



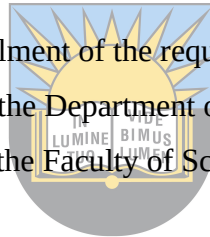
University of Fort Hare
Together in Excellence

Small-scale livestock farmers' knowledge, attitudes, practices (KAPs), and willingness to pay for fodder seed technology in OR Tambo District Municipality of Eastern Cape Province, South Africa

BY

Ayabonga Toko

A dissertation submitted in fulfillment of the requirements for the MSc Agriculture (Agricultural Economics) degree in the Department of Agricultural Economics, Extension and Agribusiness in the Faculty of Science and Agriculture



University of Fort Hare
Together in Excellence

Supervisor: Dr A. Mayekiso

Co-supervisor: Dr M. Mamabolo (Agricultural Research Council)

2025

Declaration of Originality

I, **Ayabonga Toko (201820990)**, hereby declare that, aside from the properly cited references, the work presented in this dissertation, titled “**Small-scale livestock farmers' knowledge, attitudes, practices (KAPs), and willingness to pay for fodder seed technology in OR Tambo District Municipality of Eastern Cape Province, South Africa**” is entirely my own. I further confirm that this work has not been submitted, either wholly or partially, for any degree at this or any other institution.



University of Fort Hare
Together in Excellence

Dedication

I dedicate this work to all those who offered me their support and encouragement, both practically and emotionally, to help make this study a success.



University of Fort Hare
Together in Excellence

Abstract

The importance of the adoption of agricultural technology in productivity and productivity gains can be realized when yield-enhancing technologies are used and disseminated. This study's main objective was to analyse small-scale livestock farmers' knowledge, attitudes, practices (KAP), and willingness to pay (WTP) for fodder seed technology in the OR Tambo District Municipality, Eastern Cape, South Africa. Livestock farming is a vital component of the region's economy and food security; however, small-scale farmers face significant challenges, including poor-quality feed, land degradation, and climate change.

The study's objectives included profiling small-scale livestock farmers' demographic and socio-economic characteristics, assessing small-scale livestock farmers' KAP regarding fodder seed technology, determining the relationship between their KAP regarding fodder seed technology and socio-economic characteristics, and examining small-scale livestock farmers' WTP for fodder seed technology. Data was collected from 151 small-scale livestock farmers across three local municipalities of King Sabata Dalindyebo, Port St Johns, and Ingquza Hill using a semi-structured questionnaire. Purposive sampling procedures were employed to select small-scale livestock farmers who participated in this study.

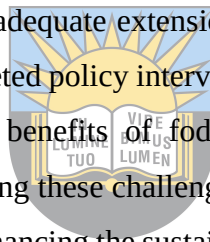
The ordered probit model was used to determine the relationship between farmer's socioeconomic characteristics and their KAP. Where the dependent variable was the KAP and was regressed with a set of independent variables (socioeconomic characteristics of the farmers). For farmers' knowledge of fodder seed technology, three variables were found to have a significant influence. The variables, age of the farmer, education level, and source of feed for livestock were significant at 5% 10%, and 5% significance levels respectively. For the attitude of the farmers toward fodder seed technology, two variables were found to have a significant influence.

The variable farmer's occupation status (Full-time/Part-time) was significant at a 5% significance level and the source of feed for livestock was found to be significant at a 1% significance level. For farmers' practices towards fodder seed technology, three variables were found to be significant. Estimated monthly income was significant at a 10% significance level, source of feed was significant at a 5% significance level and sources of agricultural information were significant at 1%.

The study also utilized the Contingent Valuation Method (CVM) to examine small-scale livestock farmers' WTP for fodder seed technology. To assess how the socio-economic factors of farmers influence farmers' WTP for fodder seed technology, the study used a logistic regression model. Descriptive statistics showed that 95.36% of farmers are willing to invest in this technology, driven by the perceived benefits of increased livestock productivity and having livestock feed also in the dry seasons.

Logistic regression analysis revealed that age negatively influences WTP for fodder seed technology, with older farmers being less inclined to adopt the technology. Gender was also a significant factor, with male farmers showing a higher likelihood of WTP when compared to female farmers. Additionally, higher estimated monthly income and larger household size were positively correlated with WTP, while larger arable land size, interaction with extension officers, and ownership of more goats were associated with a decreased likelihood of WTP.

Despite the high willingness to adopt fodder seed technology, challenges such as high seed costs, limited access to credit, and inadequate extension services remain significant barriers. The study highlights the need for targeted policy interventions that improve access to financial services, enhance education on the benefits of fodder seed technology, and ensure the distribution of quality seeds. Addressing these challenges can significantly boost the adoption of fodder seed technology, thereby enhancing the sustainability and productivity of small-scale livestock farming in the region.



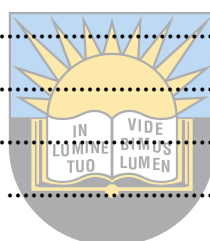
University of Fort Hare
Together in Excellence

Keywords: *Small-scale livestock farmers; Forage seeds; KAP index; Ordered probit model; Willingness to pay.*

Table of Contents

Declaration of Originality	ii
Dedication	iii
Abstract	iv
Table of Contents	vi
List of Figures	x
List of Tables	xi
List of abbreviations	xii
Acknowledgments.....	xiv
 Chapter One	 1
Introduction.....	1
1.1 Background of the study	1
1.2 Problem Statement	3
1.3 Objectives.....	4
1.3.1 Main Objective.....	4
1.3.2 Specific Objectives	4
1.4 Research Questions.....	4
1.5 Hypotheses	5
1.6 Significance of the study.....	5
1.7 Delimitation of the study.....	6
1.8 Outline of the study.....	6
 Chapter Two.....	 7
Literature Review.....	7
2.1 Introduction	7
2.2 Definitions of Key Concepts.....	7
2.3 Livestock Production in South Africa.....	8
2.4 Forage Scarcity	11
2.5 Animal Nutrition and Natural Feeding	13
2.6 Small-scale farmer's knowledge, attitudes, and practices of fodder seed technology.....	15
2.6.1 Small-scale farmer's knowledge and extension services	17
2.6.2 Small-scale farmer's attitudes, practices, and technology adoption	20
2.7 Willingness to pay for fodder seed technology among small-scale farmers.....	22
2.8 Determinants of farmers' adoption of new technology	23

2.9 Challenges in Adopting Fodder Seed Technologies among small-scale Farmers in Africa..	27
Chapter Three.....	30
Research Methodology	30
3.1 Introduction.....	30
3.2 Description of the study area	30
3.2.1 Climatic conditions of the Eastern Cape Province.....	33
3.2.2 OR Tambo District Municipality	34
3.2.3 OR Tambo District Agricultural Potential.....	35
3.2.4 OR Tambo District climatic conditions	36
3.2.5 King Sabata Dalindyebo Local Municipality.....	37
3.2.6 Port St Johns Local Municipality.....	39
3.2.7 Ingquza Hill Local Municipality.....	40
3.3 Research Approach	41
3.3.1 Research Design.....	41
3.3.2 Ethics	42
3.3.3 Unit of analysis	42
3.4 Sampling strategy and sample size	42
3.4.1 Sampling Strategy.....	42
3.4.2 Sample size	43
3.5 Data collection method	45
3.6 Analysis Tools	46
3.6.1 Descriptive Statistics.....	46
3.6.2 KAP index.....	47
3.6.3 Ordered Probit Model	49
3.6.4 Contingent Valuation Method (CVM).....	55
3.7 Model Diagnostic Test.....	60
3.8 Description of the selected forage seed varieties	61
3.9 Chapter Summary	63
Chapter Four	64
Results and Discussions.....	64
4.1 Introduction.....	64
4.2 Socio-economic characteristics of the farmers	64



University of Fort Hare
Together in Excellence

4.2.1 Age of the farmers.....	64
4.2.2 Gender of the Farmer	66
4.2.3 Marital status of the farmers	67
4.2.4 Employment status	68
4.2.5 Educational level.....	69
4.2.6 Source of income of the farmers	70
4.2.7 Monthly income for a farmer's household.....	71
4.2.8 Household size and Arable land (ha) of the farmers.....	71
4.2.9 Number of livestock of the respondents	72
4.2.10 Source of feed for livestock	73
4.2.11 Land Ownership	74
4.2.12 Source of Agricultural Information.....	75
4.2.13 Extension Officer Contact.....	76
4.2.14 Extension Officer educating farmers about fodder varieties	77
4.2.15 Membership in Project.....	78
4.3 Knowledge, attitudes, and practices analysis.....	79
4.3.1 Knowledge of Fodder Seed Technology.....	79
4.3.2 Attitude towards Fodder Seed Technology.....	82
4.3.3 Practices in Fodder Seed Technology.....	85
4.4 Relationship between farmers' socioeconomic characteristics and KAP	88
4.5 Farmer's willingness to pay for fodder seed technology.....	95
4.5.1 Binary response for farmers' willingness to pay for fodder seed technology	95
4.5.2 Binary Responses of the farmers' willingness to pay for five different fodder Seed varieties	95
4.5.3 Farmers' maximum amount they are willing to pay for forage varieties.....	98
4.5.4 Reasons for farmers' maximum amount to pay for the fodder varieties.....	99
4.5.5 Determinants of the farmer's willingness to pay for fodder seed technology	100
4.6 Chapter Summary	103
Chapter Five.....	105
Summary, Conclusions, and Recommendations.....	105
5.1 Introduction	105
5.2 Summary	105
5.3 Limitations of the Study.....	106
5.4 Conclusions and Recommendations	107
5.5 Policy Recommendations.....	110



University of Fort Hare
Together in Excellence

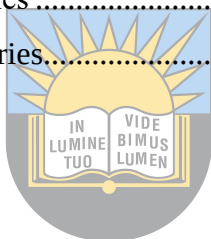
5.6 Areas for further research	111
References.....	112
Appendixes	145



University of Fort Hare
Together in Excellence

List of Figures

Figure 3.1: Conceptual Framework	32
Figure 3.2: Eastern Cape Province map.....	34
Figure 3.3: OR Tambo District Local Municipalities map	36
Figure 3.4: Average temperature and precipitation for Port St Johns.....	40
Figure 4.1: Employment status of the farmers.....	68
Figure 4.2: Educational level of the farmers.....	69
Figure 4.3: Sources of income of the farmers.....	70
Figure 4.4: Source of feed for livestock in the study area	73
Figure 4.5: Land ownership of the farmers.....	74
Figure 4.6: Extension Officer Interaction with farmers.....	76
Figure 4.7: Extension officers and talking about forage varieties	77
Figure 4. 8: Membership of farmers in Project.....	77
Figure 4.9: Farmers' Attitude Categories.....	82
Figure 4.10: Farmers' Practice Categories.....	85



University of Fort Hare
Together in Excellence

List of Tables

Table 3.1: Distribution of the farmers across the local municipalities selected	45
Table 3.2: Analytical Framework	46
Table 3.3: Hypothetical variables used in the Ordered Probit Model.....	51
Table 4.1: Age of the farmers	64
Table 4.2: Gender of the Farmers	68
Table 4.3: Marital status of the farmers	67
Table 4.4: Monthly income of the farmers	71
Table 4.5: Household size and Arable land (ha).....	71
Table 4.6: Number of livestock kept by farmers	72
Table 4.7: Source of agricultural information of the farmers	75
Table 4.8: Likert Scale for knowledge questions to the farmers	80
Table 4.9: Distribution of the farmers according to their knowledge of fodder seed technology	81
Table 4.10: Farmers' attitude towards fodder seed technology	84
Table 4.11: Practices of the farmers towards fodder seed technology	87
Table 4.12: Ordered Probit Model results for the relationship between farmers' socioeconomic characteristics and their knowledge of fodder seed technology	89
Table 4.13: Ordered Probit Model results for the relationship between farmers' socioeconomic characteristics and their attitude toward fodder seed technology	91
Table 4.14: Ordered Probit Model results for the relationship between farmers' socioeconomic characteristics and their practice toward fodder seed technology	93
Table 4.15: Farmer's willingness to pay for fodder seed technology.....	95
Table 4.16: Binary response to the farmer's willingness to pay for fodder seeds.....	97
Table 4.17: Minimum and maximum willingness to pay amounts for the forage varieties by small-scale farmers	98
Table 4.18: Farmers' reasons for the maximum amount to pay for the fodder varieties	99
Table 4.19: Binary Logistic regression results for the determinants of the farmer's willingness to pay for fodder seed technology.....	100

List of abbreviations

AI - Attitude Index

ARC – Agricultural Research Council

ASF – Animal Source Food

CVM – Contingent Valuation Method

DAE -Department of Agricultural Extension

DAFF – Department of Agriculture, Forestry and Fisheries

DALRRD - Department of Agriculture, Land Reform, and Rural Development

DBDC - Double-Bounded Dichotomous Choice

ECSECC – Eastern Cape Socio Economic Consultative Council

FEAST – Feed Assessment Tool

GDP – Gross Domestic Product

GVA - Gross Value Added

IHLM - Ingquza Hill Local Municipality

KAPs – Knowledge, Attitudes, and Practices

KI- Knowledge Index

KSDLM – King Sabata Dalindyebo Local Municipality

LMIC- Low-and-Middle Income Countries

OLS - Ordinary Least Squares

ORTDM – Oliver Reginald Tambo District Municipality

PI – Practice Index

PSJ – Port St Johns



University of Fort Hare
Together in Excellence

SSA - Sub-Saharan Africa

UREC – University Research Ethics Committee

VIF- Variance inflation factor

WTA – Willingness to Accept

WTP – Willingness to Pay



University of Fort Hare
Together in Excellence

Acknowledgments

"Now, therefore, our God, we thank You and praise Your glorious name." 1 Chronicles 29:13 (NKJV). If it was not for your compassion which fails not, I would not have been able to make it this far Lord, Thank You.

I would like to express my deepest gratitude to my supervisors, Dr. A. Mayekiso and Dr M. Mamabolo, whose unwavering support and dedication have been instrumental in the completion of this study. Your insightful and constructive feedback pushed me to work harder and strive for excellence. The countless hours you invested in guiding me through this process have not gone unnoticed. Your encouragement and belief in my abilities have made a profound impact, and I am truly grateful for everything you have done. Thank you for your exceptional guidance and for being such a remarkable mentor. Your assistance has been deeply appreciated.

