Sciences_Health REC

Date: 04/11/2024

Dear: Mrs Rachael sizakele Mkhize

NHREC Registration # : REC-170616-051
Ref #: 2024/CAES_HREC/4982
Name: Mrs Rachael sizakele Mkhize
Student #: 38680637

**Decision: Ethics Approval from
04/11/2024 to 31/10/2029**

Researcher: Mrs Rachael sizakele Mkhize
sizakele31@gmail.com 0716056844

Supervisor: Professor Baltshoetsi Mokolopi kgobebg@unisa.ac.za

Co-Supervisor: Dr Unity Chipfupa uchipfupa@gmail.com

Assessing the performance of smallholder cattle farmers in UMgungundlovu District, KwaZulu-Natal, South Africa: management practices, productivity and market access

Qualification: PhD in Agriculture

Thank you for the application for research ethics clearance by the College of Agriculture and Environmental Sciences_Health REC for the above mentioned research study. Ethics approval is granted for five years, **subject to submission of yearly progress reports. Failure to submit the progress report will lead to withdrawal of the ethics clearance until the report is submitted.**

Due date for progress report: 31 October 2025

The **low risk application** was **reviewed** by College of Agriculture and Environmental Sciences_Health REC on 04 November 2024 in compliance with the Unisa Policy on Research Ethics and the Standard Operating Procedure on Research Ethics Risk Assessment.

The proposed research may now commence with the provisions that:

1. The researcher(s) will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.
2. Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study should be communicated in writing to the College of Agriculture and Environmental Sciences_Health REC.
3. The researcher(s) will conduct the study according to the methods and procedures set out in the approved application.
4. Any changes that can affect the study-related risks for the research participants, particularly in terms of assurances made with regards to the protection of participants' privacy and the confidentiality of the data, should be reported to the Committee in writing, accompanied by a progress report.
5. The researcher will ensure that the research project adheres to any applicable national legislation, professional codes of conduct, institutional guidelines and scientific standards relevant to the specific field of study. Adherence to the following South African legislation is important, if applicable: Protection of Personal Information Act, no 4 of 2013; Children's act no 38 of 2005 and the National Health Act, no 61 of 2003.

6. Only de-identified research data may be used for secondary research purposes in future on condition that the research objectives are similar to those of the original research. Secondary use of identifiable human research data requires additional ethics clearance.
7. No field work activities may continue after the expiry date (31 October 2025). Submission of a completed research ethics progress report will constitute an application for renewal, for Ethics Research Committee approval.

Additional Conditions

1. Disclosure of data to third parties is prohibited without explicit consent from Unisa.
2. De-identified data must be safely stored on password protected PCs.
3. Care should be taken by the researcher when publishing the results to protect the confidentiality and privacy of the university.
4. Adherence to the National Statement on Ethical Research and Publication practices, principle 7 referring to Social awareness, must be ensured: "Researchers and institutions must be sensitive to the potential impact of their research on society, marginal groups or individuals, and must consider these when weighing the benefits of the research against any harmful effects, with a view to minimising or avoiding the latter where possible." Unisa will not be liable for any failure to comply with this principle.

Note

The reference number 2024/CAES_HREC/4982 should be clearly indicated on all forms of communication with the intended research participants, as well as with the Committee.

Kind regards,



Prof MA Antwi
Chair of College of Agriculture and Environmental Sciences_Health REC
E-mail: antwima@unisa.ac.za



Prof MM Ntwasa
Executive Dean / By delegation from the Executive Dean of College of Agriculture and Environmental Sciences_Health REC
E-mail: ntwasmm@unisa.ac.za

Appendix 4: Permission letter from DARD



KWAZULU-NATAL PROVINCE
AGRICULTURE AND RURAL DEVELOPMENT
REPUBLIC OF SOUTH AFRICA

DIRECTORATE: UMGUNGUNDLOVU

DISTRICT

458 Townbush Road, Cascades, Pietermaritzburg, 3200
KZN Department of Agriculture & Rural Development, Private Bag X9059, Pietermaritzburg, 3200
Tel: 071 492 4074 Email: Phindile.Shozi@kzndard.gov.za

Mrs Rachael Sizakele Mkhize
University of South Africa
26 August 2024

GATE KEEPING LETTER: Mrs Rachael Sizakele Mkhize

The DARD: uMgungundlovu District grants permission to Mrs. Rachael Sizakele Mkhize to research Assessing the performance of smallholder cattle farmers in uMgungundlovu District, KwaZulu-Natal, South Africa: management practices, productivity, and market access.

However, the research findings and draft document should be presented to DARD: uMgungundlovu District before submission.

P Shozi

District Director
uMgungundlovu District

Appendix 5: Accepted Manuscripts

Article

Factors influencing market participation by beef cattle smallholder farmers in uMgungundlovu district, Kwa-Zulu Natal, South Africa

*Rachel S. Mkhize ¹; *Gloria Mokolopi ¹, Unity Chipfupa ¹ and Olwethu Loki ²

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Abstract: Globally, the demand for beef and beef-related products has significantly escalated over the past decade. This study aimed to evaluate the factors influencing the market participation of smallholder beef cattle farmers in uMgungundlovu, South Africa. The study employed a cross-sectional research design, which followed a mixed-methods approach to collect data. Survey data were collected from smallholder cattle farmers from the uMgungundlovu District in KwaZulu-Natal using a semi-structured questionnaire. Purposive sampling was employed to select four local municipalities from the uMgungundlovu district, out of a total of seven. To determine factors that influence farmers' market choice, a multinomial logit regression model was used. A significant proportion of the farmers (43.1%) were aged between 51 and 70, followed by 35.5% aged 31 to 50. Just under half (48.2%) of farmers had received formal training in livestock production. This finding ($p < 0.001$) reinforces the central role of education in income determination. Better-educated individuals tend to earn more and diversify their income sources. This study underpinned that the livestock farming population is dominated by primarily middle-aged, male, semi-educated, and resource-poor individuals, and they rely significantly on traditional farming methods and government assistance.

Keywords: Beef; Smallholder farmers; Market participation; uMgungundlovu

1. Introduction

Globally, the demand for beef and beef-related products has significantly escalated over the past decade (Phillips *et al.*, 2015; Chung & Hadi, 2025). The major contributing country to this rise is China's 5.1% growth in beef consumption. The increase in demand compels the beef production sector, especially the commercial sector, to intensify its operations in efforts to meet the demand (RMIS, 2024). For capital gains or revenue generation, an increased demand is a desired scenario, *Ceteris paribus*. However, the beef industry is plagued with severe challenges that limit its capability to adequately meet the escalating demand. These challenges include climate change, drought, volatile consumer preferences, and socio-economic and political factors (Chibanda *et al.*, 2009). One of the adversaries for consumers in a scenario where the demand far exceeds the supply is an increase in product prices, which is done to regulate the market. Evidently, the global beef industry adopted this traditional regulation strategy, resulting in 8% beef price increase (RMIS, 2024). A rise in product prices lowers the affordability, which contradicts the pursuit of global food security. Hence, the Food and Agriculture Organization (FAO) always promotes other strategies that can advance mass production.

Many developed countries such as China, the United States, India, and European countries invest in and promote smallholder beef cattle farming to intensify the efforts to meet the risen demand (Chibanda *et al.*, 2009). This means that there is significant market participation by smallholder beef farmers, thus strengthening the beef industry and expanding supply. For instance, recently, Australia experienced a rapid growth of its herd sizes to approximately 30 million heads produced (RMIS, 2024). This can be easily and hypothetically translated into an escalation in beef supply as Australia anticipates a production growth of 16% in 2025.

Information about the underdeveloped and developing countries approaches for tackling the global challenge of increased demand for beef and beef-related products is poorly documented. Commonly, these countries opt for increasing the importation of the particular product in order to meet the demand. For instance, recently in South Africa, beef production increased by 7.3% significantly boosted by increased imports of live beef cattle from neighboring countries such as Botswana and Namibia (RMIS, 2024).

In developing and underdeveloped countries, market participation by smallholder beef farmers in Sub-Saharan Africa (SSA) remains at significantly low levels (Chibanda *et al.*, 2009). The responsible factors for the poor market participation by smallholder beef farmers remain unresolved and poorly documented. To the best of the authors' knowledge, there is no previous research that has been conducted in the current study area investigating the factors that limit market participation by smallholder beef farmers. Consequently, evaluating the factors limiting the market participation of smallholder beef cattle is warranted in order to devise strategies to improve the situation.

2. Materials and methods

2.1. Research design and data collection

The study employed a cross-sectional research design, which followed a mixed-methods approach to collect data. Survey data were collected from smallholder cattle farmers from the uMgungundlovu District in KwaZulu-Natal using a semi-structured questionnaire. Purposive sampling was employed to select four local municipalities from the uMgungundlovu district, out of a total of seven. The purposive sampling was based on the prevalence of smallholder cattle farmers in the area and accessibility regarding logistics. The survey with smallholder cattle farmers sought to collect the following information: household demographic information, socio-economic status, access to credit, livestock management practices, cattle production figures, cost of production, market participation, access to training, and livelihood outcome, among others.

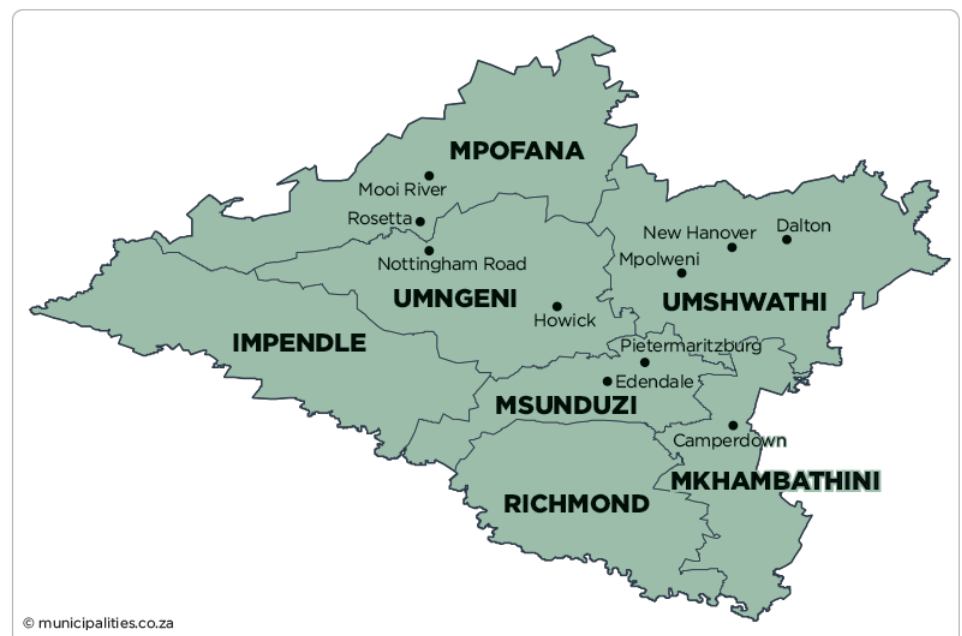


Figure 1. Map showing local municipalities under the uMgungundlovu District.

Source: Statistics South Africa (Stats SA, 2016)

2.2. Sampling procedure and sample size

The target population was the smallholder livestock farmers from the uMgungundlovu District Municipality. Farmers from the selected municipalities formed the sampling frame, and the sampling unit was a household. A comprehensive list of livestock farmers was obtained from the Department of Agriculture in uMgungundlovu. A simple random sampling technique was used to recruit farmers into the study. The sampling was conducted using Microsoft Excel, whereby each farmer was allocated a random number, and then the required sample was generated from those numbers. Sample size determination was done using a formula suggested by Gill *et al.* (2010). The assumption is that if there is a large population, but the variability in the proportion of the population that will adopt the practice is unknown, it is recommended to use a p-value of 0.5 (maximum variability). The study desires a 95%

confidence level and/- 5% precision. The resulting sample size is demonstrated in the following equation.

$$n_0 = \frac{Z^2 pq}{e^2} = \frac{(1.96)^2 (0.5)(0.5)}{(0.5)^2} = 385$$

where: n is the required sample size, p is the percentage occurrence of a state or condition, e is the percentage maximum error required, and Z is the value corresponding to the level of confidence required.

The study relied on the following eligibility criteria, based on the research objectives, for recruiting respondent farmers be practicing smallholder livestock production; have access to farming land, either owning, leasing, or communal; and must start from 18 years of age to give proper information regarding farming activities.

2.3. Analytical framework

Descriptive statistics, together with chi-squared test for association between variables, were used to characterise respondent farmers' socioeconomic characteristics. However, to determine factors that influence farmers' market choice, a multinomial logit regression model was used. The Multinomial Logit (MNL) model estimates the probability that a farmer chooses a particular market type. The implicit multinomial model was specified as:

$$P(Y_i = j) = \frac{\exp(X_i \beta_j)}{\sum_{k=1}^J \exp(X_i \beta_k)} \quad \text{for } j = 1, 2, \dots, J$$

where:

Y_i = Market type choice for farmer I, and the base category used for comparison was "informal markets".

X_i = Vector of explanatory variables

β_j = Vector of coefficients for category j

J = Number of market alternatives

In the full model, several independent variables were considered and are listed in Table 2.

Table 1. List of all independent variables considered in the full model.

Variable Name	Type	Description
Gender	Categorical	Sex of the farmer (Male, Female)
Age_group	Categorical	Age bracket (18–30, 31–50, 51–70, >70)
Education_level	Categorical	Education level (No formal, Grade 8–12, Tertiary)
Formal_employment	Categorical	Employment status
Household_income_bracket	Categorical	Household income level
Extension_service_quality	Categorical	Perceived extension quality (low, medium, high)
Access_to_credit	Binary	Credit access (Yes/No)
Average_calving_rate	Ordinal	Average calves per cow
Cattle_productivity_measure	Categorical	Type of productivity metric used
Market_distance_category	Categorical	Market access distance or constraint
Market_access_challenges	Binary	Access challenges (Yes/No)

The minimal adequate model retained only statistically significant predictors (or those with at least one significant level). These are presented in Table 2.

Table 2. List of independent variables retained in the final model.

Variable Name	Type	Base Category
Education_level	Categorical	Grade 1–7
Extension_service_quality	Categorical	>high
Gender	Categorical	Female
Market_distance_category	Categorical	Close Access
Age_group	Categorical	18–30

3. Results and discussion

Understanding agricultural behaviour, service accessibility, and technology adoption requires an understanding of farmers' socioeconomic traits. Significant insights into the demographic and economic circumstances of the surveyed population can be gained from the data displayed in the summary tables.

Table 3. Summary table of demographic and economic circumstances of the surveyed population.

Variable	Proportions (%)	Missing Values	Total (n)	Chi-square	p-value
Gender	F: 40.7%, M: 59.3%	14	383	13.162	0.000*
Age Group	>70: 13.8%, 18-30: 7.7%, 31-50: 35.5%, 51-70: 43.1%	5	392	135.531	0.000*
Farm Resident	No: 14.0%, Yes: 86.0%	19	378	195.725	0.000*
Education Level	Grade 1-7: 31.1%, Grade 8-12: 47.8%, No Formal: 12.3%, Tertiary: 8.9%	14	383	149.794	0.000*
Training on Livestock	No: 51.8%, Yes: 48.2%	32	365	0.463	0.496
Major Income Source	Crops: 6.0%, Gov Grant: 32.5%, Livestock Sales: 46.3%, Salary: 11.9%,	28	369	755.317	0.000*
Child Support Grant	Crops: 3.6%, Gov Grant: 13.3%, Livestock Sales: 73.5%, Salary: 6.0%	314	83	151.036	0.000*
Household Wealth	Less Poor: 15.1%, Poor: 58.8%, Very Poor: 26.1%	40	357	110.773	0.000*
Land Ownership	>20yrs: 17.4%, 0-5yrs: 28.0%, 10-20yrs: 21.1%, 5-10yrs: 33.5%	18	379	23.332	0.000*
Experience	>20yrs: 17.4%, 0-5yrs: 28.0%, 10-20yrs: 21.1%, 5-10yrs: 33.5%	18	379	23.332	0.000*
Cattle Breeds	Crossbreeds: 19.8%, Exotic: 2.8%, Indigenous: 77.4%	8	389	356.38	0.000*
Land Size (ha)	<2ha: 47.7%, 2-10ha: 26.7%, 10-20ha: 12.2%, >20ha: 13.5%	11	386	125.689	0.000*

3.1. Gender distribution

The study revealed that 59.3% of farmers were male and 40.7% were female, reflecting a male-dominated agricultural sector. This aligns with findings from Aliber and Hart (2009) and Ozor and Nnaji (2010), who noted that livestock farming is male-dominated, with men having more access to production resources. However, Zuwarimwe and Kirsten (2010) reported a contrasting pattern where female (58.3%) participation exceeded that of males (41.7%), highlighting contextual differences. While women remain active in agriculture, structural barriers like land ownership and access to services continue to limit their full participation.

3.2. Age distribution

A significant proportion of the farmers (43.1%) were aged between 51 and 70, followed by 35.5% aged 31 to 50. This ageing farmer population is consistent with (Van Averbek *et al.*, 2010), which emphasized low youth involvement in agriculture. Only 7.7% were under 30 years, underscoring a generational gap in farming. Similar trends were noted in Turkey (Ozdemir *et al.*, 2024) and India (Devaki *et al.*, 2016), where older males dominate the livestock farming sector. This raises concerns about the sustainability and renewal of the agricultural labour force.

3.3. Farm Residency

The results show that the majority (86%) of farmers lived on their farms. This high on-farm residency supports effective farm management and productivity, as suggested by Fanadzo and Ncumbé (2018). Proximity to livestock and cropland enables better control of inputs and rapid response to challenges.

3.4. Educational attainment

Approximately 47.8% of the farmers attained secondary education (Grade 8-12), while only 8.9% had tertiary qualifications. The low level of

tertiary education is common in rural agricultural populations and may limit access to information and adoption of innovations (Makhura *et al.*, 1997). Moreover, these findings are in line with studies in Oyo State, where 85% farmers had at least primary education or secondary (Olorunnisomo *et al.*, 2011; Devaki *et al.*, 2016; Goa Reddy *et al.*, 2017; & Ozdemir *et al.*, 2024). This lack of tertiary education rates may limit strategic planning, financial literacy, and engagement with complex technologies.

3.5. Training in livestock production

Just under half (48.2%) of farmers had received formal training in livestock production. This indicates a gap in skills development, as also noted by Van Averbeke and Mohamed (2006). Kumar *et al.* (2015) found that 44.6% of goat farmers were illiterate, indicating low baseline education levels, which often correlate with limited access to training. In addition, Mafimisebi *et al.* (2006) linked education and training to the adoption of modern livestock technologies, reinforcing the need for targeted extension services. Moreover, Singaravadelan *et al.* (2019) also reported a 60% illiteracy rate among Tamil Nadu sheep farmers, suggesting that a lack of education is a common barrier in many smallholder contexts. Hence, enhancing farmer training could significantly improve livestock management practices, contributing to productivity and income gains.

3.5. Major income sources

Livestock sales (46.3%) and government grants (32.5%) were the primary income sources, underlining the sector's importance to rural livelihoods. These results conquer with a study conducted in the Western Kenya, which revealed that 95% of their farmers rely on livestock farming as their primary livelihood. Zuwarimwe and Kirsten (2010) state that smallholder farmers continue to struggle to access external funding and other resources they need to expand and grow their farms. In addition, the dependence on government support signals vulnerability and limited resilience. The problem also lies in farmers not having access to credit, reflecting financial exclusion. Makhura *et al.* (1997) emphasized the critical role of credit in helping farmers to receive sufficient currency, regardless of income. These findings suggest that financial services are essential for unlocking farmers' productive potential.

3.6. Child support grants and household wealth

Among those receiving child support grants, 73.5% also earned income from livestock, showing the role of agriculture in complementing social safety nets. This aligns with broader evidence that social grants are often reinvested into productive activities, thereby stabilizing household income. The results showed a substantial share of households identified as poor (58.8%) or very poor (26.1%), consistent with national rural poverty statistics (Stats SA, 2018). Poverty constrains investment in agricultural inputs and technologies, contributing to low productivity and market exclusion.

3.7. Land ownership and farming experience

Most farmers had land tenure of 5-10 years (33.5%) or 0-5 years (28%), with similar trends in farming experience. This pattern may reflect

beneficiaries of land reform programs or new entrants into farming. However, short tenure duration may discourage long-term investment in infrastructure and sustainable practices (Lahiff, 2007). In contrast, in Alabama, Tackie *et al.* (2019) found that 82% of small livestock producers had farming experience of 30 years or less, and 48% owned over 60 acres, reflecting more stability and scale than in the current study. This suggests that while farming experience may be similar, landholding size differs markedly.

Kumar *et al.* (2015) categorized goat farmers into landless (25.8%), marginal (54.2%), and small/semi-medium (20.0%) landholders, closely mirroring the distribution found in the present study. The prevalence of marginal farmers also supports the assertion that smallholder status limits scale and resilience. Singaravadivelan *et al.* (2019) reported that most migratory sheep farmers had over 20 years of experience and were small to marginal dryland farmers, further supporting the link between long farming experience and small landholding. Moreover, Mafimisebi *et al.* (2006) emphasize that land ownership and farming experience directly impact the adoption of modern farming technologies. The short tenure in the current study could therefore hinder innovation adoption.

3.8. Cattle breed

In the current study, indigenous cattle breeds made up 77.4% of herds, a preference largely attributed to their resilience, adaptability, and low-input requirements traits that make them well-suited to the resource-constrained environments in which many smallholder farmers operate (Mapiye *et al.*, 2009). This trend aligns with findings from Nigeria, where Yakubu *et al.* (2019) observed that smallholder farmers with lower education levels favoured indigenous breeds due to their ease of management and ability to thrive under poor nutritional conditions. Similarly, in Ethiopia, Kassie *et al.* (2010) found that more educated cattle buyers were willing to pay a premium for traits such as disease resistance and traction potential, suggesting that education influences not just breed preference but also an appreciation for economically valuable traits. The high proportion of indigenous breeds in the current study may therefore reflect both practical adaptation to local environmental challenges and limitations in farmer education or access to genetic improvement programs. In contrast, in Tanzania, smallholder livestock keepers with formal education were more likely to adopt improved dairy and beef breeds compared to those with no formal education (Kitole, 2022).