I would like to extend my gratitude to the rural communities of the OR Tambo District Municipality, specifically King Sabata Dalindyebo, Port St Johns, and Ingquza Hill Local Municipalities. Your generous permission to conduct this research within your communities, along with the valuable information and knowledge you shared, has been profoundly appreciated. I am also deeply grateful for the warm welcome and unwavering support from the Directors and Extension Officers in these local municipalities. Your effort has been essential to the success of this study, and I am truly thankful for your kindness and assistance.

I extend my sincere appreciation to AgriSETA for funding my studies through the Agricultural Research Council. Your support has been crucial in making this research possible. Thank you for your investment in my academic journey.

Chapter One

Introduction

1.1 Background of the study

Livestock production in South Africa plays a significant role in the country's economy and food security (Gomera & Mafini, 2020). The country's diverse climatic conditions and vast landscapes have allowed for the development of various livestock farming systems, including beef, poultry, dairy, sheep, and goat production (Herd-Hoare & Shackleton, 2020). In addition, the livestock farming systems have contributed significantly to the country's gross domestic product (GDP) and employment rates, especially in rural areas (Bahta, 2020).

Rangeland grazing provides the largest proportion of all feed sources for livestock (Palmer & Ainslie, 2005; Nyambali *et al.*, 2023). However, overstocking, bush encroachment, and unplanned veld fires have reduced communal rangelands' grazing capability, making it impossible for the rangelands to produce enough high-quality feed throughout the year (Motshekga, 2022). Inadequate resource management, land degradation, and climate change are the main causes of the rangelands' progressive decline (Tokozwayo *et al.*, 2021).

According to Nkonki-Mandleni *et al.*, (2019) some of the major challenges faced by small-scale farmers in developing countries including South Africa are shortage of good quality forage and feeds, low crop yields, and declining soil fertility. Most studies (Samuels *et al.*, 2016; Negawo *et al.*, 2017; Muller *et al.*, 2019; Nyangiwe *et al.*, 2021) indicate that poor knowledge of forage sources and restricted access to improved forage varieties are additional factors contributing to the issues among small-scale farmers.

Small-scale farmers often rely on traditional agricultural techniques, which can limit productivity (Quddus, 2012). This is due to a lack of knowledge about modern agricultural technologies (their costs, benefits, and risks), as well as a shortage of skilled personnel to implement these innovations (Khan *et al.*, 2021). These technologies include a variety of improved methods and processes that have the potential to significantly enhance agricultural productivity for small-scale farmers (Quddus, 2012; Challa, 2014; Mwangi & Kariuki, 2015).

However, in South Africa, high seasonal rainfall variability and prolonged dry periods pose additional challenges to agricultural productivity. These conditions place significant pressure on livestock forage availability and quality, often leading to feed shortages during dry periods (Samuels *et al.*, 2016; Müller *et al.*, 2019; Schroeder *et al.*, 2019; DALRRD, 2020). Additionally, small-scale livestock farmers' knowledge, attitudes, and practices on fodder seed technology are not documented in South Africa, despite its advantages.

According to Njima (2016), sustainable fodder production technologies could be used as an alternative for producing fodder all year round. For South African small-scale farmers, fodder seed technology could be such technology. This technology helps in the production of high-quality seeds for forage production. In the same line Gonfa (2015), suggested that utilization of improved forages would reduce the pressure on natural pastures, improve soil fertility and erosion on lands, improve carbon sequestration to mitigate climate change, support system sustainability, and enhance natural assets and system resilience.

Most studies (Olum *et al.*, 2020; Mastenbroek *et al.*, 2021; Nazu *et al.*, 2022) have investigated the impact of various factors influencing farmers' willingness to pay (WTP) for agricultural technologies in Uganda, Bangladesh, India, Kenya, and South Africa. These studies found that farmers are generally willing to pay for innovations, but the values and determinants vary greatly depending on the innovations under investigation. In addition, factors such as personal, socioeconomic, institutional, and psychological can influence farmer's willingness to pay for agricultural technologies.

For instance, age and the cost of innovations were consistently found to be negative determinants of farmers' WTP. Furthermore, education, farming experience, income, farm size, access to arable land, access to credit, access to information, and yield were consistently found to be positive determinants across the studies conducted (Olum *et al.*, 2020; Mastenbroek *et al.*, 2021; Nazu *et al.*, 2022). Although previous studies in the above-mentioned regions have shed light on the variables affecting farmers' willingness to pay for agricultural technologies, little is known about small-scale farmers' willingness to pay for fodder seed technology specifically. This study addresses this critical knowledge gap by examining the factors influencing small-scale livestock farmers' willingness to pay for fodder seed technology in the OR Tambo District Municipality of South Africa.

The study, therefore, aimed to close the knowledge gap regarding small-scale farmers' knowledge, attitudes, practices, and willingness to pay for fodder seed technology in the OR Tambo District in the Eastern Cape province.

1.2 Problem Statement

In South Africa, rural areas are primarily populated by small-scale farmers who raise livestock on shared land and grow crops for consumption and sale in local markets (Louw & Jordaan, 2016). Communal rangelands offer natural resources that support the livelihood strategies of resource-poor rural communities. Many farmers rely on indigenous knowledge to guide their decisions about livestock farming and grazing land management (Matshawule & Beyene, 2022). However, overgrazing leads to a decline in high-quality grasses and an increase in low-value plants, reducing livestock productivity. Even though these small-scale farmers own a lot of livestock, they often face low productivity partly due to their reliance on inadequate feed from natural pastures (Mudau *et al.*, 2022).

The conditions and trends of grazing lands are becoming key challenges in feeding the numbers of livestock population (Mapiye, 2017). In addition to declining communal rangelands' grazing capability (Motshekga, 2022), there is a rapid increase in human and livestock populations, coupled with an increasing demand for food, grazing lands are steadily shrinking and being converted to arable land (Worku, 2023). In response to these challenges, improved fodder varieties must be introduced to small-scale farmers because of their higher yield potential per unit area (Wilk *et al.*, 2013; Philp *et al.*, 2019).

According to Dahirr (2016), ensuring an adequate feed supply is crucial for improving livestock production and productivity. Similarly, Ingutia and Sumelius (2022) argue that the adoption of improved agricultural technologies has been associated with increased agricultural productivity. However, despite the development of technologies specifically aimed at small-scale farmers, several studies have noted that the adoption of feed innovations remains limited (Balehegn *et al.*, 2020; Baltenweck *et al.*, 2020; Paul *et al.*, 2020).

Farmers' lack of awareness, a lack of public sector involvement, and the scarcity of inputs, such as restricted forage seed and planting materials, are reasons given for the lack of adoption in South Africa and East Africa (Owen *et al.*, 2012; Paul *et al.*, 2020). Fodder seed technology has the potential to significantly improve feed security by addressing these very issues providing reliable, higher-yielding alternatives to natural pastures and boosting productivity.

Yet, the knowledge, attitudes, practices, and willingness to pay for this technology by small-scale livestock farmers in South Africa have not been fully explored in the literature.

The link between fodder seed technology and KAPs is essential for understanding how this innovation could be effectively adopted by small-scale farmers. While other technological adoptions may also enhance fodder production, such as improvements in grazing land management, fodder seed technology stands out because it directly addresses the root cause of feed inadequacy and over-reliance on declining natural pastures. Focusing on seed varieties that are both productive and resilient, this approach offers a sustainable and accessible solution for improving livestock feed. Furthermore, exploring farmers' willingness to pay for fodder seed technology provides insights into the economic feasibility and adoption potential of fodder seed varieties.

Therefore, this study intended to fill this research gap by analysing small-scale livestock farmers' knowledge, attitudes, practices, and willingness to pay for fodder seed technology in OR Tambo District Municipality in the Eastern Cape province of South Africa.

1.3 Objectives

1.3.1 Main objective

The main objective of the study was to analyse the small-scale farmers' knowledge, attitudes, practices, and willingness to pay for fodder seed technology in OR Tambo District Municipality in the Eastern Cape province of South Africa.

1.3.2 Specific objectives

- i. To profile small-scale livestock farmers' demographic and socioeconomic characteristics to achieve objectives three and four.
- ii. To assess the KAPs of small-scale livestock farmers on fodder seed technology.
- iii. To determine the relationship between small-scale livestock farmers' KAP of fodder seed technology and their socioeconomic characteristics.
- iv. To examine small-scale livestock farmers' willingness to pay for fodder seed technology and the determinants for their willingness to pay.

1.4 Research questions

- i. What are the demographics and socioeconomic characteristics of small-scale livestock farmers?
- ii. What are the KAPs of the small-scale livestock farmers towards fodder seed technology?
- iii. What is the relationship between small-scale livestock farmers' KAP of fodder seed technology and their socio-economic characteristics?

- iv. What is small-scale livestock farmer's willingness to pay for fodder seed technology, and what are the determinants influencing their willingness to pay?

1.5 Hypotheses

- a) Hypothesis for Objective iii (Relationship between KAPs and socioeconomic characteristics)

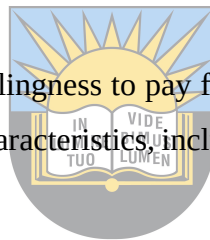
H₀: There is no significant relationship between small-scale livestock farmers' knowledge, attitudes, and practices (KAPs) towards fodder seed technology and their socio-economic characteristics.

H₁: There is a significant relationship between small-scale livestock farmers' knowledge, attitudes, and practices (KAPs) towards fodder seed technology and their socio-economic characteristics, such as income, education, and farm size.

- b) Hypothesis for Objective iv (Willingness to pay and its determinants)

H₀: Small-scale livestock farmers' willingness to pay for fodder seed technology is not significantly influenced by their socio-economic characteristics, such as income, education, and farm size.

H₁: Small-scale livestock farmers' willingness to pay for fodder seed technology is positively influenced by their socio-economic characteristics, including income, education, and farm size.



1.6 Significance of the study

The study on small-scale livestock farmers' knowledge, attitudes, practices, and willingness to pay for fodder seed technology in the OR Tambo District Municipality of the Eastern Cape Province, South Africa, is significant for enhancing livestock productivity, promoting climate change adaptation, and fostering economic empowerment. This contributes to the Draft Policy for the Sustainable Management of Veld (Range) and Forage Resources in South Africa, which aims to establish a comprehensive framework for effective veld and forage monitoring and improvement strategies.

The veld and forage monitoring and improvement strategies include the use of alternative fodder plants in the household rural farming community (DALRRD, 2023). Such efforts to understand farmers' knowledge, attitudes, and practices (KAPs) concerning alternative fodder plants are expected to boost economic activities and contribute to household food security, thereby aligning with the **2030 Sustainable Development Goals**—particularly Goal 1 (ending poverty) and Goal 13 (climate action) (United Nations Development Programme, 2015).

The insights from this study can guide policymakers and researchers in crafting educational programs, extension services, and community engagement strategies to support sustainable agricultural practices, improve livestock productivity, and promote socio-economic development in the region.

1.7 Delimitation of the study

The study was limited to the Eastern Cape Province of South Africa, with a focus on small-scale livestock farmers. Due to time and financial constraints, the study did not cover the entire country regarding fodder seed technology, the focus was only on the Eastern Cape Province, and within OR Tambo district municipality in three local municipalities (King Sabata Dalindyebo, Port St Johns, and Ingquza Hill).

1.8 Outline of the study

The **first chapter** provides the background of the study, problem statement, objectives of the study, research questions, significance, and delimitation of the study. The **second chapter** reviews the literature on livestock production in South Africa, knowledge, attitudes, and practices of small-scale livestock farmers as well as the factors that influence farmers' knowledge, attitudes, and practices (KAPs). These factors include the farmer's socioeconomic characteristics, the characteristics of technology, communication and information dissemination, and challenges with adopting fodder seed technology.

It also entails reviewed literature on farmers' willingness to pay for agricultural technologies and barriers to adoption of agricultural technologies. An outline of the study's methodology is provided in **chapter three**. The chapter explains all the steps used in the analysis of knowledge, attitudes, practices, and willingness to pay for fodder seed technology. **Chapter four** presents the findings of the study based on the specific objectives. **Chapter five** summarizes the research findings, concludes the study, and provides recommendations for policymakers.

Chapter Two

Literature Review

2.1 Introduction

This section presents recent literature on livestock production in South Africa, fodder scarcity, small-scale farmers' KAPs on agricultural technologies, challenges to the adoption of fodder seed technologies, and the impact of extension services on technology adoption.

2.2 Definitions of Key Concepts

Seed and seed system: A seed is the first determinant of future plant development. It is a crucial input for crop production. Seed supply occurs under formal, informal, and integrated agricultural systems. Informal systems are generally subsistent, while formal systems are mostly commercial, and integrated seed systems are a combination of the two systems (Hlatshwayo *et al.*, 2021).

According to Molla (2006), seed refers to any portion of a plant utilized for propagation, including both generative (actual seed) and vegetative parts. It is the most significant input in agriculture and serves as the fundamental building block for plant population distribution and maintenance. It contains the plant's genetic potential. In addition, the seed system is 'the sum of physical, organizational, and institutional components, their actions and interactions that determine seed supply and use, in quantitative and qualitative terms' (Ayamga, 2018).

Knowledge: Knowledge is defined as "an individual's stock of information, skills, experiences, beliefs, and memories". Knowledge encompasses all that a person knows or believes to be true, whether it is verified as true in some sort of objective or external way (Mohajan, 2017). Alexander and Dochy (1995) described knowledge as factual or objective information that comes about because of formal learning. One may conclude that the necessary and sufficient conditions for knowing that something is the case are first that what one is said to know be true, secondly that one be sure of it, and thirdly that one should have the right to be sure (Amasi, 2021).

Attitude: According to Johnson *et al.*, (2022), an attitude is a way of thinking that involves judging something as either positive or negative. Attitude reflects overall feelings or opinions about something. Yet attitude is defined by Kind *et al.*, (2007) as a person's feelings toward an object based on their knowledge and beliefs about that object. For this study, an object is referred to as fodder seed technology. Other authors have agreed that the concept of evaluation is central to the definition of attitude, noting that “attitudes have been defined in a variety of ways, but at the core is the notion of evaluation” (Amasi, 2021).

Practices: According to Chin (2023), practices are a person's observable collection of actions. Practice is also defined as both "doing" and "understanding" that enables doing (Wynn, 2020).

Willingness to pay (WTP): is the maximum amount a person is prepared to pay, sacrifice, or exchange to receive a good or service which is fodder seed technology in this study. It is also the difference between the discounted expected marginal utility of the change in future incomes due to the new set of agricultural technologies and the expected marginal utility under the old set of technologies that leaves the household indifferent (Nyongesa *et al.*, 2016; Ajamo, 2019).