3.9. Land size

Nearly half (47.7%) of respondents in the current study farmed on less than two hectares, reflecting a dominance of smallholder farming that limits economies of scale, mechanization, and diversification. This pattern is consistent with findings from Van Auerbeke *et al.* (2011) in Kenya and Van Auerbeke and Mohamed (2006) in South Africa, both of whom observed that small land sizes constrain income and productivity. Similarly, Vandre *et al.* (2021) reported that 35% of farmers in Madhya Pradesh held 1–2 hectares, with 7.2% being landless, while Kumar *et al.* (2015) highlighted a high prevalence of marginal and landless goat farmers, demonstrating the widespread nature of land constraints in

developing countries. In contrast, Tackie *et al.* (2019) found that nearly half of small livestock producers in Alabama owned more than 60 acres, suggesting that larger landholdings in developed contexts may enhance resilience, productivity, and capacity for modern farming practices.**3.9. Chi-Squared associations among sociodemographic variables**

Table 4. Chi-Squared Test of Association Among Sociodemographic Factors.

Variable Pair	Chi-square	p-value
Marital_status vs age_group	45.512	0.000*
Marital_status vs household_head	7.433	0.059 ^{NS}
Marital_status vs education_level	30.373	0.000*
Marital_status vs formal_employment	11.318	0.010*
Marital_status vs household_income_bracket	10.065	0.122 ^{NS}
Age_group vs household_head	13.226	0.004*
Age_group vs education_level	149.034	0.000*
Age_group vs formal_employment	6.228	0.101 ^{NS}
Age_group vs household_income_bracket	15.356	0.018*
Household_head vs education_level	7.056	0.070 ^{NS}
Household_head vs formal_employment	13.661	0.000*
Household_head vs household_income_bracket	0.65	0.722 ^{NS}
Education_level vs formal_employment	17.768	0.000*
Education_level vs household_income_bracket	39.851	0.000*
formal_employment vs household_income_bracket	9.783	0.008*

*Significant at $P < 0.05$; ^{NS} Not Significant.

3.9.1. Marital status and age group

The relationship between marital status and age group was found to be statistically significant ($p < 0.001$), which was expected. Younger individuals are more likely to be single or unmarried, while older individuals are more likely to be married or widowed. This finding aligns with population demographic trends across rural contexts in Sub-Saharan Africa (Stats SA, 2016). Age is a critical factor in marital status, with different age groups exhibiting varying marriage patterns. According to Spaull (2013), younger individuals may delay marriage due to educational or career pursuits, while older age groups may experience higher rates of marriage or remarriage. Clark and Brauner-Otto (2015) state that the timing of marriage can also affect long-term health outcomes, with early marriages sometimes linked to higher mortality risks. In addition, younger age groups are more likely to be single or never married, while marriage rates tend to increase with age, peaking in the middle age groups before declining slightly in later years due to widowhood (Cherlin, 2010). In many developing countries, early marriage remains common, particularly among women, though this trend is gradually changing with increased educational attainment and economic participation. Older age groups are more likely to include divorced or widowed individuals, especially among women, due to higher male mortality rates (Clark & Brauner-Otto, 2015).

3.9.2. Marital status and household head

Although the relationship between marital status and household headship in this study is not statistically significant at the conventional 5% level ($p = 0.059$), it does approach significance, indicating a potential association that merits attention. This finding aligns only partially with the broader literature, which consistently identifies marital status as a strong predictor of household headship. For instance, Hunter (2010) emphasizes that married individuals are more likely to assume headship roles due to entrenched traditional family structures that prioritize spousal co-residence and joint decision-making authority.

3.9.3. Marital status and education level

The significant association ($p < 0.001$) between marital status and education level suggests that individuals with different educational backgrounds may marry at different rates or ages. Prior studies have shown that higher education often delays marriage (Hunter, 2010), which may be a contributing factor here. Education level significantly influences marital status, with higher education often associated with delayed marriage. This delay is attributed to prolonged educational pursuits and the desire for compatibility in spouse selection (Bolli *et al.*, 2019). Individuals with higher educational attainment are more likely to marry later, but their marriages tend to be more stable (Martin, 2006). This is often attributed to the delaying effect of prolonged schooling and career establishment, as well as improved communication and problem-solving skills among the more educated (Schwartz & Mare, 2005). Additionally, higher education levels are associated with greater selectivity in marital decisions and a lower likelihood of divorce. Conversely, those with lower educational levels tend to marry earlier but also have higher rates of marital dissolution (Amato, 2010).

3.9.4. Marital status and formal employment

The significant association ($p = 0.01$) suggests that formal employment status may influence or be influenced by marital roles. Married individuals may be more likely to seek or maintain formal jobs due to household responsibilities, though this effect is also mediated by gender roles and regional labor market dynamics. Employment status itself can influence marriage decisions, with higher income levels and stable employment being associated with a greater inclination towards marriage, reflecting economic stability and independence (Harsono *et al.*, 2024). Marital status significantly correlates with employment patterns. Married individuals are often more likely to be formally employed compared to their unmarried counterparts. This association may be attributed to greater financial responsibilities among married people, which incentivize stable employment (Kposowa, 2002). Moreover, married men tend to experience a "marriage premium" in earnings, possibly due to employer perceptions of increased stability and responsibility (Antonovics & Town, 2004). Conversely, unmarried individuals, especially single women, may face structural labor market disadvantages and caregiving responsibilities that limit access to formal employment opportunities (Budig & England, 2001).

3.9.5. Age group and household head

This significant association ($p = 0.004$) is intuitive. Older individuals are more likely to be household heads, while younger respondents may reside within extended family arrangements. This is consistent with South African census data showing that headship increases with age (Stats SA, 2016). Older individuals are more likely to be household heads, as age is often linked to greater life experience, financial stability, and authority within family structures (Chant, 2007). In South Africa, the General Household Survey shows that household heads are typically aged between 35 and 59 years, with fewer heads under 30 years old (Stats SA, 2016). This reflects the global pattern of delayed household

formation, often due to extended education, urban migration, or unstable employment among youth (Van der Berg, 2015).

3.9.6. Age group and education level

The highly significant result ($p < 0.001$) may reflect generational changes in access to education. Younger respondents are more likely to have reached higher levels of schooling due to post-apartheid educational reforms (Spaull, 2013). Younger cohorts tend to have higher levels of formal education than older cohorts, particularly in developing countries, due to improvements in school infrastructure, government funding, and reduced gender disparities in education (Spaull, 2013). This trend mirrors global patterns where access to education has expanded over time, particularly for women (UNESCO, 2020).

3.9.7. Age group and household income bracket

These results reveal an association ($p = 0.018$) that indicates that age is linked to income differences. Older individuals may accumulate more assets or income sources over time, or may qualify for pensions or grants, while younger farmers may have more limited economic capacity. Younger age groups typically earn less due to limited work experience and entry-level job positions (Posel & Rogan, 2012). Younger age groups typically earn less due to limited work experience and entry-level job positions (Posel & Rogan, 2012). Studies show that older women or individuals in rural areas may earn less despite their age, due to cumulative disadvantages in labor markets and limited access to pensions (Posel & Rogan, 2012).

3.9.9. Household head and formal employment

The strong association ($p < 0.001$) between household headship and formal employment implies that formal income sources could elevate individuals to household leadership roles. This is particularly relevant in rural settings where income diversity is limited. Higher education levels are associated with better employment opportunities and reduced poverty risk. For instance, in Turkey, households with heads who have higher education levels are less likely to be poor, and vocational or technical education can be more beneficial than general high school education in certain regions (Bilenkisi *et al.*, 2015). The education level of household heads is a critical factor influencing formal employment. Higher education levels are associated with better employment opportunities and reduced poverty risk. For instance, in Turkey, households with heads who have higher education levels are less likely to be poor, and vocational or technical education can be more beneficial than general high school education in certain regions (Bilenkisi *et al.*, 2015). Similarly, in Vietnam, results revealed that formal employment is more accessible to those with higher education, reducing poverty risk (Duc, n.d.).

3.9.10. Education level and formal employment

The significant relationship ($p < 0.001$) between education and formal employment confirms long-standing findings that higher educational attainment is linked to better access to the formal labor market (Bhorat *et al.*, 2014). Formal education significantly enhances the likelihood of securing formal employment. A study conducted in Nepal

reveals that individuals with tertiary education are more likely to be employed in the formal sector compared to those with only primary or secondary education (Bolli *et al.*, 2019). This trend is consistent over time, although the strength of the relationship between lower levels of education and formal employment has decreased (Bolli *et al.*, 2019). Moreover, a study conducted in China states that a correlation between education and urban employment has evolved, with higher education levels increasingly necessary for employment growth (Liu, 2023). In addition, a study conducted in Gorontalo Province, Indonesia, revealed that education level positively influences income in both formal and informal sectors, highlighting the importance of education across different employment types (Banini *et al.*, 2024).

3.9.11. Education level and household income bracket

This finding ($p < 0.001$) reinforces the central role of education in income determination. Better-educated individuals tend to earn more and diversify income sources. This aligns with economic theories on human capital and findings from South African labor market analyses (Van der Berg, 2015). The education level within a household, particularly the highest educational attainment, is positively correlated with household income. This is supported by studies from China, which show that higher family education levels lead to increased household income (Liu, 2023). The education of the household head is a significant determinant of household income, with higher education levels leading to better financial decision-making and income growth (Liu, 2023).

3.9.12. Formal employment and household income bracket

A significant relationship ($p = 0.008$) exists between formal employment and income. Formal jobs provide stable and often higher incomes than informal or subsistence-based livelihoods, supporting improved household economic outcomes. The results are consistent with a study conducted in Sukabumi, which revealed that individuals in formal employment earn more than those in informal sectors, highlighting the income disparity between these sectors (Bolli *et al.*, 2019). Bilenkisi *et al.* (2023) also concur that there is a relationship between formal employment and income, and it is also influenced by education, as higher education levels facilitate access to formal employment, which in turn enhances household income.

3.10. Multinomial logit regression model results: market participation analysis

The table below presents the results of a multinomial logit model. The model assessed factors affecting the market choice of beef cattle smallholder farmers. The dependent variable, market type, was modelled against various socioeconomic factors, which were selected based on the literature. The informal market type was used as a reference category. Thus, the model compared the likelihood of choosing to sell in informal markets relative to selling in auction markets and selling butcheries.

Table 5. Multinomial logit results of factors influencing market choice.

Variable	Coefficient
Predictors Influencing Participation in Auctions (vs Informal Markets)	
Education: Grade 8 - 12	-1.38
Education: Tertiary	-2.41

Lack of access to quality bulls	-2.17
Limited knowledge on breeding	-1.55
Predictors Influencing Participation in Direct to Butcheries (vs Informal Markets)	
Extension Service Quality: low	-2.57

The table below presents full multinomial logit regression model results with the raw coefficients, standard s, z-values, p-values, and confidence intervals. The asterisks (*) indicate statistically significant variables ($p < 0.05$). The following were reference (base) categories for categorical predictors: Education Level: Grade 1 – 7, Extension Service Quality: 50 – 75, Gender: F, Market Distance Category: inbreeding, Age Group: 18 – 30.

Table 6. Full multinomial logit regression model results of the factors influencing market participation.

Equation	Coefficient	SEM	z	P> z
Intercept	1.48	0.93	1.59	0.11
education_level_Grade 8 - 12	-1.38	0.34	-4.01	0.0
education_level_No Formal Education	-0.25	0.45	-0.55	0.58
education_level_Tertiary	-2.41	0.72	-3.33	0.0
extension_service_quality_Medium	-26.95	404559.72	-0.0	1.0
extension_service_quality_low	0.33	0.64	0.52	0.6
extension_service_quality_Very high	1.5	1.27	1.18	0.24
Gender_Male	0.37	0.29	1.29	0.2
lack of access to quality bulls	-2.17	0.48	-4.5	0.0
limited knowledge on breeding practices	-1.55	0.44	-3.49	0.0
low conception rates	-0.83	0.79	-1.05	0.29
resistance to diseases	-21.69	27630.77	-0.0	1.0
age_group_31 - 50	0.22	0.58	0.37	0.71
age_group_51 - 70	-0.1	0.6	-0.17	0.86
age_group_>70	-0.34	0.73	-0.47	0.64

The variables that were statistically significant in predicting the market choice by farmers were education, lack of access to quality bulls, limited breeding knowledge, and extension service quality. Grade 8-12 and tertiary education level reduced the likelihood of participating in auction markets. This means that farmers who had obtained these qualifications were likely to participate in auction markets compared to farmers who did not have formal education. Moreover, farmers with lack of access to quality bulls and limited breeding knowledge has lower likelihood of participating in auctions compared to farmers with access to quality bulls. This means that not having access to quality bulls and having limited breeding knowledge reduces the chance of participating in auction markets. Auction markets are competitive and based on certain traits. Thus, breeding knowledge is crucial to increase participation in auction markets.

Moreover, poor extension services also reduce the chance of selling directly to butcherries. It means farmers who have access to poor extension services have a lower chance of selling directly to butcherries compared to farmers with quality extension services. Thus, poor extension services increase the likelihood of participating in informal markets. Therefore, education level, distance-related challenges, and extension service quality significantly influence market participation. While a higher level of education is related to a preference for informal markets over formal markets, poor extension service support also discourages participation in formal channels such as auctions and butcherries.

4. Conclusion and recommendations

This study underpinned that the livestock farming population is primarily middle-aged, male, semi-educated, and resource-poor, and they rely significantly on traditional farming methods and government assistance. Productivity and income diversification are hampered by most farmers' marginal landholding circumstances and lack of formal training. These results highlight the pressing need for focused policy changes. The expansion of extension services to enhance knowledge transfer, youth-focused agricultural initiatives to draw and keep younger generations and land reform laws that guarantee long-term tenure to

encourage investment are some of the main recommendations. Furthermore, increasing productivity within indigenous systems should be the top priority of livestock development strategies, and educational programs should raise awareness of the economic potential of livestock. Improving marginal farmers' livelihoods and empowering them will require improved access to markets, credit, and financial literacy.

With significant ramifications for policy and development planning, these findings highlight the intricate and interconnected nature of demographic and economic characteristics. Education is shown to be a significant factor in determining employment and income outcomes, underscoring the necessity of ongoing investments in easily accessible, high-quality education. Because different age groups face different opportunities and challenges in the labour market, employment strategies should be age responsive. Development initiatives aimed at households must consider the complex ways that household headship, marital status, and educational attainment influence socioeconomic well-being, going beyond crude standards. Furthermore, taking gender into account is crucial, especially when figuring out how women's participation in formal employment and leadership is impacted by marital status and household duties. Therefore, a more intersectional approach is required to guarantee that policies adequately address the layered.

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Management Practices, Market Dynamics, and Profitability of Smallholder Beef Cattle Farmers in uMgungundlovu District, KwaZulu-Natal, South Africa

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Abstract

Smallholder beef cattle farming remains pivotal in sustaining rural livelihoods and forms part of South Africa's government efforts to promote rural development. However, the poor performance of the sector due to poor management practices, limited access to formal markets, and weak profitability continues to raise concerns. This study sought to investigate the performance of smallholder beef cattle farmers in the uMgungundlovu District, KwaZulu-Natal, focusing on livestock management practices, productivity, and profitability. A cross-sectional survey was conducted with 397 farmers across four municipalities. Descriptive statistics were used to analyse the performance measurement methods of smallholder farmers. Moreover, an ordinal regression model was used to determine the effect of socio-economic and management factors on revenue outcomes. The results revealed the predominant use of informal methods such as visual appraisal of animal weight and market price, with limited record-keeping by farmers. Furthermore, the results further revealed the significant positive influence of higher cattle prices on achieving higher revenue categories. However, mid-range labour costs had a negative influence on revenue. This suggests improvement in labour efficiency to raise revenues for smallholder beef cattle farmers. Therefore, there is a need for the establishment of structured performance measurement systems, improved herd and management interventions. Government policies that target strengthening extension services, promoting training in record-keeping and breeding management, and improving farmers' bargaining power in formal markets are critical for enhancing the profitability, sustainability, and the commercialization of smallholder beef enterprises.

Keywords: smallholder cattle farming; performance measurement; revenue; ordinal logistic regression; KwaZulu-Natal

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1. Introduction

The profitability of beef cattle enterprises, particularly among smallholder farmers in Sub-Saharan Africa, is shaped by a range of interrelated factors. These factors include economic, social, environmental, and technological dimensions. Understanding these factors is crucial for gauging and developing the necessary interventions that are aimed at improving the livelihoods of these smallholder farmers and enhancing the sustainability of the production of beef cattle in the region. Among the most critical of the factors is access to finance.

The accessibility of credit and financial services is an important determinant when it comes to the profitability of beef cattle enterprises. However, beef cattle smallholder farmers in Sub-Saharan Africa face hurdles when it comes to accessing credit, which limits their ability to invest in inputs essential for their production. Inputs such as improved breed stock, high-quality feed, and veterinary services. One relevant example is that one of the studies carried out in Tanzania and Zambia showed that limited access to credit not only limits farmers but forces them to depend on unreliable and informal credit sources with unrealistically high interest rates, which ultimately reduces their profit margins [1–3].

Beyond credit and financial access, market-related factors also critically influence profitability. The market plays a crucial role in determining the profit of beef cattle enterprises. Smallholder farmers often face low and fluctuating prices due to challenges such as poor market structures and the presence of exploitative intermediaries, which often prey on their lack of bargaining power [4]. Farmers in Zambia, for instance, in most cases, receive low prices for their cattle due to the presence and dominance of intermediaries [5]. A similar situation was observed with the farmers in Tanzania, who were found selling their cattle for unprofitably low prices due to inadequate pricing methods [2].

In addition to price volatility, rising production costs bring forth another constraint in the profitability of beef cattle enterprises. The findings of a study carried out in Tanzania have shown that medication costs alone accounted for 44% of total variable costs in the production process of beef cattle [2]. Similarly, a study conducted in Zambia discovered that the high costs of feed and the veterinary services were identified as major profit constraints [3].

Access to the most reputable and quality veterinary services is one of the factors that are closely tied to productivity and profitability. There are several diseases that are prevalent in Sub-Saharan Africa that often result in high mortality rates among beef cattle farms. Diseases such as East Coast fever and parasitic infections affect not only the profitability but also the productivity of these enterprises. Infrastructural hindrances, especially those related to long distances affecting transportation and market access, introduce new challenges to profitability. Most Sub-Saharan beef cattle enterprises face long-distance challenges that hinder their market access; however, this is not the only challenge they face. Transportation is also another hurdle that has become a hindrance in the profitability of the enterprises. Zambia experiences similar challenges,

particularly with transportation; the issue of poor transport networks has been identified to have played a huge role in hindering the access to markets and often limiting market participation of these enterprises and their profitability [3].

Education and knowledge capacity appears as another significant factor in shaping profitability outcomes. Farmers with high levels of education are most likely to enhance their profitability by adopting improved production practices such as value addition and cattle fattening. Studies in Tanzania and Zambia have shown that farmers with higher levels of education participated more in markets and, as a result, experienced an increase in their profits [1,2].

Cultural traditions emerge as an influencing factor on farming practices and, by extension, on profitability. As regards cultural practices such as traditional cattle herding systems, in Zambia, for instance, studies have found that transhumant herding systems limited the adoption of more improved husbandry practices. These constraints have led to low profitability and poor productivity of these enterprises [3].

Another factor tied closely to profitability is the quality of the breed. The use of improved breeds can contribute to more enhanced and greater profitability of beef cattle enterprises. However, beef cattle smallholder farmers in Sub-Saharan Africa are highly dependent on local breeds, which do not aid in terms of increasing their profitability. The local breeds are lower in productivity and profitability. For example, in Tanzania, over-reliance on local breeds has been identified as one of the most significant constraints to the profitability of these businesses [2].

Breed improvement is interlinked with the practice of cattle fattening as one of the factors. The fattening of cattle plays a crucial role in the beef cattle industry. Not only does it enhance the profitability of beef cattle enterprises, but these practices also improve the quality and the value of the cattle. However, lack of quality feed and knowledge of the right feeds limits these practices from being adopted and materialising. For example, in Ethiopia, smallholder beef cattle farmers face challenges related to the lack of quality feed, which limits their ability to perform these beef cattle fattening practices [6].

Beyond individual farming practices, policy formulation and regulation also play a pivotal role. The government plays a key role in the profitability of these enterprises. Thus, policy inconsistencies and inadequate government support often hinder smallholder farmers from producing a profit in the beef cattle sector. In Zambia, for example, land ownership issues and policy inconsistencies have been identified as major limitations and barriers towards market participation and profitability [3]. Tanzania's lack of government support in the production of beef cattle has negatively impacted the profitability of beef cattle enterprises [1]. This review synthesizes the insights gathered from multiple studies, with a focus on identifying and analysing the key factors influencing the profitability of these enterprises.

Limited information or a lack thereof has been identified as one of the barriers to beef cattle profitability in Sub-Saharan Africa. Smallholder farmers often face challenges of a lack of access to information about

market prices, which often leads to them being exploited by intermediaries, as observed from a case study conducted in Tanzania, whereby the lack of information has affected beef cattle enterprises by reducing their profitability [2].

Moreover, as discussed in the section on education and knowledge capacity, smallholder farmers with a higher level of education often have higher profitability in the beef cattle sector. This is because market participation has become a significant determinant of profitability in this sector. Smallholder farmers with high levels of education tend to participate more in the market, which explains their high levels of profitability. Hence, factors such as low education levels, poor access to credit, and high transaction fees or costs can act as barriers to market participation. Zambian small-holding farmers with a high level of education and access to credit, as a particular example, are more likely to participate in the market and achieve higher profits [3].