2.3 Livestock Production in South Africa

In South Africa, approximately 80% of agricultural land is suitable for livestock production, and the sector accounts for roughly 40% of agricultural income (DAFF, 2018). Livestock farming remains a vital activity for small-scale farmers in sub-Saharan Africa (Dovi, 2021), and a key component of the livelihoods of more than 52.5 million poor livestock keepers in Southern Africa (McDermott *et al.*, 2010). Over 90% of livestock farmers in Southern Africa are classified as small-scale farmers and they own about 75% of the livestock in the region (Nyamushamba *et al.*, 2017).

In both commercial and small-scale farms, cattle are the most important livestock activity. Cattle production is concentrated in the Eastern Cape, KwaZulu Natal, Free State, and Northwest provinces of South Africa. Beef cattle account for roughly 80% of the national herd, while dairy cattle account for 20%. In the livestock farming sector, there is a dual system with a highly commercialized system on one end and a subsistence system on the other (Mapiye *et al.*, 2021).

Given the wide availability of suitable land for livestock farming, South Africa may be able to maintain the advantages of livestock farming, which would support food security and economic stability. However, to address environmental issues and preserve the long-term viability of this important agricultural sector, it is important to ensure sustainable and responsible practices. The country primarily uses three methods for producing beef: extensive, semi-extensive, and intensive production.

The finishing stages of beef cattle are handled by specialists under the intensive production method; this is often done in the feedlot. Feeding is controlled to achieve the desired weight in livestock in the shortest amount of time due to precisely defined stages of production (Oduniyi *et al.*, 2020). Livestock are grazed on pastures for primary production, and they must be fed in a feedlot for secondary output. Activities for primary and secondary production are mixed since many communal farmers permit livestock to graze freely. These kinds of systems are frequently called extensive. However, sometimes there are overlaps between the production systems (DAFF, 2018; Meisnner *et al.*, 2023).

The overlaps between primary and secondary production systems in communal farming occur due to the common practice of allowing livestock to graze freely. In extensive farming, livestock are typically given the freedom to roam and feed on pastures as part of their primary production phase. However, the transition to the secondary production phase, which involves feeding the livestock in a feedlot, may not always be a distinct and separate process.

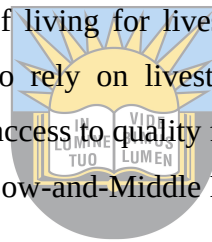
The overlaps can manifest in several ways. For example, some small-scale farmers may start with free grazing but then decide to introduce supplementary feed to enhance the growth or quality of their livestock. In such cases, elements of both primary and secondary production are blended. Additionally, the decision to confine livestock to a feedlot might not be universal or consistent across all livestock or throughout the entire production cycle.

A more precise method of defining the production system is by what the livestock eat and where they sleep. Production systems that allow the livestock to forage their food often and spend much of their life cycle outside are referred to as pasture-based (Meisnner *et al.*, 2013). The defining characteristic in pasture systems is that supplementation of feed is rare and only temporary shelter is provided. Whilst pasture-led systems in the industrialized sector are a result of consumer-driven demand for naturally fed livestock, in developing countries it is usually associated with a lack of resources for intensification therefore common in the small-scale sector (Oduniyi *et al.*, 2020).

The livelihoods of households in rural communities are also significantly impacted by sheep production on both an economic and sociocultural level. Food supply, a source of income, jobs, crop production manure, agricultural diversification, and sustainable agricultural production are some of the roles that are played by farming sheep. Since sheep production is a source of cash income and so supports the livelihoods of small-scale farmers, it is crucial to the South African livestock industry (Muller *et al.*, 2019).

In South Africa, the farming of cattle, sheep, and goats accounts for about 53% of all agricultural land, this is inclusive of both small-scale and commercial farmers (Majaha, 2023). The livestock industry in South Africa is expanding rapidly due to a few factors, including changes in lifestyle, globalization, migration from rural to urban areas, growing demand for livestock products, and an increase in income and population growth.

The demand for livestock products is expected to grow quickly, which will put more pressure on livestock farmers to increase production. This increase in production is anticipated to improve the incomes and standard of living for livestock farmers, particularly small-scale farmers in developing countries who rely on livestock production (Nyam *et al.*, 2022). Furthermore, lack of availability and access to quality feed continues to be the most important limitation to livestock production in Low-and-Middle Income Countries (LMIC) (Kamanzi & Mapiye, 2012; Balehegn *et al.*, 2020).



University of Fort Hare
Together in Excellence

For instance, in six African and Asian focus countries of the Feed, the Future Innovation Lab for Livestock Systems, feeds, and feeding-related issues were ranked consistently as the primary constraint to livestock production and consumption of animal source food (ASF) (ME, 2018). There are important market opportunities and drivers for improving the supply of quality feed in developing countries. These include population growth, urbanization, and rising incomes, and these drivers of demand strongly support the need to enhance the supply of quality feed in low- and middle-income countries (Balehgn *et al.*, 2020).

Small-scale farmers frequently lack adequate information on formal markets, including the carcass classification system and pricing structure, which typically pays lower prices for older, indigenous, and crossbred cattle (Oduniyi *et al.*, 2020). Small-scale livestock production systems are characterized by low production efficiency and poor livestock condition, which is primarily due to poorly managed seasonally overgrazed and overstocked rangelands (Bennett *et al.*, 2013).

In essence, there are interconnected challenges faced by small-scale farmers, encompassing both market access issues and the ecological management of rangelands. Addressing these issues requires interventions that provide better market education and support sustainable rangeland management practices to improve the overall well-being of small-scale livestock producers.

2.4 Forage Scarcity

According to Ndaru *et al.*, (2020), forage is the main feed for ruminants used in supporting ruminant productivity both in fulfilling the basic requirement, reproduction, and production. For this reason, forage plays a crucial role in sustaining ruminants, and its continuous availability is essential. The term "fodder" refers to plants specifically grown for animal feed. This includes grasses, legumes, tree species, and crop residues, as well as sprouted grains like barley, wheat, maize, alfalfa, oats, millets, rye, sunflower seeds, and lentils (Ahamed *et al.*, 2023).

Hall *et al.*, (2007) note that livestock producers fulfill their fodder needs through a mix of crop residues and grazing on common lands, private lands, forests, fallow agricultural areas, and harvested fields. Fodder is also sourced from cultivated forage crops, typically grown by large landowners for instance commercial farmers, while some farmers purchase it. However, the availability and access to high-quality fodder resources are becoming significant challenges in livestock production



University of Fort Hare
Together in Excellence

In underdeveloped nations, the availability of quality fodder seeds is further constrained by informal seed systems that often lack stringent quality control, resulting in poor yields (Welu, 2015). The scarcity of high-quality feed is recognized as a major contributor to low livestock productivity (Balehegn *et al.*, 2020; Slayi *et al.*, 2023). This emphasizes the need for distributing improved forage seed varieties, which is crucial for enhancing food and nutritional security for resource-poor livestock farmers (Amuge & Osewe, 2017). This highlights the critical role of fodder in animal feed, emphasizing the importance of quality in the feed for optimal agricultural productivity.

It draws attention to the informal systems through which underdeveloped nations access seeds, resulting in low-quality requirements and subsequently poor yields of livestock feed. The recognition of the link between low productivity and a lack of feed and fodder highlights the need for improvements in fodder seed technology. This is crucial to address global food and nutrition security issues, particularly among livestock farmers with limited resources like those of South Africa. This paragraph provides valuable insights into the challenges faced by agricultural systems in certain regions (Kenya, Ethiopia, and South Africa) and the potential solutions being explored.

The shortage of adequate feed and fodder, especially during the dry season, significantly reduces livestock productivity in arid and semi-arid regions of Sub-Saharan Africa (SSA), including South Africa. Mpanza *et al.*, (2020) highlight that fodder scarcity during the dry winter months diminishes livestock productivity potential due to limited plant growth caused by low soil moisture and cooler temperatures.

In the Eastern Cape province, Moyo & Ravhuhali (2023) observed that winter forage deficits are common, with rain-fed autumn planting of winter forage being a potential solution to improve year-round livestock production. Magawana *et al.*, (2021) similarly noted that forage shortages during the dry winter season are exacerbated by the poor quality of perennial grasses, which have matured and lost nutritional value (Kwaza *et al.*, 2016; Moyo & Ravhuhali, 2023).

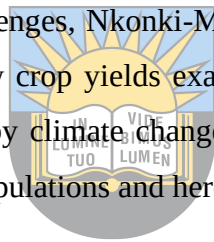
The studies (Kwaza *et al.*, 2016; Moyo & Ravhuhali, 2023) suggest that rain-fed autumn planting of winter forages could be a viable option to address forage deficits in natural rangelands, ultimately enhancing livestock production. Lack of adequate winter feed is probably the most important production constraint to high livestock production in arid and semiarid regions, not only at national levels but across the world.

Magawana *et al.*, (2021) in a study conducted at Kokstad Research Station in KwaZulu Natal, also echo that forage scarcity happens in the dry winter season when plant growth is curtailed by low soil moisture and ambient temperatures for the predominant summer grasses found in the rangelands. During this season, perennial grasses would have reached maturity and therefore be poor in quality (Kwaza *et al.*, 2016; Moyo & Ravhuhali, 2023).

The dependence on summer grasses in the rangelands implies a seasonal pattern of forage availability, with a reliance on these plants during the growing season. The decrease in soil moisture and ambient temperatures during the dry winter season acts as a natural limitation, hampering the growth of these grasses. Addressing these challenges may require strategic interventions, such as implementing sustainable forage management practices or exploring alternative feed sources, to mitigate the impact of seasonal fluctuations and ensure more consistent livestock nutrition throughout the year.

Hall *et al.*, (2007), highlight that the primary strategy for addressing the lack of feed and fodder in the past involved evaluating different forage crops (grasses, shrubs, and trees). This was because of their yield, nutritional value, and impact on livestock production parameters (such as milk yield, and live weight gain). However, not disseminating knowledge of fodder technology (typically manifested as a seed of improved varieties and their management and use) has resulted in limited progress in resolving the fodder scarcity problem.

In addition to these agricultural challenges, Nkonki-Mandleni (2013) highlights that climate change, soil fertility decline, and low crop yields exacerbate feed shortages for small-scale farmers. Rainfall variability, driven by climate change, directly impacts fodder availability, leading to fluctuations in livestock populations and herd productivity farming (Ericksen *et al.*, 2013).



University of Fort Hare
Together in Excellence

Nkonki-Mandleni (2013) further highlights that several factors played both a good and a negative role in changes in the number of livestock. Some of the factors include economic expansion, an increase in demand for livestock products brought on by urbanization and the rapid growth of the human population, advancements in breeding, nutrition, and animal health, rapid technological advancements that are changing consumer tastes in food, and genetic advancements.

2.5 Animal Nutrition and Natural Feeding

In South Africa, natural veld, rangelands, and pastures serve as the foundation for livestock production and are typically the most affordable sources of feed for cattle (Palmer & Ainslie, 2006). The term "veld" in South Africa refers to the natural vegetation that animals browse and graze on. Veld productivity is largely influenced by temperature and rainfall, making veld management systems vulnerable to both climate change and variability.

The significant year-to-year climate variability, particularly drought and rising temperatures, significantly affects the quantity and quality of available fodder. Additionally, veld productivity is shaped not only by climatic factors but also by stocking rates, grazing strategies, and other management practices that affect livestock production in a changing climate (Tjelele *et al.*, 2020).

Rangeland condition, which reflects the health of the ecosystem, resistance to soil erosion, and ability to produce forage for sustained livestock production, is gradually deteriorating in South Africa (Ndandani, 2016). Poor resource management, land degradation, and climate change are key factors contributing to this decline (Tokozwayo *et al.*, 2021). Despite this, communal rangelands continue to provide rural households, including small-scale farmers, with essential resources for livestock. However, many rangelands are perceived to be degraded, likely due to overstocking and excessive harvesting (Mdiya *et al.*, 2021).

South Africa's natural veld is in poor condition, with approximately 60% of the veld classified as degraded, 30% in moderate condition, and only 10% in good condition (Van de Pol & Jordaan, 2008; Tjelele *et al.*, 2020). Despite its condition, the veld remains a primary feed source for livestock farmers. However, the veld faces several challenges that limit livestock productivity, including extreme rainfall seasonality, which leads to significant fluctuations in forage availability and quality, often resulting in feed shortages during the dry season (Schulze *et al.*, 2016; Samuels *et al.*, 2016; Müller *et al.*, 2019; Schroeder *et al.*, 2019; DALRRD, 2020).

Veld and pastures can complement one another in providing feed for livestock (Tjelele *et al.*, 2020). With future climate change scenarios, integrating planted forage reserves with natural rangelands could become a key strategy for addressing feed shortages during dry periods. As Makkar (2016) points out, poor feeding reduces livestock productivity, while proper nutrition improves both milk production in lactating animals and growth in meat-producing animals. Furthermore, good nutrition enhances reproductive efficiency, leading to higher fertility rates, earlier calving, shorter inter-calving intervals, longer productive lifespans, and increased profitability for farmers.

As a subtropical country, South Africa experiences temperature variations depending on altitude, with grasslands mainly located in the semi-arid to arid interior and decreasing rainfall toward the west (Koshe, 2022). Grasslands are a vital resource for grazers in South Africa's developing areas, particularly in the former homelands of KwaZulu-Natal, Ciskei, and Transkei, where local populations rely on them to produce meat, milk, hides, and fleece.

In grazing systems, both natural meadows and cultivated grazing areas provide the bulk of livestock feed. However, during periods of environmental stress, such as drought or snow, farmers supplement with hay or silage, though this practice is challenging due to the seasonal fluctuations in grass availability and quality (Sollenberger *et al.*, 2020).

2.6 Small-scale farmer's knowledge, attitudes, and practices of fodder seed technology

The term "small-scale" often describes black smallholder farmers in South Africa as those engaged in traditional, subsistence farming practices with limited commercial activity (Funde & Oyelana, 2018). The South African Department of Agriculture (2015) defines small-scale farmers as those who produce for both household consumption and market sales, providing a vital income source for their families. Although these farmers have the potential for expansion into commercial agriculture, they require substantial support, including technical, financial, and managerial resources (Carelsen *et al.*, 2021).