Value addition on beef cattle presents another avenue for enhancing profitability. However, this requires a certain capacity and the necessary skill set, which most smallholder farmers in Sub-Saharan Africa often lack due to limited access to processing technologies and markets. In Tanzania, only about 3.8% pastoralists add value to their cattle before selling them, which explains the low profitability they acquire [2]. Despite the potential of increasing income that value addition presents, its adoption is constrained by the lack of skillset and resources. This underlines the systematic challenges faced by smallholder beef cattle enterprises.

The profitability of smallholder beef cattle enterprises in Sub-Saharan Africa is influenced by several complex factors, ranging from economic, social, infrastructural, technological, and policy regulatory factors. Despite the importance of smallholder beef cattle farming in sustaining rural livelihoods, the performance of the sector remains poor. Factors such as limited access to credit, high transaction costs, and inadequate infrastructure all restrict their ability to invest in improved breeds, feeds, and veterinary services.

The existing literature on smallholder beef cattle farming in South Africa highlights poor management practices, limited access to extension services, and weak market integration that smallholder farmers face. For instance, Mapiye et al. [7] identified smallholder beef cattle farming constraints, including drought, rangeland degradation, and feed shortages, in Limpopo, whereas Bareki et al. [8] found that inconsistent breeding and record practices result in varied calving intervals. Ndoro [9] noted the role that is played by extension participation in improving calving rates and veterinary uptake, even though its supply-driven nature limits the broader impact. Ramoroka et al. [10] highlighted the genetic potential of non-descript cattle in smallholder systems, suggesting opportunities for breed improvement.

Previous studies in Sub-Saharan Africa have examined issues of market access, production practices, and livestock profitability-related issues [2]. However, most studies focus on isolated production or market factors. Few have integrated management practices, market dynamics,

and revenue outcomes into a unified analytical framework. Moreover, there is a paucity of research that integrates management practices, performance measurement methods, and revenue outcomes into a single analytical framework. This study addresses that gap by employing an ordinal logistic regression model to link socio-economic and herd management factors with profitability outcomes, offering a comprehensive understanding of smallholder beef cattle performance in uMgungundlovu District. There are also few studies that have employed the ordinal logistic regression models to assess the effect of pricing, labour, and veterinary costs on revenue categories in smallholder beef enterprises. Thus, this study seeks to fill an important literature gap by linking socio-economic and herd management practices with market dynamics and revenue outcomes among smallholder beef farmers in uMgungundlovu, KwaZulu-Natal. Specifically, this study aims to describe beef cattle herd management and performance-measurement practices used by smallholders in uMgungundlovu. Moreover, this study seeks to determine the association between socio-economic factors and revenue categories using an ordinal logistic regression model.

The current study is anchored in the Sustainable Livelihoods Framework (SLF) and Household Production Theory (HPT). The SLF perspective is that smallholder beef farmers' profitability is an outcome of the interaction between livelihood assets, institutional structures, and external shocks such as market or climatic stressors. Thus, within this framework, the current study posits that improving the management capacity, access to services, and market participation of smallholder farmers enhances livelihood resilience and income generation. Moreover, HPT is complementary to SLF, as smallholder beef cattle farmers are viewed as rational and aim to maximise profits by allocating scarce resources such as labour and capital efficiently. This study contributes towards empirical evidence that aims at guiding policies and interventions on productivity and sustainability of smallholder beef cattle farming systems.

2. Methods and Procedures

2.1. Data Collection

The target population was the smallholder livestock farmers from the uMgungundlovu District Municipality. Farmers from the selected municipalities formed the sampling frame, and the sampling unit was a household. A comprehensive list of livestock farmers was obtained from the Department of Agriculture in uMgungundlovu. A simple random sampling technique was used to recruit farmers into this study. The sampling was conducted using Microsoft Excel, whereby each farmer was allocated a random number, and then the required sample was generated from those numbers. Sample size determination was carried out using a formula suggested by [11]. The assumption is that if there is a large population, but the variability in the proportion of the population that will adopt the practice is unknown, it is recommended to use a p -value of 0.5 (maximum variability). This study desires a 95% confidence level and $\pm 5\%$ precision. The resulting sample size is demonstrated in the following equation.

$$n_0 = \frac{Z^2 pq}{e^2} = \frac{(1.96)^2 (0.5)(0.5)}{(0.5)^2} = 385$$

where: n is the required sample size, p is the percentage occurrence of a state or condition, e is the percentage maximum error required, and Z is the value corresponding to the level of confidence required. However, more than the calculated sample data (397) was collected.

This study relied on the following eligibility criteria, based on the research objectives, for recruiting respondent farmers to practice smallholder livestock production; access to farming land, either owning, leasing, or communal; and must start from 18 years of age to give proper information regarding farming activities. A structured questionnaire was used to collect data from farmers. This included data on management practices. In this study, management practices were viewed as encompassing a range of operational decisions and routines that influence herd performance and profitability. Beyond record-keeping and weight estimation methods, the questionnaire included questions on feeding and nutrition strategies (including reliance on natural grazing and use of mineral licks), breeding management (such as mating systems and record-keeping), pasture access and land tenure, and disease prevention and control practices. Thus, information on daily feeding routines, vaccination frequency, access to veterinary services, and methods of health monitoring was collected. Trained enumerators administered the questionnaire, translating questions from English to isiZulu where necessary. However, the high rate of missing responses in certain variables caused by broader structural challenges in smallholder beef cattle farming settings, where management practices are informal and documentation capacity is low, resulted in the implementation of certain mitigation strategies to improve data reliability. These included cross-validation of the responses of farmers with extension officers and enumerator spot verification visits during the survey to confirm the number of livestock. The ethics clearance was obtained from the University of South Africa College of Agriculture and Environmental Sciences Health REC with reference number 2024/CAES_HREC/4982. Moreover, respondents were asked to sign a consent form to declare understanding of this research and voluntary participation prior to data collection.

2.2. Analytical Framework

To examine the factors influencing farmers' revenue outcomes, an ordinal logistic regression model was employed. This model is appropriate when the dependent variable is ordinal in nature, as is the case with the revenue categories used in this study. The ordinal logistic model estimates the cumulative probability that a farmer falls into a particular revenue bracket or below, conditional on a set of explanatory variables. Prior to model estimation, descriptive statistics and chi-square tests were used to characterize the sample and test for associations between categorical variables. The implicit ordinal logistic regression model was specified as follows:

$$Y_i^* = X_i\beta + \varepsilon_i$$

where, Y_i^* is the ordered categorical dependent variable that represents the annual revenue category for farmer i , X_i is the vector of independent variables for farmer i , β is the vector of parameters to be estimated, and ε_i is the error term assumed to follow a logistic distribution. Tables 1 and 2 shows the list of considered and retained in the full empirical model, respectively.

Table 1. List of all independent variables considered in the full model.

Variable Name	Type	Description
gender	Categorical	Sex of the farmer (Male, Female)
age_group	Categorical	Age bracket (18–30, 31–50, 51–70, >70)
education_level	Categorical	Education level (No formal, Grade 8–12, Tertiary)
formal_employment	Categorical	Employment status
household_income_bracket	Categorical	Household income level
extension_service_quality	Categorical	Perceived extension quality (low, medium, high)
access_to_credit	Binary	Credit access (Yes/No)
average_calving_rate	Ordinal	Average calves per cow
cattle_productivity_measure	Categorical	Type of productivity metric used
market_distance_category	Categorical	Market access distance or constraint
market_access_challenges	Binary	Access challenges (Yes/No)

The minimal adequate model retained only statistically significant predictors (or those with at least one significant level). These are presented in in Table 2 below.

Table 2. List of independent variables retained in the final model.

Variable Name	Type	Base Category
education_level	Categorical	Grade 1–7
extension_service_quality	Categorical	>high
gender	Categorical	Female
market_distance_category	Categorical	Close Access
age_group	Categorical	18–30

3. Results and Discussion

3.1. Socio-Economic Characteristics of Respondent Farmers

Table 3 presents the results of the socio-economic characteristics of the respondent farmers in uMgungundlovu, KwaZulu Natal. The smallholder beef cattle farming population in uMgungundlovu is male-dominated, with 59.3% men and 40.7% women. This reflects the persistence of gender disparities in accessing resources and the male-dominated participation livestock farming. Moreover, middle-aged to old farmers (51–70) dominated the farming population (43.1%) followed by senior youth to young adults (31–50 years) at 35.5%. Only about 7.7% of respondents were younger than 18–30 years. This highlights a weak generational renewal of the smallholder beef cattle sector.

Moreover, a notable and significant proportion of respondent farmers (86%) resided in their farms. This offers advantages for daily monitoring and management of livestock. However, there were low education levels, with only 8.9% of the respondents possessing a tertiary

education. The majority of smallholder beef cattle farmers in uMgungundlovu possessed secondary and primary education, 47.8% and 31.1%, respectively. Moreover, about half of the farmers have received livestock production training. This suggests that exposure to advanced skills, technologies and technical knowledge is limited. This aligns with the findings of Mbatha [12] that farmers in the Eastern Cape struggled with poor production methods and limited market access due to fragmented training and weak extension services.

Income was derived from livestock sales for most of the respondent farmers (46.3%). Government grants were the secondary source of income, with about 32.5% of the farmers dependent on them. Moreover, the household wealth indicators showed that most farmers (84.9%) considered themselves as either being poor or very poor. This suggests vulnerability among farmers in study area. Most farmers (61.5%) had short land tenure (0–10 years), and this may be a hindrance to long-term investments.

Table 3. Summary table of socio-economic characteristics of respondent farmers.

Variable	Proportions (%)	Missing Values	Total (n)
Gender	F: 40.7%, M: 59.3%	14	383
Age Group	>70: 13.8%, 18–30: 7.7%, 31–50: 35.5%, 51–70: 43.1%	5	392
Farm Resident	No: 14.0%, Yes: 86.0%	19	378
Education Level	Grade 1–7: 31.1%, Grade 8–12: 47.8%, No Formal: 12.3%, Tertiary: 8.9%	14	383
Training on Livestock	No: 51.8%, Yes: 48.2%	32	365
Major Income Source	Crops: 6.0%, Gov Grant: 32.5%, Livestock Sales: 46.3%, Salary: 11.9%,	28	369
Household Wealth	Less Poor: 15.1%, Poor: 58.8%, Very Poor: 26.1%	40	357
Land Ownership	>20 yrs: 17.4%, 0–5 yrs: 28.0%, 10–20 yrs: 21.1%, 5–10 yrs: 33.5%	18	379
Experience	>20 yrs: 17.4%, 0–5 yrs: 28.0%, 10–20 yrs: 21.1%, 5–10 yrs: 33.5%	18	379
Cattle Breeds	Crossbreeds: 19.8%, Exotic: 2.8%, Indigenous: 77.4%	8	389
Land Size (ha)	<2 ha: 47.7%, 2–10 ha: 26.7%, 10–20 ha: 12.2%, >20 ha: 13.5%	11	386

About 77.4% of the smallholder beef cattle farmers in uMgungundlovu kept indigenous breeds. Although these breeds are popular for their resilience, they are often less productive compared to exotic breeds. The farmers also had small land sizes, with about half (47.7%) of the farmers having less than 2 hectares of land. This reflects the significant constraint that land size has always placed on the commercialization of beef cattle in smallholder farming. Therefore, the descriptive results depict smallholder beef cattle farming as being resource-poor, ageing, and semi-educated farming population, dependent on livestock sales and social grants, with limited agricultural training and land sizes. These traits often have negative consequences on

productivity, market participation, and resilience, and increase reliance on informal markets.

3.2. Production and Herd Management Practices

The findings of this study reveal a strong dependence on natural resources for livestock production among the surveyed smallholder farmers. Natural grazing (87.5%) and river water (91%) were the dominant feed and water sources, respectively. This heavy reliance on the environment echoes the observations of Musemwa et al. [13], who reported that communal farmers in the Eastern Cape predominantly utilize unimproved grazing systems. While these resources are accessible and cost-effective, such dependence heightens vulnerability to climatic shocks, particularly droughts and rainfall variability, which severely compromise forage availability and overall livestock productivity.

To compensate for nutritional gaps inherent in natural grazing systems, a significant proportion of farmers 81% reported the use of feed supplements, especially mineral licks. This suggests an awareness of the limitations of natural pastures and a proactive attempt to address nutritional deficiencies. The trend aligns with findings by Khapayi and Celliers [14], who observed increasing, though uneven, adoption of improved feeding strategies among smallholder farmers. These efforts demonstrate an evolving approach to livestock nutrition management, although resource constraints may still limit uniform uptake across farming communities.

Despite attempts to enhance nutrition, this study highlights persistent challenges in animal health management. Although 96% of farmers indicated that they feed their livestock daily which is a sign of relatively high management intensity, disease outbreaks remain prevalent. The widespread use of self-administered treatments, coupled with limited access to veterinary services, does little to address the challenge. This mirrors the findings of Khapayi and Celliers [14], who reported that smallholder farmers often lack the technical knowledge required to effectively manage livestock diseases. This is further complicated by the low levels of regular vaccination, with only one-third of respondents adhering to consistent vaccination practices. These gaps in animal healthcare align with observations by Khapayi and Celliers [14] and Sibanda et al. [15], who both emphasized the inadequacy of veterinary extension support and the resultant shift toward reactive, rather than preventative, disease management approaches. Such shortcomings increase livestock susceptibility to diseases such as foot and mouth disease (FMD) and lumpy skin disease (LSD).

Health monitoring practices also reflect the limitations in formal veterinary oversight. Approximately 79% of farmers rely on personal observation to detect animal illness, a method that, while accessible, is often unreliable without adequate training. This pattern is common in resource-poor settings. Masika et al. [16] noted similar tendencies in the Eastern Cape, where observable symptoms were often used in lieu of professional diagnostics due to cost and access barriers. The high prevalence of diseases such as diarrhea 72%, external parasites, and black quarter further underscores the impact of insufficient veterinary outreach

and inadequate farmer training. Moyo and Masika [17] similarly reported that parasite infestations remain widespread in communal areas due to poorly coordinated control programs.

In terms of productivity assessment, farmers primarily relied on visual performance indicators such as weight gain (38%) and market price trends (33%). This aligns with Montshwe [18], who found that many smallholder farmers depend on visual appraisal and informal market cues due to limited access to weighing infrastructure or record-keeping systems. Musemwa et al. [13] also highlighted the rarity of formal performance monitoring, with many farmers gauging productivity based on observable body condition and market reception rather than objective measurements.

3.3. Discussion of Breeding Management Practices

Efforts to improve livestock productivity, enhance genetic potential, and establish sustainable and profitable farming systems must begin with effective breeding management practices. For smallholder farmers, these practices are not merely technical decisions; they are often shaped by available resources, local knowledge systems, and the socio-economic realities of daily life. The findings from the survey offer valuable insights into how farmers select breeding stock, manage mating systems, and navigate the various challenges associated with maintaining herd quality. Understanding these practices is critical for identifying both the existing strengths within current systems and the areas where targeted support or interventions could yield significant improvements.

3.3.1. Breeding Methods

The results showed an overwhelming reliance on natural mating (85.6%) among surveyed farmers, reflecting a broader trend seen across rural livestock systems in Southern Africa (see Figure 1). This approach is consistent with earlier findings by Mdladla et al. [19], who attribute the limited uptake of artificial insemination (AI) to poor infrastructure, technical skills, and cost barriers. The observed AI usage (3.3%) is strikingly low, especially when compared to settings like Eastern Cape, where Muchenje et al. [19] reported AI use of up to 30% typically linked to commercial farmers or those with strong extension support.

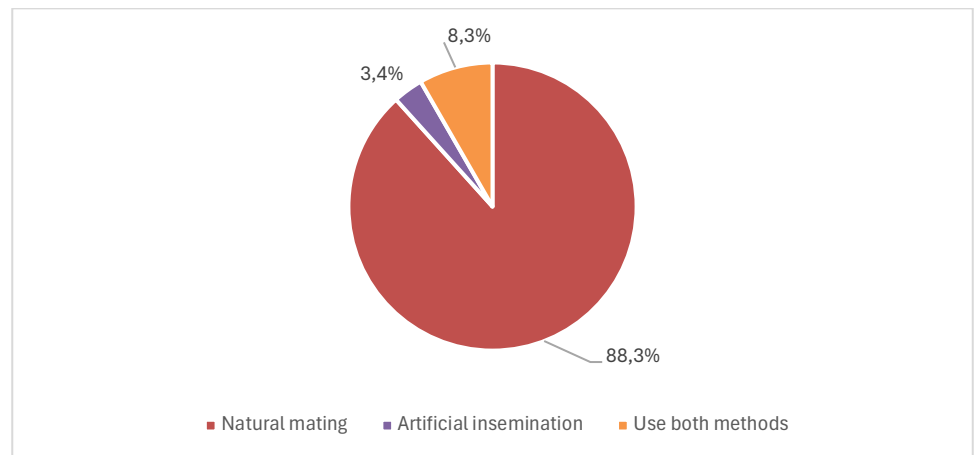


Figure 1. Distribution of breeding method.

This reliance on traditional methods is also aligned with the work of Thénard et al. [20], who found that smallholders lack access to performance-based genetic tools. In contrast, a study conducted by Nurye and Dereje [21] shows that larger and more resource-endowed farms had greater AI adoption, benefiting from its ability to enhance genetic gain and reproductive efficiency. The implication here is clear: bridging the infrastructure and knowledge gap could improve productivity.

3.3.2. Keeping Breeding Records

The results from that study showed that only 50.1% of farmers maintained breeding records. These results are consistent with the findings of the study conducted in the Eastern Cape by Nqeno et al. [23], which found that fewer than 20% of farmers kept any records.

The finding is critical considering the vital importance of record-keeping in monitoring herd performance, planning breeding decisions, and preventing inbreeding [24]. According to Rowan [24], record-keeping is essential in monitoring herd performance, planning breeding decisions, and preventing inbreeding. In addition, Zwane et al. [25] note that where training interventions have been introduced, record-keeping has improved significantly. Although many farmers struggle with technical literacy and data management [20], this limits long-term gains from

genetic selection. Strengthening extension programs and digitized record-keeping solutions may help overcome this bottleneck.

3.3.3. Breeding Challenges

The result shows that nearly half (49.6%) of farmers cited a lack of breeding knowledge as their primary challenge, followed by poor access to quality bulls (32.7%) (see Figure 2). These issues echoed across the region. Scholtz et al. [26] advocate for farmer education and community bull schemes to address such deficits. High inbreeding rates due to communal grazing, as documented by Madilindi et al. [27] in Limpopo and Bester et al. [28] in Namibia, further highlight the risks of limited genetic literacy and unregulated breeding.

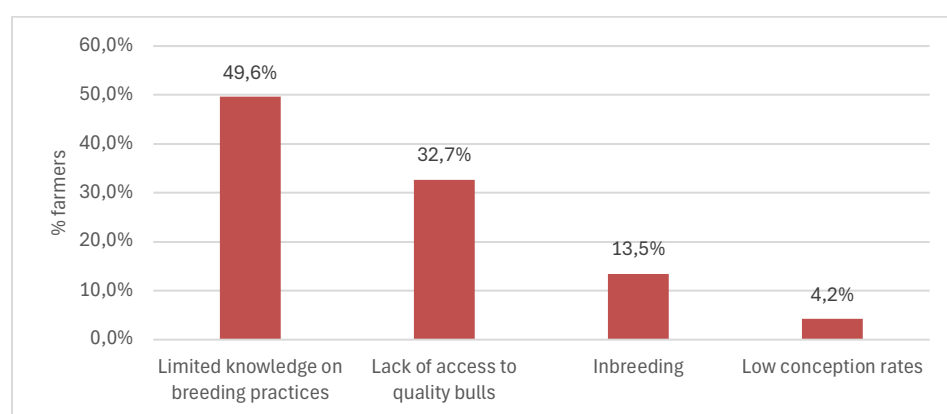


Figure 2. Distribution of breeding challenges.

3.3.4. Practice of Selective Breeding

The results revealed that 59.4% of respondents practice selective breeding. However, the remaining 40.6% represent a missed opportunity. Selective breeding, even when based on simple observable traits, has been shown to yield measurable gains in productivity [29]. However, Comparative studies showed regional variation, where Tada et al. [30] found only 40% adoption in the Eastern Cape, whereas Haile et al. [31] reported higher rates (>60%) in Ethiopia, driven by national programs. In addition, Mateescu [32] and Rowan [24] note that while advanced techniques (e.g., selection indices) are effective, they remain underutilised in smallholder settings due to complexity and cost.

3.3.5. Type of Selective Breeding Practiced

The results revealed that the most reported methods used by farmers were natural Oestrus observation (53.5%) and visual cues (38.3%) (see Figure 3). These techniques, while accessible, lack precision and leave room for error. Low adoption of technologies like heat detection pads (1%) signals a missed opportunity for improving reproductive timing and efficiency. As reported by Malatji et al.[33], visual appraisal based on body size and behavior is prevalent. In contrast, Tanzanian farmers [34] emphasized traits like milk yield and disease resistance, suggesting that where awareness of economic traits is stronger, breeding decisions are more strategic.

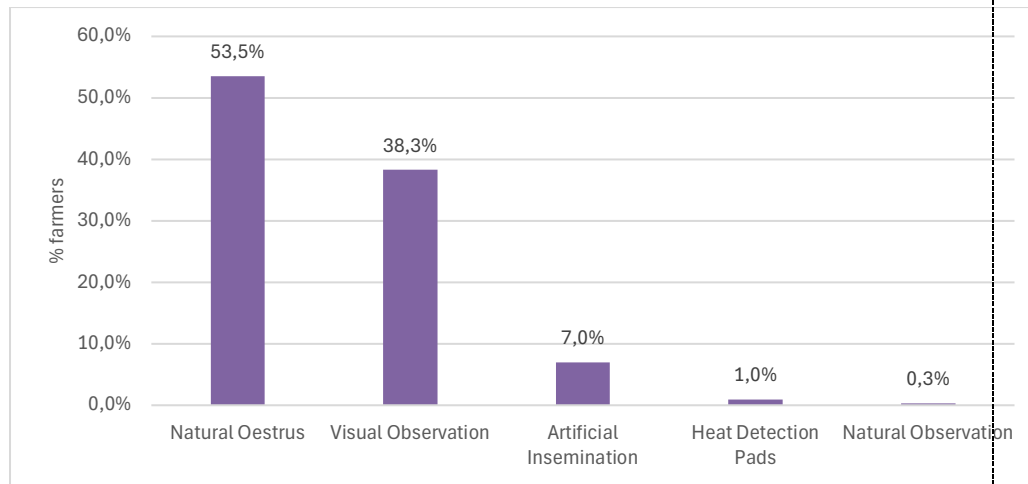


Figure 3. Distribution of types of selective breeding practices.