Small-scale farmers are not a uniform group; they exhibit diverse farming practices and needs based on their specific circumstances (Pienaar, 2013; Tshoni, 2015; Fanadzo & Dube, 2018). Common characteristics include low education levels and limited land access, with some having less than one hectare for production (Tshuma, 2014; Hlatshwayo *et al.*, 2021). These factors, along with financial constraints, challenge their ability to sustain production, particularly during prolonged droughts.

Additionally, small-scale farming systems are characterized by the production of forage and fodder at sub-optimal levels integrated with other aspects of agricultural production. Growing and utilizing larger quantities of locally produced, high-quality forages reduce livestock production costs without compromising productivity, thereby enhancing on-farm sustainability (Lukuyu *et al.*, 2019). Introducing improved forages into small-scale mixed farming systems can reduce the competition for land by utilizing the same land for both crop and forage production (Lugusa *et al.*, 2016). The characterization of small-scale farming systems by sub-optimal levels of forage and fodder production suggests an opportunity for improvement.

Emphasizing the cultivation and utilization of locally produced high-quality forages provides an opportunity to improve the nutritional value of livestock diets. This not only contributes to the well-being of livestock but also has the potential to reduce the costs associated with external feed sources. Introducing improved forages into small-scale mixed farming systems can alleviate competition for land. Using the same land for both crop and forage production creates a synergy that can enhance overall agricultural productivity. This integrated approach minimizes the trade-offs often associated with land use conflicts, where farmers need to choose between cultivating crops or dedicating land to forage production.

Lukuyu *et al.*, (2015) study in Tanzania, notes that small-scale farmers keep an average of three to four heads of cattle per household. A feed assessment (FEAST) survey conducted in 2015 identified the availability of adequate feeds in terms of quantity and quality as one of the factors constraining smallholder dairy production (Lukuyu *et al.*, 2015). Furthermore, access to extension services is limited leading to limited knowledge of good livestock production practices, as noted in a study conducted in Zimbabwe (Chakoma & Chummun, 2019).

Also, high livestock productivity, reduction in the incidence of pests and diseases, and quality of produce as well as increased farm incomes, can be realized through increased access to quality extension services (Marwa *et al.*, 2020). Additionally, access to quality extension services is crucial for disseminating best practices, improving animal husbandry skills, and addressing challenges related to pests and diseases. That is, increased access to extension services is highlighted as a pathway to realizing higher livestock productivity, improved produce quality, and enhanced farm incomes.

A KAP study is a social research method that measures changes in human knowledge, attitudes, and practices in response to a specific project activity, usually education or outreach. The KAP studies can also detect people's barriers and constraints (Current *et al.*, 2019). A KAP survey is a representative study of a specific population to collect information on what is known, believed, and done about a particular topic.

In most KAP surveys, data are collected orally by an interviewer using a structured and standardized schedule (Islam & Islam, 2020). The KAPs (knowledge, attitude, and practices) analyses are frequently used to assess the effectiveness of informational campaigns and support policymakers in modifying education programs to meet the needs of the public at large (Tiongco *et al.*, 2012). In addition, KAP studies aim to collect the following information using three complementary approaches to understand how the public feels about the problem at hand (Tiongco *et al.*, 2012).

1. Knowledge: the depth of factual understanding of the subject and related problems.
2. Attitude and perceptions: thoughts and opinions about the topic, including judgments of its significance and impact on people's lives.
3. Practices: the acts that are now being taken because of the issues' knowledge, attitude, and perception.

2.6.1 Small-scale farmer's knowledge and extension services

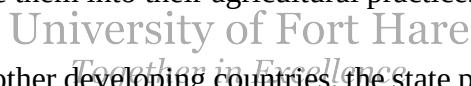
As reported by Meijer *et al.*, (2015), knowledge refers to information and understanding of how the new technology operates and what it is capable of, while perceptions are the views farmers have about it based on their perceived needs and prior experiences—views that may or may not be accurate. In practicality, knowledge is a crucial element of all forms of progress. Thus, knowledge is essential to any creative process and can be referred to as organized or processed information or data. Knowledge and attitude are interrelated and have an impact on one another, this means knowing a technology can shape one's attitude towards it.

Jaleta *et al.*, (2013), state that due to different factors that are either internal or external to the farmers' circumstances, small-scale farmers' knowledge and use of agricultural technologies in general, and fodder seed technology, are limited. Farmers' attitudes toward risk, farm characteristics that influence the level of production and consumption, and resource endowments are the most often researched internal factors that influence the use and acceptance of agricultural technologies (Jaleta *et al.*, 2013). External factors could be access to technologies, through a well-developed seed system infrastructure. In situations where farmers have no education to low years of formal education, knowledge of technology use becomes limited, and such farmers are slow to learn or adopt new technological innovations (Beke, 2011).

According to Hulme (2018), there are four categories of knowledge: (i) scientific and social scientific knowledge; (ii) local knowledge; (iii) tacit knowledge; and (iv) self-reflective knowledge. Chakoma (2012) adds that technology must be applicable and pertinent for farmers to use it. Research should be conducted in actual field conditions rather than under idealized controlled conditions on an experimental farm since contributions from local knowledge are particularly essential. This would ensure that information about agricultural technologies is properly disseminated to its users (farmers).

Extension services then provide farmers and other agricultural people with recent farming information and education so that they can improve their agricultural practices and technical skills. This includes not only the technology of farming practices, but also the farmers' management skills, which allow them to interact in the respective markets more effectively, communicate with relevant people more effectively, and reach better and more efficient markets (Utami *et al.*, 2019).

Mwangi & Kariuki (2015), assert that the use of modern technology in extension services results in high productivity. Such services inform farmers about the most recent technology, which they then use to increase their profits, and this also raises people's living standards (Elias *et al.*, 2016). Extension service providers ensure that more people become aware of modern technologies and incorporate them into their agricultural practices (Utami *et al.*, 2019).



In South Africa, just like in other developing countries, the state provides all extension support services to small-scale farmers. These services are offered free of charge as social welfare, which makes the government bear all the costs (Terblanché, 2013). However, the recent economic plunge, coupled with bureaucratic inefficiencies in the agricultural sector, has led to the government reducing its investment in extension provision services.

According to Mzuyanda *et al.*, (2022), the limited funding for extension services has aggravated the administration of the sector, leading to poor service delivery amongst small-scale farmers who rely on the government for extension services. Furthermore, funding is at the center of several institutional challenges currently facing the administration of extension services (Christian *et al.*, 2022). These include the low extension worker-to-farmer ratio, which stands at 1:1500, the laying off of skilled and experienced workers, poor essential support, like transport, and the inadequate supply of inputs and information (Hlatshwayo & Worth, 2016; Nkosi, 2017).

Evidence of this poor performance can be seen in the low output of small-scale farmers, who largely depend on government-supplied extension services (Sikwela, 2013; Ntsiapane *et al.*, 2023), and this has led to many criticisms of the government-led extension service (Hall and Kepe, 2017). The background of agricultural and advisory services is different from any other African country. Its foundation and premise are a result of both colonialism and the apartheid era (Mzuyanda *et al.*, 2022).

Agricultural extension and consulting services are the most common public sector supports for knowledge dissemination and learning in South Africa (Liebenberg, 2015). According to Loki *et al.*, (2022), extension and advisory services provide farmers with information about livestock and cropping techniques, including which inputs to use and how to use them. The main barrier preventing small-scale farmers from adopting accessible technologies and management techniques provided by technology is their lack of information and skill gaps.

Small-scale farmers frequently place their trust in mediators, who typically take advantage of their lack of agricultural information. It is indicated that different information sources have a variety of effects on how farmers approve agricultural technologies and practices at different phases (Mdoda *et al.*, 2022). As stated by Bese *et al.*, (2020), extension officers are crucial in the adoption of new farming practices. It has been demonstrated that small-scale farmers trust extension officers to provide important expertise and information on the improvement of their farming activities. Cheteni *et al.*, (2014) state that extension officers had a favourable impact on farmers' perceptions and that many farmers were willing to use farming techniques taught by officers.

According to Meijer *et al.*, (2015), enhancing knowledge, perceptions, and attitudes concerning agricultural advances, extension, and training play a significant role. There has been a rising emphasis on farmer-led extension, in which farmers are the major agents of change in their community and help disseminate the new technology to other farmers. The "farmer first" theory, which emphasized the value of local expertise and farmer innovation as a complement to more conventional approaches to the transfer of technology in agricultural research and extension, catalysed this. Although the approach has encountered much criticism, the idea of linking agricultural research to farmers' knowledge has been broadly embraced (De Wolf, 2010).

The degree to which farmers themselves are involved in the development of and experimentation with the new technology is a factor that has frequently been overlooked in adoption studies. Often, a new technology is believed to be a ‘finished product’ and farmers are assumed to either adopt or not adopt the technology. However, farmers frequently experiment with various technology adaptations, which is frequently disregarded by scientific research institutions (De Wolf, 2010).

2.6.2 Small-scale farmer’s attitudes, practices, and technology adoption

According to Boochan (2020), attitude is a psychological construct, a mental and emotional entity that is deeply rooted in or characterizes a person. A person's attitude is characterized as a mental preparedness that has been organized through extensive experience and that also stimulates in one direction or has a dynamic influence on how people react to all the items to which it is related.

The attitude toward innovation is then determined by one's understanding and impressions of it. According to the theory of planned behaviour, the attitude component includes not only attitudes toward the behaviour but also attitudes toward perceived behavioural control and subjective norms. When it comes to this situation, it can be anticipated that a favourable attitude toward an agricultural innovation can increase the likelihood of adoption and a negative attitude can decrease the likelihood of adoption (Meijer *et al.*, 2015).

Adoption is defined in different ways by various authors. For instance, Loevinsohn *et al.*, 2013 define adoption as the integration of new technology into existing practice and is usually preceded by a period of ‘trying’ and some degree of adaptation. Citing the work of Feder *et al.*, (1985), Bonabana-Wabbi (2015) defines adoption as a mental process an individual passes from first hearing about an innovation to final utilization of it.

There are limitations to increased agricultural productivity in small-scale agriculture in sub-Saharan Africa, which include unreliable and poorly distributed rainfall; low and unattractive prices; lack of small-scale irrigation facilities; insufficient selection of suitable crop varieties, especially for the marginal areas; pest and disease problems; large post-harvest losses; poor research-extension linkages; poor supply of inputs, especially seed and fertilizers; infertile soils; and failure of the small-scale farmer to adapt to changing environments and adopt new technologies (Muzari *et al.*, 2012).

In Sub-Saharan Africa, there are many potential agricultural innovations but very slow uptake due to extrinsic characteristics of the adopter (knowledge, attitude, and practices) which inform their choices and decision-making (Meijer *et al.*, 2015). In the context of new agricultural technologies, adoption studies aim to close adoption gaps and estimate the likely economic effects of technology adoption (Onsomu, 2019).

Along the same line Sunny *et al.*, (2018) state that the factors that influence the adoption of new technology are diverse or complex making it hard for a farmer to try and explain the factors influencing adoption and the patterns of adoption. According to Ullah *et al.*, (2018), the important factors influencing farmers' decision of technology adoption are the size of a farm, gender, age, marital status, level of education, wealth, availability of labour, years of experience, and risks (production risk and uncertainty related to the use of new technology).

The size of a farm is significant in decisions made in the adoption of technology. According to Teshome *et al.*, (2019), larger farms are more likely to adopt improved technology compared to small farms. Larger farms have a greater ability to raise capital, bear the cost of the innovations, and bear the risk of failure, they are likely to be less risk-averse compared to relatively small farms and are more likely to make risky investments compared to smaller farms (Kahan, 2013). It is assumed that large families provide the labour required for improved production practices. Kawula (2019) maintains that smaller farms might be more willing to take the risk and costs associated with early adoption as they are looking for new niches and opportunities.

A farmer's age may influence adoption decisions in several ways. A younger farmer due to his or her education and exposure to technology might be more likely to adopt innovations early in his life cycle as cited by Rattey *et al.*, (2011). On the other hand, an older farmer with a low level of education might prefer to stick to traditional methods of farming which may be related to the ability to judge opportunities to innovate.

On the contrary, a well-experienced and well-resourced older farmer might be willing to try new technology. Unlike older farmers, younger farmers have greater flexibility in accepting new ideas and a high appetite for risks (Khapayi & Celliers, 2016). Practice describes routine actions that are influenced by commonly accepted social norms and ideas. The scientific literature support, however, makes it clear that no KAP survey research has been done on overall fodder seed technology, notably in South Africa.

2.7 Willingness to pay for fodder seed technology among small-scale farmers.

The amount of money a person is willing to part with to purchase a good or service is known as their willingness to pay (Gumber & Rana, 2017). According to Eyinade *et al.*, (2021), the willingness to pay function determines how much a person is willing to pay for a particular degree of quality at a particular price, income, and preference. Mulatu (2016) mentions that it is clear that numerous research has been done to determine the direction and strength of the impact of various factors on farmers' willingness to pay for agricultural technologies.

Market is a factor that influences WTP, for instance, farmers who have access to a market are more likely to be willing to pay for agricultural services than those who do not. On the other hand, the willingness to pay for agricultural services is inversely connected with the distance to the market. Mulatu (2016) further goes on to say it is challenging to create a universal model of the process of WTP for technology with defined determinants and hypotheses that are held everywhere, even though some recognized determinants tend to have wide applicability.

The most popular technique known as the contingent valuation method, utilizes either an open-ended or a closed-ended question to assess respondents' willingness to pay for a specific change or improvement in comparison to the present situation of conditions (Gumber & Rana, 2017). In a closed-ended question, respondents are asked whether they would be willing to pay for the new product, but in an open-ended question, respondents are asked to state the amount they would be willing to pay (Owusu, 2009).

The determinants of WTP by farmers largely depend on the type of innovations studied. The determinants can be categorized into the following groups (sociodemographic, technological, and institutional factors) (Olum *et al.*, 2020). Sociodemographic information relates to the characteristics of the farmers as individuals (such as age, gender, and education level) or those of the farmers' household (such as household size and household income).

In various studies, the most significant factors reported are education, age, gender, household income, and farming experience. While many studies found a positive influence of education on willingness to pay/ willingness to accept (WTA), the influence of age has produced mixed results, with most studies indicating that younger farmers tend to be willing to pay more than older ones. Also, the level of income produced a positive influence on WTP, with wealthier farmers willing to pay relatively higher premiums.

On the same note, family size is linked to both the labour available for farm work and the variety of income sources within a family, potentially explaining why it could have a positive effect on willingness to pay (WTP) (Olum *et al.*, 2020). Technological factors are the characteristics of the technology or innovation, such as the cost, usefulness, or ease of use. The ease of use, usefulness, and amount of improvement in the technology has positive effects on farmers' WTP (Olum *et al.*, 2020).

Literature on WTP for agricultural technologies in Africa, and South Africa in general is rather scant. Past research reveals that the magnitudes of small-scale farmers' WTP for agricultural technologies, as well as the type of payment, vary with the nature of the technology. Asrat *et al.*, (2004) examined the determinants of farmers' WTP for soil conservation practices in Ethiopia's south-eastern highlands and reported that most of the farmers in the study area were less willing to pay cash.

However, the farmers were prepared to put in a lot of effort and time to conserve the soil. Education is another aspect that is anticipated to have an impact on farmers' WTP for agricultural technologies. Farmers' capacity to acquire, process, and use information is anticipated to rise with increased levels of education. Therefore, it is believed that education plays a beneficial impact in the choice to invest in new agricultural technologies. Numerous studies on Ethiopian farmers' WTP for sustained land productivity technologies as well as extension visitation or other extension services in Uganda, Ethiopia, and Nigeria have discovered this beneficial effect (Ulimwengu & Sanyal, 2011).

2.8 Determinants of farmers' adoption of new technology

Innovation adoption is a difficult mental process that heavily depends on the recipient's capacity for innovation (Rogers, 1995). Thus, among many other aspects, farmers' acceptance of innovation depends on their personal and social traits as well as the necessity for the innovation (Meijer *et al.*, 2015; Kamrath *et al.*, 2019).

2.8.1 Farmers' socio-economic characteristics

Socioeconomic characteristics (age, education, farming experience, family size, family labor, sources of income and credit), farm characteristics (farm size, land size, herd size, farm production, management, and technological levels), and farmers' wealth have been linked to decisions to adopt or reject technologies (Garcia *et al.*, 2012). On the same note, Christian *et al.*, (2019) in a study on the adoption of irrigation systems, acknowledge that factors that may affect the adoption of irrigation include the farmer's age, the size of their family, and their access to financing, their contacts with extension officers, and their involvement in a farming/farmers' group.

The findings revealed that an increase in technology usage is correlated with an increase in the age of the household head. These findings are very similar to those of Daniel (2011), Salome & Rotimi (2013), who found that age played a significant role in the decision of the household head to accept new technology. On the other hand, a study by Mattee & Gebreyes (2013) found that younger farmers are more innovative in their use of technology and are more inclined to take risks than older small-scale farmers.

A. Age

This variable represents the age of the farmer. According to Obi & Pote (2012), younger farmers are generally seen as having less technical knowledge compared to older farmers, who are believed to have accumulated more farming experience and resources. Farmers with higher levels of education are more likely to adopt new technologies due to their ability to understand and implement them.

Education also enhances farmers' access to information and their capacity to assess the benefits of technology adoption, leading to higher adoption rates among educated farmers. On the same note, an older farmer with a low level of education might prefer to stick to traditional methods of farming which may be related to the ability to judge opportunities to innovate. On the contrary, a well-experienced and well-resourced older farmer might be willing to try new technology. Unlike older farmers, younger farmers have greater flexibility in accepting new ideas and a high appetite for risks (Khapayi & Celliers, 2016).

B. Education Level

Education level is the number of years that the farmer spent in school. It is expected that a lack of education would hurt the agricultural technology (fodder seed technology) under study. Farmers with higher levels of education are more likely to adopt new technologies due to their ability to understand and implement complex innovations (Dhraief *et al.*, 2018). Education also improves farmers' access to information and their capacity to learn about new technologies, making them more receptive to change. Additionally, educated farmers are better equipped to assess the benefits of technology adoption and make informed decisions, leading to greater adoption rates compared to less educated farmers.

C. Family size

Family size refers to the number of individuals living in a household. Obi & Pote (2012) suggest that a larger household may lead to a higher dependency ratio, potentially affecting investment and savings. Conversely, a larger household could also mean more available labour, which can enhance farm production in communal agriculture's labour-intensive farming systems. There is an anticipation that larger families may have more available labour, which could facilitate the adoption of labour-intensive technologies. However, larger families may also face higher dependency ratios, limiting their ability to invest in technology. Smaller families, on the other hand, might have fewer labour resources but could be more flexible in adopting technologies that require less labour.

D. Farm income and source of income

Farm income and sources of income represent the total amount of money that a household receives in South African rands per month. Household income can come from social grants, remittances, non-farm income, fruit sales income, or a combination of these. According to Koshe (2022), higher-income households are more likely to participate in technology adoption, as compared with lower-income households, because the former would be able to hire labour or purchase farm inputs if they were constrained in these areas.

E. Farm size

Farm size is the land area of the farm, typically measured in hectares. The size of the farm is the most important part of agricultural production. However, it is not easy to increase the size of the land under production without increasing the labour. Farmers with larger land sizes tend to achieve higher production and income levels when there is an adequate supply of labour (Abrah, 2015). Farm size typically shows a positive association with technology adoption, as larger farms often possess greater resources and scale advantages to invest in and profit from advanced technologies. Nevertheless, small farms can also embrace technologies if they are cost-effective and provide evident advantages, affected by factors such as access to support services and the compatibility of the technology with the farm's size.

F. Farming experience

Farming experience refers to the number of years a person has been involved in farming. This experience is anticipated to positively influence farm employment, as experienced farmers tend to manage larger land holdings compared to those with less experience. Larger land sizes and higher production volumes typically necessitate more labour for farm operations (Nenngwekhulu, 2019).

G. Farmer's wealth

A farmer's wealth refers to the total value of assets (such as land, livestock, machinery, and savings) owned by the farmer. It represents the financial resources and assets that a farmer can use to support their agricultural activities and overall livelihood. Wealth also influences technology adoption in agriculture. Farmers who have larger financial resources of their own are likely to adopt innovations earlier (Yigezu *et al.*, 2018).

Farmers' annual turnover is a good proxy for wealth. It is often farmers with larger annual turnover that are more likely to adopt relatively new innovations. Wealthier farmers may be the first to try new technology because they can take risks, and likely have better access to extension information and their own cash resources to experiment with a new technique (Kahan, 2013).

Rogers (1995) outlined the "diffusion of innovations" theory which it is explains how innovations become adopted over time. Diffusion describes the method by which innovations spread over time among the members of a social system. An innovation might be a thought or notion, technical knowledge, or a real-world action that a person perceives as new. Rogers (1995) highlighted five factors, relative advantage, compatibility, complexity, trialability, and observability that affect how quickly an innovation is adopted.

Five stages make up the fundamental process of adopting an innovation: knowledge, persuasion, decision, implementation, and confirmation. Rogers (1995) proposed that an individual's capacity for creativity influences when they embrace a new idea and identified five groups of successive adopters: innovators, early adopters, early majority, late majority, and laggards. The adoption process is also affected by the so-called receiver variables, such as personality characteristics, social characteristics, and the perceived need for innovation (Meijer *et al.*, 2015).

There exists a vast literature on factors that determine agricultural technology adoption. According to Loevinsohn *et al.*, (2013), farmers' decisions about whether and how to adopt new technology are conditioned by the dynamic interaction between characteristics of the technology itself and the array of conditions and circumstances. Diffusion itself results from a series of individual decisions to begin using the new technology, decisions which are often the result of a comparison of the uncertain benefits of the invention with uncertain costs of adopting it. An understanding of the factors influencing this choice is essential both for economists studying the determinants of growth and for the generators and disseminators of such technologies.

2.9 Challenges in Adopting Fodder Seed Technologies among small-scale Farmers in Africa

The adoption decision is a dynamic process involving changes in the farmer's perceptions and attitudes. The decision of whether to adopt a new technology is based on a careful evaluation of several technical, economic, and social factors associated with the technology (Manyeki *et al.*, 2013). The lack of adoption could be related to failure of the technology for technical or socio-economic reasons, that is the technology did not live up to expectations and/or was not targeted at the appropriate production system (Kebede *et al.*, 2016).

Adoption of a pasture improvement technology refers to the use of technology for one and/or more than one year, on the other hand, non-adoption of technology refers to not using these technologies or using them for less than one year (Robert *et al.*, 2020). Manyeki *et al.*, (2013) assert that the rate of adoption is the relative speed with which members of a social system utilize an innovation and can be measured as the number of individuals who utilize a new technology within a specified period (Robert *et al.*, 2020).

According to Balehegn *et al.*, (2022), a lack of understanding of the importance of proper forage conservation as well as a lack of knowledge and skills to do so are frequent causes of the low level of forage conservation adoption among small-scale producers in Sub-Saharan Africa. Other causes include a lack of access to resources such as equipment for precise cutting and baling, suitable silos, land for forage production, and conducive weather conditions (Muinga *et al.*, 2015).

Against the literature presented above, small-scale farmers in South Africa face several challenges when it comes to adopting new fodder seed technologies. One of the main obstacles is the lack of access to quality seeds and information about modern farming practices. Many small-scale farmers rely on traditional methods and have limited awareness of the potential benefits of improved fodder seed varieties (Senyolo *et al.*, 2021). In addition, there are often logistical challenges in rural areas where most small-scale farmers are operating, such as limited access to transportation and marketplaces for selling surplus fodder. This can make it difficult for farmers to access and utilize new technologies effectively (Mpandeli & Maponya, 2014).

Balehegn *et al.*, (2022) also note that limited labor availability, financial constraints, and poor access to markets for the saved fodder are other factors contributing to the low adoption of fodder seed technology. Along the same line, Khapayi & Cellier (2015) note that small-scale farmers often struggle to afford the upfront costs of purchasing high-quality seeds and may be hesitant to take on additional financial risk without a guarantee of increased yields.

The lack of knowledge and technical skills required to effectively use fodder seed technologies presents a significant barrier. Other issues encompass the general shortage of conservable forage, stemming from the lack of breeding programs prioritizing optimal forages for livestock, instead focusing on dual-purpose forages. Additionally, there is a notable absence of farmer participation in improved forage research and insufficient extension support, as highlighted by Balehegn *et al.*, (2022).

Additional factors socioeconomic factors (age, dependency ratios, literacy levels, years of formal education, livestock ownership, access to other productive resources, and the degree of poverty, socioeconomic status, and aspiration) have all been identified as demographic determinants. Institutional factors (familiarity with a practice, prior farming experience, training, financial motive, inventiveness, information source and use, agent credibility, and adoption) (Hanyani-Mlambo, 2017).

Social scientists studying farmers' adoption patterns have gathered a lot of data demonstrating how factors including demographics, technology traits, information sources, knowledge, awareness, attitude, and group influence impact adoption patterns (Oladele, 2005). Motshekga (2022) notes that improved forages provide several benefits which include social benefits by improving the welfare of individuals, households, communities, and entire countries.

Improved forages can generate a variety of economic benefits, including improved soil quality, increased water infiltration, and lower fertilizer requirements. Improved livestock feeding and forages have previously been highlighted as a triple-win strategy toward achieving climate-smart agriculture (CSA), increasing food security and resilience, and decreasing Green House Gas emission intensities (Thorntorn *et al.*, 2015). The adoption of introduced forages in tropical developing countries has been limited due to a lack of evidence of economic profitability or inadequate technical support, such as seed availability (Motshekga, 2022).

Poor rates of adoption for improved forage technologies have been reported in most parts of Sub-Saharan Africa (SSA) where they were introduced in Malawi (Kumwenda & Ngwira, 2003); Ethiopia (Gebremedhin *et al.*, 2003); Central Kenya (Mwangi & Wambugu, 2007); Zimbabwe (Mapiye *et al.*, 2006) and in Tanzania (Ndah *et al.*, 2017). In general, the adoption of resource conservation technologies is influenced by the features of the proposed technology, farmers' perceptions of its needs and benefits, and the availability and distribution of production factors (e.g., land, labour/time, capital, knowledge, skills, etc.). Important variables also include the policy environment, institutional support and knowledge sharing, and farmers' attitudes toward risk and experiments (Senyolo *et al.*, 2021).

Chapter Three

Research Methodology

3.1 Introduction

This section discusses the research methodology by explaining the description of the study area. The study further highlights the sampling frame, sampling procedure, sample size, methods of data collection, and data analysis.

3.2 Description of the study area

The study was conducted in the OR Tambo District Municipality, located in the Eastern Cape province of South Africa. The Eastern Cape is one of the country's largest regions, covering an area of 168,966 km². It was established in 1994, primarily from Xhosa-speaking areas of the former Transkei and Ciskei homelands. With a population of 6,562,053, the Eastern Cape accounts for 12.7% of South Africa's total population, making it the third most populous province after Gauteng (23.7%) and KwaZulu-Natal (19.2%) (Hlomendlini, 2015; Mdoda & Obi, 2019). The province is predominantly rural, with agriculture, tourism, and formal employment serving as the primary sources of income for most people.

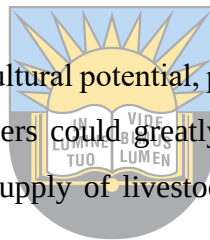
Geographically, the Eastern Cape is positioned between the sub-tropical climate of KwaZulu-Natal and the Mediterranean climate of the Western Cape. It experiences a bimodal rainfall pattern, with the western part receiving winter rain and the eastern part receiving summer rain. Due to these diverse weather conditions, the growing seasons vary across the province. The climate is ideal for agricultural production, particularly the cultivation of perennial and horticultural crops, as well as the raising of livestock (including ruminants and monogastric). Most of the region's inhabitants are small-scale farmers who rely on farming as their main source of income (Mdoda & Obi, 2019).

The Eastern Cape province is also one of the poorest provinces in South Africa, with high levels of poverty exacerbated by rising unemployment and limited economic opportunities. The situation is worse in the former homeland areas of this province where very few improvement efforts have been successful, such as introducing irrigation schemes for small-scale farmers, have had limited success. The province has a significant number of small-scale farmers engaged in both livestock and crop production, with many keeping sheep, goats, and cattle for livelihood purposes (Petronella, 2015).

The Eastern Cape is one of the top three provinces in South Africa with the highest number of small-scale farmers, particularly in livestock farming. Many of these farmers manage large herds of indigenous cattle, sheep, and goats. The province's vast tracts of land are well-suited for livestock grazing, but much of this land, especially under communal management, suffers from overgrazing (Koshe, 2022).