3.3.6. Criteria for Selecting Cattle for Breeding

The results revealed that farmers primarily use visual traits like body condition (39.2%) and age (15.5%) to select breeding females (see Figure 4). This practical approach aligns with low-resource contexts but underrepresents genetic and reproductive traits such as fertility (9.2%) and longevity (10.7%). This indicates a need for increased awareness of economically valuable traits. In contrast, Zander and Drucker [35] found that selection in West Africa was often culturally motivated. Nqeno et al. [23] similarly reported reliance on visual assessments, highlighting a widespread gap in structured genetic evaluation.

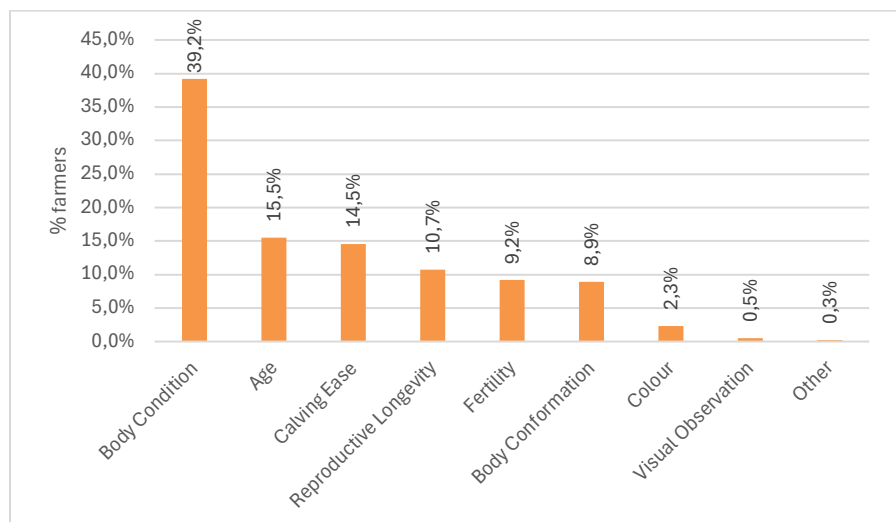


Figure 4. Distribution of criteria for selecting cattle for breeding.

3.3.7. Criteria for Selecting Breeding Males

When asked what criteria they consider when selecting a breeding male, 74.3% of the respondents did not respond. This implies that the selection of breeding males is either neglected or not well understood. Among farmers who responded, age (39.2%), body conformation (18.6%) and fertility (16.7%) dominate selection decisions (see Figure 5). Ndlovu

et al. [36] and Sanarana et al. [37] observed that farmers often select bulls based on maternal productivity and size, rather than objective fertility or pedigree data. Nqeno et al. [23] also concur that some farmers used observable traits like size and calving intervals. In addition, Zander and Drucker [35] found that in West Africa, selection was more culturally based (e.g., color, horn shape).

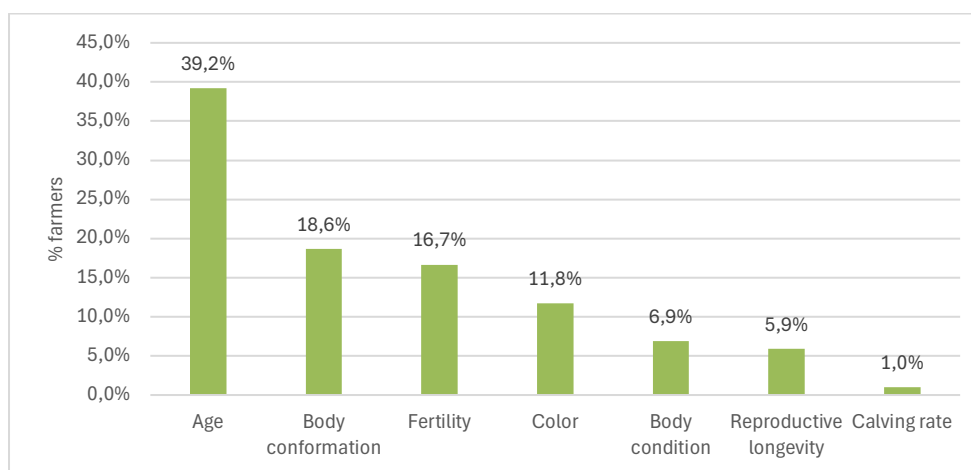


Figure 5. Distribution of criteria for selecting breeding male.

3.3.8. Breeding-specific Marketing Challenges

These results showed a high rate of non-responses (95.72%) to the marketing question, which suggests farmers may not distinguish breeding-specific marketing challenges from general livestock marketing issues. However, the literature highlights key breeding-specific marketing challenges. Musemwa et al. [13] underlined a weak market integration and poor infrastructure as key constraints. These issues limit the viability of breeding enterprises and may explain the limited focus on marketing breeding stock. In addition, Rowan [23] notes that evolving market demands require farmers to align breeding goals with buyer preferences. Furthermore, according to Mateescu [32] and Maltseva [38], environmental sustainability and animal welfare are emerging considerations influencing market access.

3.3.9. Challenges in Selecting Breeding Cattle

The results show that most farmers frequently cited body condition (37.4%), libido (17.2%), and age (16.7%) when identifying challenges in selecting breeding cattle (see Figure 6). These are sensible criteria, but the neglect of temperament (1.4%) and disease resistance (12.2%) is concerning. This is consistent with findings from Tada et al. [30], who noted poor access to structured breeding programs, and Bester et al. [28], who emphasized knowledge gaps in trait prioritization. A shift toward multi-trait selection informed by both performance and adaptability would better support herd sustainability.

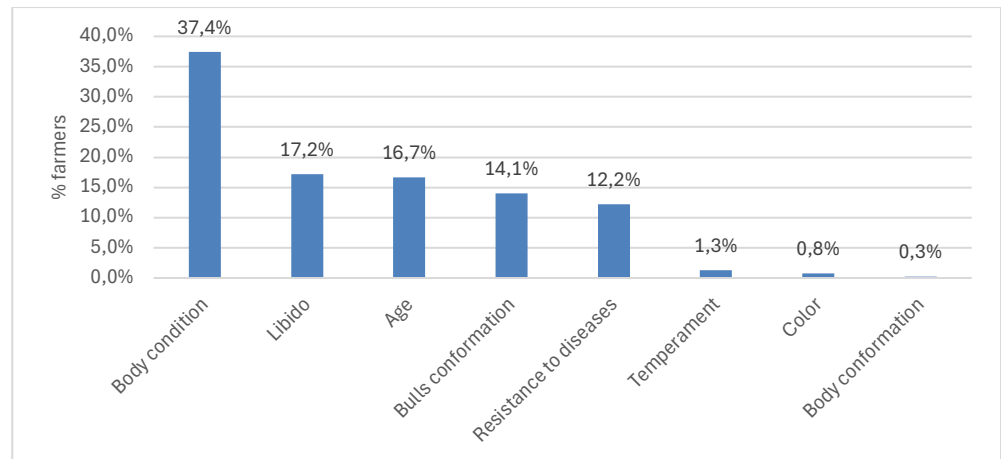


Figure 6. Distribution of challenges in selecting cattle breeding.

3.4. Market Access and Dynamics

The results reveal a dominance of informal markets (59.3%) in livestock sales, alongside the low uptake of group marketing (38.8%) and a high proportion of farmers unwilling to participate in collective sales (67.8%). This is consistent with broader trends observed among smallholder farmers across Sub-Saharan Africa. Alene et al. [39] and Barrett [40] attribute this reliance on informal markets to lower transaction costs, greater flexibility, and minimal entry requirements. Similarly, in the South African context, Randela et al. [41] found that communal livestock farmers often preferred informal channels due to proximity, established social networks, and the immediacy of cash-based transactions. Therefore, market rejections reflect under-commercialisation and perpetuate a cycle of low profitability and reduced market confidence among smallholder beef producers.

The limited participation in group marketing confirms the findings by Ortmann and King [42], who emphasized that mistrust, lack of cohesion, and weak institutional support to be a major deterrent to cooperative arrangements. These observations are further supported by Steinfeld et al. [43], who underscored the role of social capital and trust in determining the success of group marketing initiatives.

Access-related challenges were reported by most respondents (85%), with transport difficulties (23%), limited market information, poor infrastructure, and low prices cited as key barriers. These findings resonate with studies by Musemwa et al. [13] and Hlongwane et al. [44], which documented similar impediments constraining smallholder commercialization in South Africa. Inadequate infrastructure, particularly in remote rural areas, contributes to a spatial mismatch between producers and markets, thereby reinforcing smallholders' dependence on informal buyers. This dependency often leads to unfavourable terms of trade, with middlemen exploiting information asymmetries and weak bargaining power [45].

The high incidence of market rejections (78%), largely due to uncastrated males, disease, and missing documentation, reflects significant quality and compliance issues that are characteristic of low-input livestock systems. These results align with findings from Namibia

and Botswana by Mmbengwa et al. [46], where deficiencies in animal health management and lack of traceability systems restricted smallholder access to formal beef markets. Montshwe [18] similarly associated frequent market rejections in South Africa with weak veterinary support, inadequate regulatory knowledge, and poor extension service delivery. The persistence of such challenges underscores the critical need for targeted veterinary services and farmer training to enhance compliance with formal market standards [47].

In terms of sales behaviour, most farmers reported selling livestock annually (56%) or during emergencies (42%), suggesting a non-strategic, reactive engagement with the market. This finding is indicative of “distress sales,” a concept well-documented in the literature, where livestock serve primarily as a form of savings or insurance rather than a commercial asset [48]. The fact that 83% of sales were driven by household income needs, rather than by favourable market conditions, further supports this subsistence-oriented livelihood strategy. Comparable behaviour has been observed in Ethiopia and Kenya, where livestock sales are often liquidity-motivated and disconnected from market signals [49], ultimately limiting farmers’ ability to take advantage of price seasonality and resulting in low profitability.

The expressed need for financial access (35%), along with requests for training and government support, highlights the demand for enabling interventions that can facilitate livestock commercialization. These priorities reflect calls in the literature for inclusive livestock development strategies that provide smallholders with access to credit, inputs, and extension services. According to Malusi et al. [50], without such support, smallholders remain locked in low-productivity cycles. In line with this, the Department of Agriculture, Forestry and Fisheries [50] emphasized the importance of integrating emerging farmers into formal markets through policy support and financial inclusion.

Moreover, the preference for informal markets and the high rate of market rejections reflect broader structural challenges. As Nkhori [51] argues, many smallholder farmers are effectively excluded from formal markets due to stringent quality requirements, high transaction costs, and insufficient institutional support. Informal markets, therefore, often present the most accessible for resource-constrained producers.