Agriculturally, the Eastern Cape is South Africa's leading livestock province, housing one-fifth of the country's cattle, a quarter of its sheep, and nearly half of its goats. The province also produces a quarter of the nation's milk supply. Wool-producing merino sheep and mohair-producing Angora goats are particularly successful in the interior regions. Other significant agricultural products include deciduous fruit from the Langkloof, citrus fruits around Addo, Kirkwood, and Fort Beaufort, and chicory from Alexandria, which forms the important components of the province's farming mix. Pineapple farming is common in the Cacadu district, while sugarcane is grown along the northern border of the province in North Pondoland (Petronella, 2015).

Given the Eastern Cape's strong agricultural potential, particularly in livestock farming, fodder seed technology for small-scale farmers could greatly enhance livestock productivity. This technology would ensure a reliable supply of livestock feed, especially during dry seasons when natural forage is scarce.



University of Fort Hare
Together in Excellence

Figure 3.1 below presents a conceptual framework of factors that determine the knowledge, attitudes, practices, and willingness to pay for an agricultural technology which in this study is fodder seed technology in South Africa.

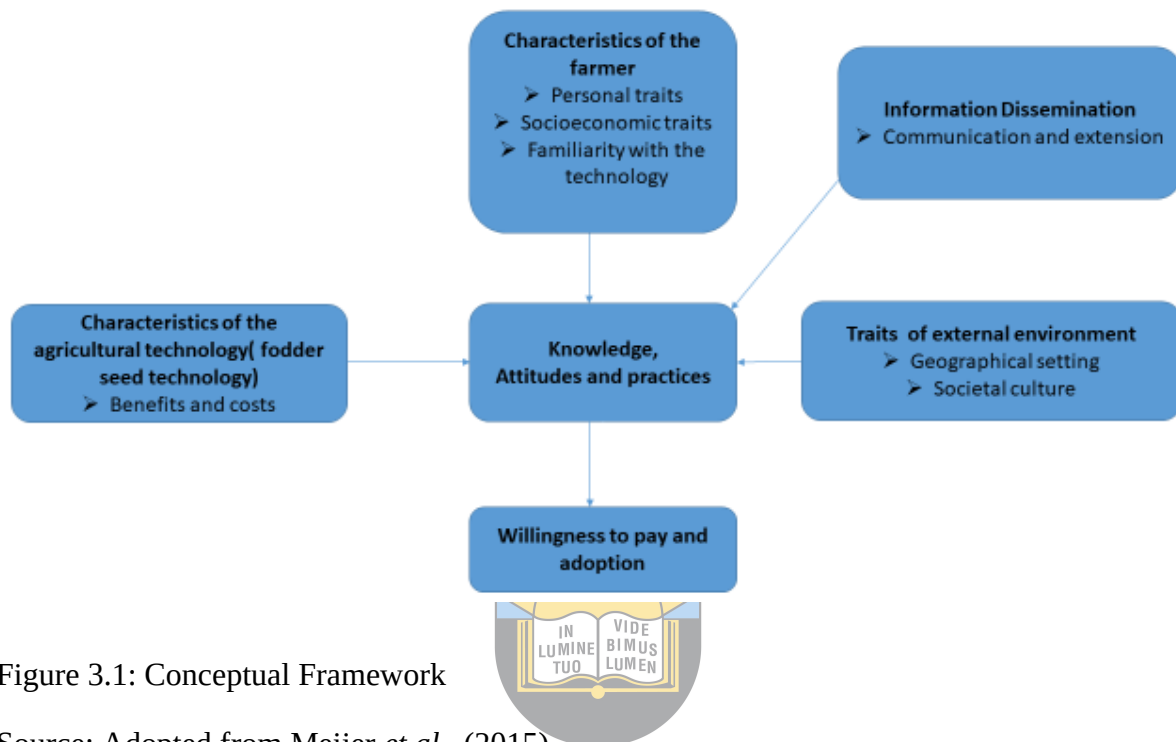


Figure 3.1: Conceptual Framework

Source: Adopted from Meijer *et al.*, (2015)

A complete idea of the adoption process could not be provided by using a single theory to analyse decision-making since the adoption of technology is a complicated nonlinear process that is influenced by many factors, including the user's qualities and the technology itself. Therefore, a thorough understanding of the adoption process cannot be supplied by applying a single theory to examine the decision-making.

The elements mentioned above might enhance farmers' understanding of an agricultural innovation as well as their attitudes and behaviours toward it. For instance, the dissemination of information may keep farmers informed about recent developments in the agricultural sector. This consequently encourages farmers to adopt the technology and pay for it. It is necessary to have a thorough framework that considers how different aspects interact while making decisions.

The study provided a conceptual framework (Figure 3.1) considering all the variables that could affect the adoption of new technologies. This framework consisted of four linked factors (characteristics of the agricultural technology, characteristics of the farmer, and traits of external environment and information dissemination) that may interact to influence positive knowledge, attitudes, and practices toward fodder seed technology. Therefore, the use of this conceptual framework allowed the researcher to explain the main factors that were likely to affect the knowledge, attitudes, practices, and willingness to pay for fodder seed technology.

Knowledge refers to farmers' awareness of the technology, shaped by education, experience, and access to information. Positive attitudes reflect farmers' perceptions of the technology's benefits, influenced by factors like risk tolerance and perceived ease of use. Practices involve the actual application of the technology, driven by the farmers' knowledge and attitudes. Finally, WTP reflects farmers' financial commitment, determined by affordability, perceived benefits, and access to credit. Together, these factors interact to explain technology adoption.

3.2.1 Climatic Conditions of the Eastern Cape Province

The Eastern Cape is a province in South Africa that lies between Kwa-Zulu Natal and the Western Cape provinces, and its climate is a cross between the two. The province's western region, the Karoo region, has long, hot summers and mild winters. The Great Escarpment, which stretches high on the eastern side of the province toward Lesotho, is often covered in snow during the winter months in the Free State. The province has a bimodal precipitation pattern, with winter rainfall in the west and summer rainfall in the east, leading to varying growing seasons across the province.

The climatic conditions mentioned above are favourable for agricultural production, particularly for crops, vegetables, citrus fruits, and livestock such as cattle and sheep. The province's coastal cities have a subtropical and Mediterranean climate, whereas the inland is slightly hotter. The region is vast, stretching from the coast to more mountainous escarpment regions inland, resulting in a highly variable climate. Inland weather is typically hotter and drier, with lower rainfall levels than along the coast. The province has a high level of annual sunshine, with temperatures ranging from 16 to 26 degrees Celsius in the summer and 7 to 20 degrees Celsius in the winter (Koshe, 2022).



Figure 3.2: Eastern Cape Province map

Source: Maps of the World (2015).

3.2.2 OR Tambo District Municipality

The OR Tambo District Municipality (ORTDM) is one of the poorest districts in South Africa, it is situated along the wild coast and includes a larger chunk of the old Transkei homeland territory of the Eastern Cape Province (OR Tambo District Municipality, 2020; Taruvinga *et al.*, 2023). According to OR Tambo District Municipality (2020), the district is a Category C2 municipality that is predominately rural. It is located along the wild coast, bordered to the West by Amathole District Municipality while sharing a common border with the KwaZulu Natal province to the Northeast.

The OR Tambo district municipality is comprised of five local municipalities, namely, Nyandeni, King Sabata Dalindyebo, Port St Johns, Ingquza Hill, and Mhlontlo. The district measures 15 947 km² in extent with a varied terrain ranging from rolling valleys to broken mountainous ranges and a varied climate that responds to the elevation and distance from the sea (OR Tambo Integrated Development Plan [IDP], 2022). With an estimated 1.51 million residents OR Tambo District is thought to be the province's most densely populated district (123 people per square kilometer) (OR Tambo District Municipality, 2020).

According to Ngumbela *et al.*, (2020), the district has high rates of poverty, underdevelopment, and infrastructural backlogs. The district has a low rate of urbanization (9.24%) and a predominantly black population (90.22%) who live on tribal territory. The OR Tambo municipality is the only district that receives more rainfall than any other municipality in the Eastern Cape Province because of its geographic location. Inland areas receive little rainfall; hence, they may be targeted for biofuel production.

Given that the OR Tambo District has a diverse climatic environment that responds to elevation and distance from the Indian Ocean, high rainfall areas (Port St. Johns), average rainfall areas (Ingquza Hill), and low rainfall areas (King Sabata Dalindyebo) of the district were purposely chosen to provide a diverse climatic environment (OR Tambo District Municipality, 2020). The varying climatic conditions experienced by small-scale livestock farmers could lead to differing reactions to fodder scarcity, potentially resulting in the need for supplemental feed during dry seasons, which could be provided by planting fodder.

3.2.3 OR Tambo District agricultural potential

Briefly, farming in the OR Tambo district municipality is predominantly subsistence in communal lands. Cheteni (2014) notes that the area is favored by moderate temperatures that are ideal for farming rain-fed crops like maize, potatoes, and others. The OR Tambo district is endowed with a vast ocean line which creates a good climate for a thriving agricultural economy as well as the potential to unlock the ocean economy (OR Tambo IDP, 2022). Its suitable terrain and numerous river valleys provide irrigable land, plentiful water resources, large tracts of grazing land, suitable pasture species for stock grazing, and many stocks owned by rural communities.

The district has the most abundant natural resources, the most fertile soils, and the most favourable climatic conditions. However, farming practices are intensive, despite being climate dependent. The district has a wide range of vegetation types, including grasslands, thickets, forests, and bushveld (Nkamisa *et al.*, 2021). The availability of various vegetation types could create opportunities for diverse agricultural activities, including grazing for livestock in grasslands, cultivation of crops in fertile soils of forests, and utilization of bushveld for agroforestry or wildlife management.

Figure 3.3 shows the local municipalities of OR Tambo district municipality.

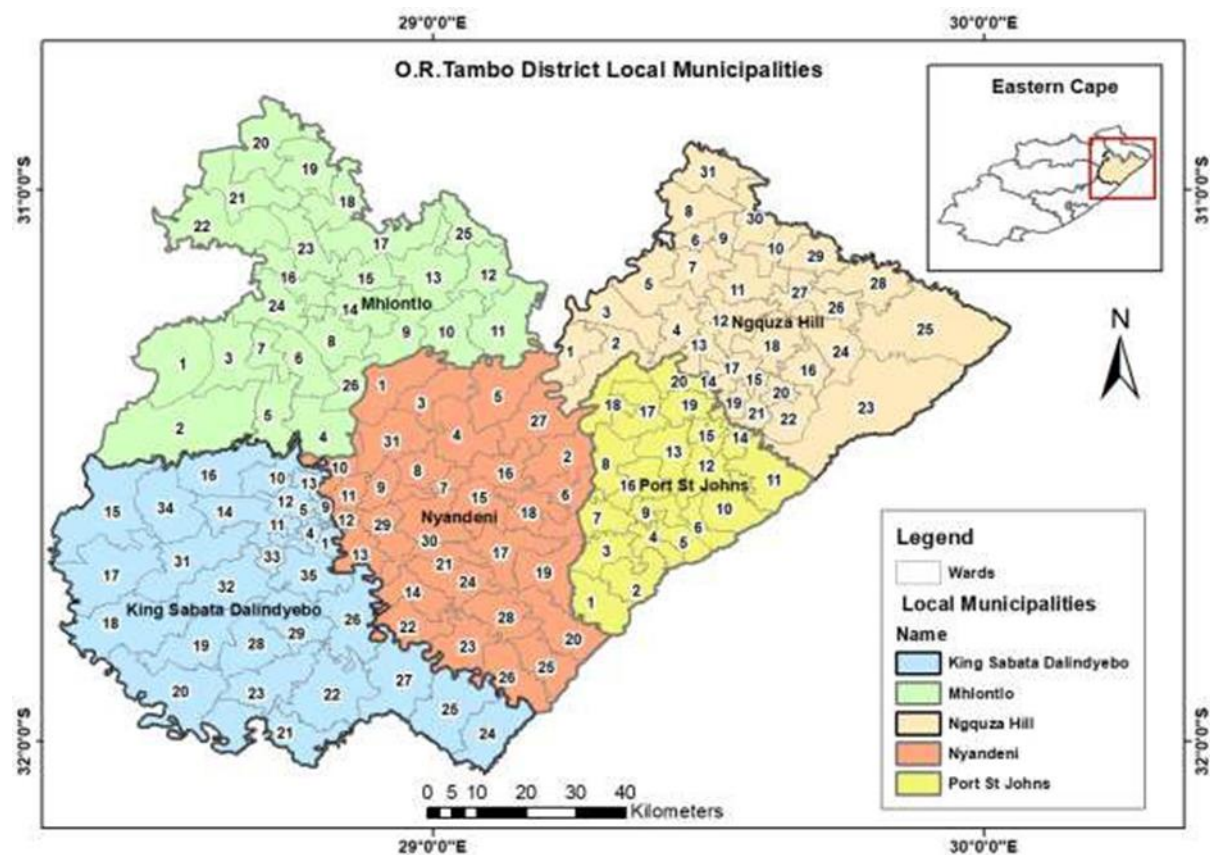


Figure 3.3: OR Tambo District Local Municipalities map

Source: ArcGIS

University of Fort Hare
Together in Excellence

3.2.4 OR Tambo District climatic conditions

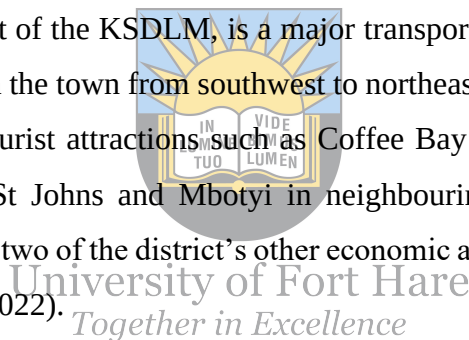
The OR Tambo district experiences a warm and temperate climate, with mostly frost-free conditions throughout the year. The region enjoys abundant sunshine annually, with summer temperatures ranging from 16°C to 28°C and winter temperatures from 7°C to 20°C. The winter season extends from April to August, while the summer temperatures peak between November and April. The district experiences all four seasons summer, winter, spring, and autumn each marked by varying weather conditions, including hot, cool, mild, windy, and cold periods (Nkamisa *et al.*, 2022).

According to the ARC (2020), the OR Tambo district experiences a median annual rainfall typically between 800 and over 1000 mm. This climate is generally favourable for rain-fed arable farming, provided that the terrain and soil conditions are suitable. The region sees a moderate peak in rainfall during the summer, with the rainy season beginning in September. The heaviest rainfall occurs in November and December, while the driest period spans from May to August.

3.2.5 King Sabata Dalindyebo Local Municipality

The King Sabata Dalindyebo Local Municipality (KSDLM) is one of the five local municipalities in the ORTDM in South Africa's Eastern Cape province. The KSDLM is a Category B local municipality, with an area of 3 028 km². It is the largest of the five municipalities in the district, accounting for a quarter of its geographical area (Mahlombe, 2018). Most of the municipality's population lives in rural areas, where they practice cultural customs.

Mthatha, located in the heart of the KSDLM, is a major transport and regional service center, with the N2 running through the town from southwest to northeast. Mthatha is a popular stop-over point on the way to tourist attractions such as Coffee Bay and Hole-in-the-Wall in the KSDLM, as well as Port St Johns and Mbotyi in neighbouring local municipalities. The municipality is also home to two of the district's other economic activities, namely forestry and agriculture (KSDLM IDP, 2022).



The King Sabata Dalindyebo local municipality has a variety of climatic conditions and topography throughout the year. Mqanduli is the tropical region and Mthatha is a temperate climate region, both of which play an important role in and contribute to the diversity of agricultural production in the municipality, which includes beekeeping, beef farming, dairy farming, crop farming, wool farming, forestry and fishing, tropical and deciduous fruits (KSDLM IDP, 2022).

According to KSDLM IDP (2022), the local municipality is made up of small-scale land-use farming, which is widely associated with clearing natural vegetation for agricultural purposes such as crop and livestock farming, as well as veld burning for grazing purposes, and occurs without formal control. Farmers have access to communal land, which is typically used for farming and forestry activities. As much as the municipality has diverse climatic conditions, climate change and variability change these climatic conditions, either positively or negatively, affecting agricultural potential in the municipality.

Climate change and variability change suitable places for growing certain crops to crops that were previously suitable in such regions, as well as changing crop and livestock species habitation. Other sectors that contribute to the municipality's economic growth include forestry, ocean economy, tourism, manufacturing, agro-processing, construction, wholesale & retail, transport & communications, finance & business services, and general government services (KSDLM IDP, 2022).

The King Sabata Dalindyebo Local Municipality had a total Gross Domestic Product (GDP) of R 33 billion, or 66% of the national average (Municipal Turnaround Strategy [MTAS], 2023). This indicates that the municipality plays a significant role in the economy of the Eastern Cape province and, by extension, South Africa. For the Eastern Cape province, this implies that the KSDLM is a major contributor to the provincial economy.

The municipality's GDP likely has a considerable impact on employment, investment, and economic growth within the province. It may also reflect the economic activities and industries that are prominent in the area, which can inform policy decisions and development strategies for the province. On a national level, the municipality's GDP contributes to South Africa's overall economic output. A municipality with a GDP that is 66% of the national average indicates a significant economic presence within the country. This can influence national economic policies, resource allocation, and development priorities.

In terms of total contribution to the GDP of the OR Tambo District Municipality, the KSDLM is ranked first among all regional economies contributing to the GDP of the OR Tambo District Municipality (KSD Annual Report, 2023). The economic strength of the municipality could result in improved infrastructure, services, and resources, which could have an impact on the agricultural environment. For small-scale livestock farmers, this economic context becomes crucial, as it could impact farmer's access to resources and their adoption of innovative technologies.

Additionally, the farmers' attitudes and practices may be shaped by the economic stability within the region. The willingness to pay for fodder seed technology, a key aspect of the study, is likely to be influenced by the farmer's financial capacity, which can be closely tied to the overall economic health of the municipality.

3.2.6 Port St Johns Local Municipality

The Port St Johns (PSJ) Local Municipality (Area: 1 291km²) is a Category B municipality on the coast of the Indian Ocean in the rural province of the Eastern Cape province. The municipality is bounded to the north by Lusikisiki, to the south by Mthatha, and the west by Libode. Also, the municipality is the smallest of the district's five municipalities, accounting for 11% of its total land area, and consists of coastal and inland areas governed by the former Transkei (Bontsa *et al.*, 2023).

The municipality's seat is in Port St Johns, which is known for its beautiful beaches and mountainous terrain, hills, cliffs, and sandy dunes. The main city or town in Port St Johns' local municipality is Port St Johns, and the main economic sectors are tourism and agriculture. Agriculture accounts for 1.4% of Gross Value Added (GVA) in PSJ. Agriculture employs 47.0% of households in Port St. Johns, with a higher employment rate of 5.4% (ECSECC, 2017).

The above figures suggest a scenario where agriculture, although not a dominant economic force, serves as a significant source of livelihood for a considerable portion of the population. Understanding the knowledge base, attitudes, and practices of small-scale farmers becomes crucial, especially given the notable reliance on agriculture for household employment. Moreover, the willingness to pay for fodder seed technology may be influenced by the economic and employment dynamics within the agricultural sector in PSJ.

Port St Johns has a subtropical climate that is ideal for vegetable cultivation in both the winter and summer seasons. The city of PSJ receives approximately 990 mm of rainfall per year, the majority of which falls during summer. The municipality receives the least rainfall (about 17 mm) in June and the most (about 136 mm) in March per annum. The combination of mountains and sea creates its temperate zone, with temperatures rarely falling below 14 degrees Celsius (Betek & Jumbam, 2015).

The average temperature and precipitation for PSJ are shown in Figure 3.4.

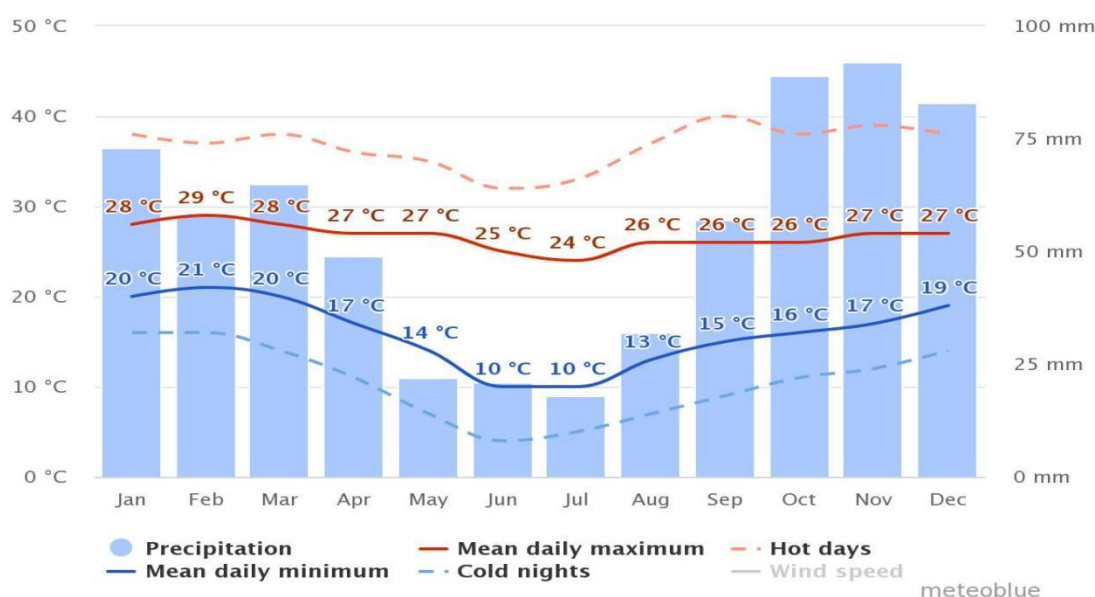


Figure 3.4: Average temperature and precipitation for Port St Johns

Source: Meteoblue Weather (2023).

3.2.7 Ingquza Hill Local Municipality

The Ingquza Hill local municipality, formerly known as Qaukeni local municipality, is a Category B municipality (area: 2 477km²) in the Eastern Cape province of OR Tambo District. It is bounded to the north by the Ntabankulu and Mbizana local municipalities, and to the south by the Port St Johns Local Municipality and the Indian Ocean. Ingquza Hill is one of the district's five municipalities, accounting for nearly a quarter of its total land area. Agriculture accounts for 2.0% of the municipality's Gross Value Added (GVA) (ECSECC, 2017). In the municipality, agriculture employs 53.9% of households and has a 4.1% employment rate (Bontsa *et al.*, 2023).

The three local municipalities (KSD, PSJ, and ILM) are chosen due to their notable agricultural significance, with a substantial contribution to the regional and national economy through livestock farming. The variability in economic conditions, demographic characteristics, and geographical features among these municipalities provided a diverse landscape for examining the factors influencing small-scale livestock farmers. Additionally, the choice aligns with potential differences in livelihood patterns and exposure to specific agricultural policies or interventions, offering a comprehensive understanding of adoption patterns.

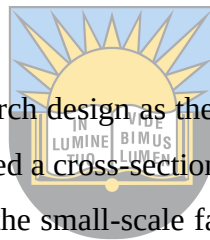
Proximity and established community engagement opportunities in these areas further facilitate effective communication with farmers, ensuring the research is grounded in the local context. Ultimately, by focusing on King Sabata Dalindyebo, Port St Johns, and Ingquza local municipalities, the research aimed to generate insights that are not only academically valuable but also practically relevant for policymakers, extension services, and the small-scale farming communities in these dynamic agricultural settings.

3.3 Research Approach

The study used a quantitative research approach. The quantitative research approach is a systematic and objective procedure that helps to describe and assess the relationships and examines the cause and effect of relationships among variables (Muzerengwa, 2017). This approach was chosen because of its strength in numerically describing the phenomenon under study. It can also be used to assess the strength of correlations between two variables (Bese & Cheteni, 2021).

3.3.1 Research design

Mweshi & Sakyi (2020), define research design as the discipline of how to plan and conduct empirical research. The study employed a cross-sectional research design, using primary data. Questionnaires were administered to the small-scale farmers through face-to-face interviews. As part of the cross-sectional survey research strategy, this was done through gathering primary data.



University of Port Harcourt
Together in Excellence

Interviews focused more on the small-scale farmer's socioeconomic and demographic characteristics, as well as information on KAPs and willingness to pay for fodder seed technology. Data from a population that was gathered at one point in time is used in cross-sectional study designs (Busk, 2014). For, the study, the data was collected at one point in time, hence the cross-sectional research design.

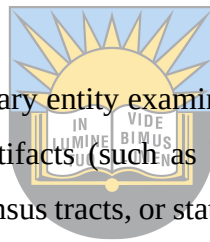
3.3.2 Ethics

Ethical clearance was obtained from the University of Fort Hare's Research Ethics Committee (UREC) with reference number MAY031STOK01. The study involved human participants; therefore, ethical approval was required to ensure the participants' safety and protection. Informed consent to participate in the study was signed by the participants and the researcher. The objectives of the study were clearly articulated in the informed consent and the respondents were informed that their privacy, anonymity, integrity, and confidentiality would be maintained.

The respondents were informed of their voluntary participation and the fact that they could withdraw from participation, should there be a need, without any fear of reprisal. Privacy and confidentiality were carefully maintained. After data was collected, administered questionnaires were kept in a secured cabinet and locked room to protect the participant's information.

3.3.3 Unit of analysis

The unit of analysis refers to the primary entity examined in a study (Bless *et al.*, 2011). This could include individuals, groups, artifacts (such as books, photographs, and newspapers), geographical locations (like towns, census tracts, or states), or social interactions. In this study, the main units of analysis were small-scale livestock farmers, from whom the primary data was collected



University of Fort Hare
Together in Excellence

3.4 Sampling strategy and sample size

3.4.1 Sampling strategy

Sampling involves selecting a subset of individuals from a larger population for closer examination using either probabilistic or non-probabilistic methods (Mweshi & Sakyi, 2020). The Eastern Cape province was specifically chosen for this study due to its leading position in livestock production in South Africa. The province represents 30% of agricultural households engaged in livestock farming and is home to over 60% of the country's small-scale farmers (Stats SA, 2016).

This study specifically targeted small-scale livestock farmers. The OR Tambo District Municipality was chosen because of its significant livestock farming activities and its crucial role in enhancing farmers' livelihoods, improving food security, and increasing farm revenues (Christian *et al.*, 2019; Mdoda *et al.*, 2022).

A purposive sampling technique was employed to select both participants and non-participants of fodder seed technology among small-scale livestock farmers. This method is appropriate for exploratory studies and focuses on gaining in-depth insights into farmers' knowledge, attitudes, practices (KAPs), and willingness to pay for the technology (Mweshi & Sakyi, 2020). In purposive sampling, units are selected based on specific criteria relevant to the study's objectives (Singh & Masuku, 2014). Farmers from each local municipality were assembled in a hall for interviews. While purposive sampling has the potential to result in sampling bias due to its non-random nature, to reduce bias and ensure a more representative sample, efforts were made to include a diverse range of farmers from each local municipality. Farmers from different age groups, genders, and farming experiences were selected. Additionally, meetings with farmers were organized in accessible community halls where both male and female farmers were encouraged to participate. Extension officers played an important role in identifying farmers from various socio-economic backgrounds and demographic groups. These measures helped to reduce selection bias and ensured that a variety of perspectives were included in the study, improving the overall representativeness of the sample.

3.4.2 Sample size

The sample size is carefully chosen as the number of individual cases for the study to yield information that will represent the entire population. If the sample is well chosen, then the sample statistics or characteristics will come closer to the entire population parameters or characteristics. Sample size determination is the technique of selecting the number of observations to include in a sample.

The sample size is an important feature of any study or investigation in which the aim is to make inferences about the population from a sample. In general, the sample size used in a study is determined based on the cost of data, collection and based on sufficient statistical power (Singh & Masuku, 2014). To determine the sample size, the study used the Cochran Formula (Cochran, 1977) as presented in the equation below.

$$n = z^2 \cdot p \cdot \frac{1-p}{e^2}$$

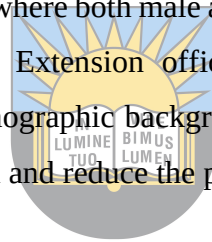
$$n = (1.96)^2 \cdot (0.05) \cdot \frac{1-0.05}{(3.48)^2} = 151$$

Where:

- n = sample size,
- p = the population proportion
- e = acceptable sampling error,
- z = z value at reliability level. The reliability level is 95% therefore $z = 1.96$

Therefore, the total number of small-scale livestock farmers that were used for the study is 151. The sample size was determined using Cochran's formula, which considers the population proportion, acceptable sampling error, and reliability level. Although the exact population size of small-scale livestock farmers was not known, the sample size was designed to be representative of the livestock farming communities within the selected local municipalities.