These management practices have implications for smallholder beef cattle profitability. Efficient use of resources and adoption of good husbandry practices have a direct positive influence on productivity and revenue outcomes. Therefore, management practices such as feeding, breeding control, disease prevention, and record-keeping determine how labour, land and capital inputs are converted into outputs that can be marketed. For example, poor record-keeping and veterinary management obscure cost structures, reducing farmers’ capacities to plant and evaluate investment returns and leading to poor allocation of resources and lower profits. Conversely, better management practices lead to minimal losses for farmers and respond to price incentives, leading to better market outcomes and higher revenue. Therefore,

management behaviour is an important driver through which socio-economic and market factors influence profitability.

3.5. Performance Measurement Methods

The findings reveal that communal livestock farmers predominantly assess cattle performance based on weight gain (38.4%) and market price (33.0%). Less frequently used indicators include calving rate (15.7%) and mortality rate (12.9%), highlighting a focus on immediate physical and financial outcomes rather than on reproductive efficiency or herd health management. Notably, the reliance on these indicators occurs within an informal, experience-based system, with minimal use of structured, digital, or paper-based record-keeping tools.

This informality aligns with Ndlovu and Sibanda [51], who found that smallholder and communal farmers in Southern Africa often depend on visual appraisal and experience when evaluating livestock performance. These subjective approaches, while valuable in traditional contexts, lack the precision and traceability required in formal and export markets [13]. Consequently, farmers are at a disadvantage when trying to access premium or regulated markets that demand verifiable animal histories, vaccination records, and performance documentation [52].

Comparable trends have been observed across Southern Africa. For example, Chagunda et al. [53] noted that in Malawi, most smallholder cattle farmers lacked basic production records, limiting their ability to manage reproduction, plan sales, or monitor disease trends effectively. Similarly, Nkosi and Kirsten [54] found that in South Africa, the absence of structured performance tracking was a key factor constraining the commercialization of emerging beef producers.

The informal performance assessment is compounded by significant gaps in animal health management, particularly in access to vaccination and veterinary services. This study's findings support broader evidence indicating that veterinary coverage in rural areas is often fragmented and under-resourced. Mapiye et al. [22] and Schneider et al. [55] emphasize that public veterinary services are stretched thinly, with mobile clinics either unavailable or inconsistently deployed. Furthermore, Ngoshe et al. [56] report that emerging farmers often lack knowledge of disease symptoms, appropriate treatment protocols, and the timing of vaccinations, which exacerbates herd vulnerability.

Studies by Swanepoel et al. [57] also stress that animal health constraints are not merely technical but are also shaped by institutional and policy failures such as the lack of coordinated extension support, poor disease surveillance infrastructure, and underfunded veterinary networks. Without improved access to health services and record-keeping training, many communal farmers will remain locked out of more lucrative livestock value chains.

3.6. Ordinal Logistic Regression Results

Table 4 presents the results of the ordinal logistic regression model, which was used to examine the effect of average beef cattle prices and cost-related variables (labour and veterinary costs) on the likelihood of farmers falling into higher annual revenue categories. The *a priori* expectations were that higher cattle prices are positively associated with

higher revenue categories, and higher labour and veterinary costs have a significant negative effect on profitability outcomes. Statistically significant variables were price and labour costs. Veterinary costs and perceived major cost drivers such as feed did not statistically significantly influence revenue. This indicates that perceptions may not always align with actual cost impacts, or that farmers may misallocate resources based on perceived rather than measured cost burdens. Nkosi and Kirsten [54] have noted that misperceptions in communal livestock budgeting, where feed and labor were overestimated relative to their revenue contribution. Thus, there is a need to bridge the gap between farmer perceptions and real cost-revenue relationships in training interventions, helping them make evidence-based financial decisions.

Although the way profitability was measured due to data availability presented some drawbacks for rigorous analysis, the examination of the profitability of smallholder farmers remains important for evidence-based policy planning and interventions. However, the development and analysis of robust profit function models is hampered by poor farm records. Smallholder farmers beef cattle farmers in remote areas rarely keep data on sales' prices and input costs for planning and decision-making purposes due to poor data collection, storage and analytical techniques.

Table 4. Ordinal logit regression results of the factors that influence profitability.

Variable	Coefficient	p-Value
price category >R4000	2.22	0.00
price category R2000 - 4000	0.92	0.01
labour costs >R3000	0.74	0.32
labour costs R1500 - R2000	-0.96	0.00
vet costs >R3000	-0.44	0.34
vet costs R1000 - R2000	-0.57	0.06
vet costs R3000	-11.21	0.91
major costs for managing Feed costs	-0.75	0.75
major costs for managing Labour	0.51	0.33
major costs for managing Transportation	0.32	0.60
major costs for managing Veterinary services	-0.58	0.14
1/2	-0.66	0.00
2/3	1.45	0.00

The ordinal regression results revealed that higher cattle prices had a statistically significant positive influence on farmers' revenue categories. Specifically, the likelihood of farmers who received a price that was over R4000 per head of cattle was significantly higher than those with less than R1500 revenue per head, with a very strong positive effect ($p < 0.001$). Moreover, there was also a positive and significant association between higher revenue and farmers with an average price per head that is between R2000–R4000. This means that farmers who receive medium to higher prices are more likely to belong to higher revenue brackets. This finding highlights the role of dynamics in profitability outcomes. This is consistent findings of Musemwa et al. [13] that price volatility and limited market information constrain profitability among communal farmers.

This is also consistent with findings by Lubungu et al. [58] that better pricing is associated with improved farm-level revenue outcomes and market participation in beef value chains in Zambia and South Africa. This has implications for enhancing revenue outcomes through facilitating smallholder beef cattle farmers' price discovery, market access, and bargaining power strategies. Government interventions should aim at improving marketing strategies and access to high-value chains for better farm-gate prices and smallholder incomes.

However, mid-range labour costs (R1500–R2000) affected higher revenue negatively ($p = 0.004$). This suggests inefficient labour management practices at that expenditure level. Moreover, this is an indication of poor productivity gains from moderate spending. Khapayi and Celliers [14] similarly noted that emerging farmers often lack managerial skills to optimize labour inputs. Strangely, there was no significant association between high labour costs (>R3000) and veterinary costs (>R3000) and with revenue outcomes.

Therefore, the significant driver of revenue is the average cattle price. Mid-range labour costs negatively affect profitability. This is similar to the observation by Nkonya et al. [59] that inefficient labour allocation among semi-commercial farmers constrains income generation. This calls for further examination of labour efficiency and training programmes that emphasise the importance of labour planning and control measures. There are several plausible explanations for the findings of a statistically insignificant effect of veterinary costs on revenue outcomes, indicating inefficient resource allocation. For instance, smallholder farmers do not normally engage in preventative care such as routine vaccination and parasite control and are therefore forced to react and use veterinary services during disease outbreaks [13]. These interventions are normally ineffective and mistimed due to episodic and underreported disease pressure in the study area, which results in limited use of veterinary services relative to actual herd health needs. Therefore, the insignificant effect of veterinary costs may not be a reflection of low disease burden, but poor timing, targeting, and quality of veterinary interventions.

Therefore, price signals are important, but to fully determine profitability, there is a need to consider the capacity of farmers in translating these signals into efficient production and marketing decisions. The current study shows that record-keeping, labour management, and access to extension services are critical in enabling market responsiveness. This suggests that managerial efficiency and market participation should be viewed as integrated processes and not as separate processes for smallholder beef cattle commercialization. This study advances a conceptual model of smallholder commercialization that links livelihood assets, management capabilities, and institutional support to income outcomes by integrating management behaviour into profitability analysis, thereby informing targeted policy interventions for rural transformation. Therefore, this study contributes to a broader understanding of profitability in smallholder beef cattle settings by

revealing how revenue outcomes are jointly shaped by management practices, market dynamics, and resource allocation.

4. Conclusions

The findings indicate that breeding practices among smallholder farmers are predominantly traditional, relying heavily on natural mating with limited integration of modern technologies and systematic record-keeping. Moreover, the heavy reliance on informal markets, subjective measurement methods, and inefficiencies in cost management constrain the performance of smallholder beef cattle farmers in uMgungundlovu District. The predominant measures of performance are observable traits such as weight gain and market price. The use of calving or mortality rates for measuring performance is limited. Thus, farmers' ability to accurately track herd productivity, plan breeding cycles, and meet formal market requirements is reduced by the reliance on visual appraisal and experience-based judgment, coupled with minimal record-keeping. As a result, farmers are locked in informal markets, and this limits their potential for improving revenue and long-term enterprise sustainability.

Economic factors remain important in shaping the profitability outcomes of smallholder farmers in uMgungundlovu, as highlighted by ordinal logistic regression results. The strong and positive relationship between cattle prices and revenue underlines the role of market access and fair pricing in profitability. Nevertheless, there are labour management inefficiencies as mid-range labour costs exerted a negative effect on revenue. This reflects the broader challenge of limited financial literacy and poor record-keeping, which hampers evidence-based decision-making.

Taken together, these findings point to two key imperatives. First, strengthening structured performance measurement systems—including training in record-keeping, reproductive monitoring, and herd health management—is essential for improving productivity and market readiness. Specifically, there is a need to promote simple and low-cost record-keeping tools. These could include pictorial logbooks, laminated herd cards, or mobile-based applications tailored for low-literacy users. Second, interventions that enhance farmers' bargaining power in markets and equip them with tools for labour efficiency and cost control will directly improve profitability. There is a need to address both technical and economic gaps to allow for the transitioning of smallholder farmers in uMgungundlovu from subsistence-oriented, informal market participation to sustainable and commercially competitive beef cattle enterprises. Specifically, there should also be more focus on improving labor efficiency through farmer cooperatives, shared herding services, and training in time-saving practices such as rotational grazing and group vaccination. These strategies have the potential to reduce individual labor burdens while maintaining herd health and productivity. Interventions by government and key stakeholders should include building the capability of extension services, promoting the adoption of new technologies, and strengthening record-keeping systems. Specifically, training programs that address knowledge gaps in breeding management, including areas such as selection criteria, genetic

improvement, and inbreeding prevention, should be prioritized. Moreover, the introduction of appropriate breeding technology, such as low-cost artificial insemination services and heat detection tools, should be targeted for the enhancement in reproductive efficiency and genetic gains. Moreover, there should be the establishment of bull schemes and male selection support through structured bull exchange programs and community-based breeding centers to facilitate access to quality breeding males and a reduction in inbreeding.

5. Limitations

This study was limited by the absence of systematic record-keeping among respondents, which resulted in a high rate of missing responses in certain variables. These gaps reflect broader structural challenges in smallholder beef cattle farming settings, where management practices are informal and documentation capacity is low. However, certain mitigation strategies were implemented to reduce bias. These included cross-validation of the responses of farmers with extension officers and enumerator spot verification visits during the survey to confirm the number of livestock. Moreover, there was a lack of farm-level climate exposure variables (e.g., drought episodes), which may mediate productivity and revenue. These variables should also be considered in future studies to contextualize profitability outcomes.

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Appendix 6: Turnitin report