To ensure diversity and inclusivity, the selection of farmers was carried out with careful attention to gender, age, and other demographic characteristics. Community meetings were organized in the three municipalities, where both male and female farmers, across different age groups, were invited to participate. Extension officers for each community assisted in identifying farmers from various demographic backgrounds, ensuring that the sample would reflect the broader farming population and reduce the potential for biases.



University of Fort Hare
Together in Excellence

The table below shows the distribution of the farmers across the three local municipalities.

Table 3.1: Distribution of the farmers across the local municipalities selected

OR Tambo local municipalities selected	No. of selected farmers
King Sabata Dalindyebo	39
Port St Johns	51
Ingquza Hill	61
Total	151

Source: Author's compilation from a field survey data

Table 3.1 represents the distribution of small-scale livestock farmers across the three municipalities. King Sabata Dalindyebo had 39 farmers, Port St Johns had 51 farmers, and Ingquza Hill had 61 farmers. The distribution of farmers across the selected municipalities was designed to ensure that the sample accurately reflects the farming populations in these areas. Some farmers in the local municipalities were unavailable or difficult to reach due to logistical challenges, such as availability or scheduling conflicts. As a result, the sample was distributed based on the presence of small-scale livestock farmers in each area, with efforts made to ensure that the sample remains as representative as possible given the constraints.

3.5 Data collection method

Data was collected from the farmers who were sampled using interviewer-administered semi-structured questionnaires, which involved asking written questions that small-scale farmers answered with the assistance of an interviewer. This method is more efficient and saves time compared to formal interviews.

The interviewer read each question to the respondents and recorded their answers. This approach also allowed for probing, reducing the likelihood of misinterpretations or misunderstandings of questions, as highlighted by Bless *et al.*, (2011). The questionnaire included both closed and open-ended questions, with most being closed-ended to gather detailed information quickly. The analysis of the responses indicated that some small-scale livestock farmers were using fodder seed technology, while others were not.

3.6 Analysis tools

The collected data was analysed using descriptive statistics, the KAP index, the ordered probit model, and the contingent valuation method (CVM). Distribution tables, percentages, and methods were among the descriptive statistics used. The socioeconomic, household, and agricultural aspects of farmers were presented using descriptive statistics. The Stata software was used for empirical analysis. The table below shows the research questions and analytical tools associated with each objective of the study.

Table 3.2: Analytical Framework

Objectives	Research questions	Analytical tools
To profile the small-scale based on their demographic and socio-economic characteristics to achieve objective three.	What are the demographics and socioeconomic characteristics of small-scale livestock farmers?	Descriptive statistics
To assess the KAPs of small-scale livestock farmers towards fodder seed technology.	What are the knowledge, attitudes, and practices of small-scale farmers towards fodder seed technology?	KAP index
To determine the relationship between small-scale livestock farmers' KAPs of fodder seed technology and their socio-economic characteristics.	What is the relationship between small-scale livestock farmers' KAPs of fodder seed technology and profiling their socio-economic characteristics?	Ordered Probit Model
To examine small-scale livestock farmers' willingness to pay for fodder seed technology and their determinants.	Are small-scale livestock farmers willing to pay for fodder seed technology, and what are the determinants for willingness to pay?	Contingent Valuation Method Binary Logistic Regression Model

Source: Authors' Compilation (2023)

3.6.1 Descriptive statistics

Descriptive statistics are used to summarize data in an organized manner by describing the relationship between variables in a sample or population. Calculating descriptive statistics

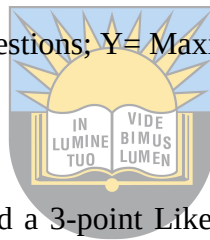
represents a vital first step when conducting research and should always occur before making inferential statistical comparisons. Descriptive statistics include types of variables (nominal, ordinal, interval, and ratio) as well as measures of frequency, central tendency, dispersion/variation, and position (Kaur *et al.*, 2018).

3.6.2 KAP index

The KAP index measures knowledge, attitude, and practices using a set of questions. The Knowledge, Attitudes, and Practices (KAP) index is a composite measure used to assess an individual's or a group's understanding, beliefs, and behaviours in a particular context. The construction of a KAP index involves assigning scores to responses related to knowledge, attitudes, and practices and then combining these scores into an overall index. To calculate the KAP index the study followed Farooq *et al.*, (2019) KAP index methodology, using this formula; $KAP\ Index = (\frac{X}{Y}) \times 100$ (1)

Where, KAP index: Knowledge, Attitude and Practice Index; X: scores achieved by respondents on knowledge, attitude and practice questions; Y= Maximum achievable scores

Knowledge Index (KI)



To measure knowledge, the study used a 3-point Likert Scale. Scored as follows: (1 = don't know; 0 = neutral/unsure; 3 = true); then scores were combined. For the sake of clarity, for each question, a valid response (true) was awarded one point, while a false response (false) or "don't know" and neutral received a zero point, this is like Islam & Islam's (2020) method.

- For each knowledge question, assign a score:
 - 1 point for correct (True)
 - 0 points for incorrect (False, don't know, or Neutral)
- Sum up the scores for all knowledge questions.
- Calculate the Knowledge Index:

$$KI = \frac{\sum \text{Knowledge Scores}}{\text{Maximum Possible Knowledge scores}} \times 100 \dots\dots\dots (2)$$

Attitudes Index (AI)

To measure attitudes, the study utilized a 5-point Likert scale. Scored: 5 means strongly agree, 4 means agree, 3 means neutral, 2 means disagree, and 1 means strongly disagree.

- For each attitude question, assign a score based on the Likert scale:
 - 5 points for Strongly Agree
 - 4 points for Agree
 - 3 points for Neutral
 - 2 points for Disagree
 - 1 point for Strongly Disagree

Farmers who agreed (4) or strongly agreed (5) to the statements were considered to have a positive attitude (equated to 1), while disagree, strongly disagree, and neutral were considered to have a negative attitude (equal to 0). This approach is like that of Chuang *et al.*, (2020) study in Taiwan exploring farmers' knowledge, attitude, and adoption of Smart Agriculture Technology. It is also like that of Ntawuruhunga *et al.*, (2020) used in a study in Kenya to assess farmers' knowledge, attitudes, and practices (KAP) on the production of African indigenous vegetables.

- Sum up the scores for all attitude questions.
- Calculate the Attitudes Index:

$$AI = \frac{\sum \text{Attitude Scores}}{\text{Maximum Possible Attitude scores}} \times 100 \dots \dots \dots (3)$$

Practices (PI)

To measure this variable, the researcher used a binary response. Denoting: 1 if the farmer uses fodder seed technology for growing supplementary feed and 0 if the farmer does not use fodder seed technology. This approach is like that of Ntawuruhunga *et al.*, (2020) used in a study in Kenya to assess farmers' knowledge, attitudes, and practices (KAP) on the production of African Indigenous vegetables

- For each practice-related question, assign a score:
 - 1 point if the farmer uses fodder seed technology.
 - 0 points if the farmer does not use fodder seed technology.
- Sum up the scores for all practice questions.
- Calculate the Practices Index:

$$PI = \frac{\sum \text{Practice Scores}}{\text{Number of Practice Questions}} \times 100 \dots \dots \dots (4)$$



3.6.3 Ordered Probit Model

Multiple response models are used when the number of alternatives that can be chosen is more than two. The models are developed to describe the probability of each of the possible outcomes as a function of personal or alternative specific characteristics. Ordered response models are applied where there exists an ordered or logical ordering of the alternatives. In this case, it was assumed that there exists an underlying latent variable that drives the choice between the alternatives. The results in this case were sensitive to how the alternatives are numbered.

The relationship between small-scale livestock farmers' KAP and socioeconomic characteristics was determined using an ordered probit model. Ordered probit is a generalization of the probit analysis to the case of more than two categorical outcomes of an ordinal dependent variable. Estimating the model using Ordinary Least Squares (OLS) would have yielded biased and inconsistent results; hence the maximum likelihood of the ordered probit model of the relationship between farmers' socioeconomic characteristics and their KAP.

The study estimated the three KAP models using the ordered probit model to determine the likelihood of greater knowledge, attitudes, or practices. For example, knowledge in the KAP

was formulated on a scale of 1–3, where 1= Know, 2= Not sure, and 3= Don't know, and it was categorized according to low, medium, and high. In other words, the dependent variables were the KAP categories where the scores are ordered taking on the values $\{0; 1; 2; \dots J\}$ for some known integer J , where larger values are assumed to correspond to higher knowledge KAP, correct attitudes KAP, and higher concerns about fodder seed technology KAP.

The ordered probit model for Y (conditional on explanatory variables X_i) can be derived from a latent variable model as follows:

$$Y_i^* = \beta X_i + \epsilon_i \text{ where } i = 1 \dots n \dots \dots \dots (1)$$

Y^* is unobserved, but what is observed are threshold values of Y (Wooldridge 2010), which in the present case would be:

$$Y = 0 \text{ if } Y^* \leq 0$$

$$Y = 1 \text{ if } 0 < Y^* \leq 1$$

$$Y = 2 \text{ if } Y^* \geq 2 \dots \dots \dots (2)$$

- Y^* is the unobserved latent variable representing the overall KAP.
- X is a matrix of independent variables (socioeconomic characteristics of farmers).
- β is the vector of coefficients to be estimated.
- ϵ is the error term assumed to follow a standard normal distribution.

The ordered probit model assumes that the latent variable Y_i^* follows a normal distribution, and by specifying thresholds, you categorize the latent variable into ordered categories. The model estimates how changes in socioeconomic.

Table 3.3: Hypothetical variables used in the Ordered Probit Model

Variables	Description of variables	Type of Variable	Expected sign
<i>Farmer's socioeconomic characteristics</i>			
Age	Age of the farmer in years	Continuous	-
Gender	Gender of the farmer (Female=1, Male=2)	Nominal	-
Employment status	Unemployed=1, Employed=2, Self-employed=3, Other=4	Ordinal	+
Education level	1= No formal education, 2= Primary education, 3=Secondary education, 4= Tertiary education		+
Source of income	Old age pension=1, Child grant=2, Farm produce=3, Off farm wages/ salaries = 4, Other=5	Categorical	-
Estimated monthly income	South African Rands	Continuous	+
Full/Part-time farmer	Yes=1, No=2	Binary	-
Household size	Number of family members (headcount)	Discrete	+
Source of feed	1= Communal grazing land, 2= Crop residues, 3=Commercial feed, 4= Cut grass and browses, 5= Other (Planted forage), and 6= Combination	Categorical	+
Arable land	1= >0.5-hectare, 2= 0.5-1-hectare, 3= 1.5-2 hectares, and 4= >2 hectares	Continuous	+
Sources of agricultural information	1= Extension Officer, 2=Neighboring farmers, 3= research stations, 4= social media, 5=Other (Traditional knowledge), and 6= Combination	Categorical	+
Extension officer interaction	1= Yes and 2= No	Binary	+
Fodder seed technology Knowledge	1=Low knowledge, 2= Medium knowledge, and 3=High knowledge	Ordinal	+
Fodder seed technology Attitude	1=Negative attitude, 2=Neutral attitude, and 3= Positive attitude	Ordinal	+
Fodder Seed Technology Practice	1=Low practice level, 2= Medium practice level, and 3=High practice level	Ordinal	+

Source: Researchers' compilation (2023)

3.6.3.1 Mathematical representation of the ordered probit model

In this study, the dependent variables of the farmer's KAP (Knowledge, Attitudes, and Practices), were placed in three categories for each of the aspects. An ordered probit model was used to determine the relationship between farmer's socioeconomic characteristics and KAP. To develop an ordered probit model where the dependent variable is KAP (Knowledge, Attitudes, and Practices), each with three categories, the researcher constructed separate ordered probit models for each aspect (Knowledge, Attitudes, Practices). Below are the mathematical expressions for these models.

Knowledge

The latent variable K_i^* is determined by the socioeconomic characteristics X_i :

$$K_i^* = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik} + \epsilon_i \dots \dots \dots (6)$$

Knowledge Index = f(age, gender, education level, household size, employment status, farm size,

estimated monthly income

The observed knowledge category K_i is related to K_i^* through threshold parameters μ_1 and μ_2 :

$$K_i = \begin{cases} \text{Low} & \text{if } K_i^* \leq \mu_1 \\ \text{Medium} & \text{if } \mu_1 < K_i^* \leq \mu_2 \\ \text{High} & \text{if } \mu_2 < K_i^* \end{cases} \dots \dots \dots (7)$$

Attitudes

The observed latent variable A_i^* is determined by socioeconomic characteristics X_i

$$A_i^* = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik} + \epsilon_i \dots \dots \dots (8)$$

The observed attitude category A_i is related to A_i^* threshold parameters γ_1 and γ_2 :

$$A_i = \begin{cases} \text{Negative} & \text{if } A_i^* \leq \gamma_1 \\ \text{Neutral} & \text{if } \gamma_1 < A_i^* \leq \gamma_2 \\ \text{Positive} & \text{if } \gamma_2 < A_i^* \end{cases} \dots \dots \dots (9)$$

Attitude Index = f(age, gender, education level, household size, employment status, farm size,

estimated monthly income

Practices

The latent variable P_i^* is determined by socioeconomic characteristics X_i

$$P_i^* = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik} + \epsilon_i \dots \dots \dots (10)$$

The observed practice category P_i is related to P_i^* through threshold parameters δ_1 and δ_2 :

$$P_i = \begin{cases} \text{Low} & \text{if } P_i^* \leq \delta_1 \\ \text{Medium} & \text{if } \delta_1 < P_i^* \leq \delta_2 \\ \text{High} & \text{if } \delta_2 < P_i^* \end{cases} \dots \dots \dots (11)$$

$$\text{Practice Index} = f(\text{age, gender, education l, household size, employment status, farm size, estimated monthly income})$$

3.6.3.2 Description of Independent Variables

Age is a continuous variable measured in years, it can be used as a proxy for experience in farming (Ntshangase *et al.*, 2018).

Gender- in this study, gender indicates whether the farmer is male or female. Anang (2018) states that male farmers are more likely to adopt technologies. This is because most farming activities are carried out by men, while women often engage in non-farm activities. As a result, male farmers generally have more farming experience and better access to information about various agricultural technologies.

Education level refers to the number of years of schooling completed by the farmer. Rasanjali *et al.*, (2021) note that educated farmers are more likely to appreciate and benefit from modern technology. Such farmers also tend to seek out technical knowledge and information about agricultural technologies.

Source of income- this variable identifies the sources of a farmer's income. The greater the income, the more likely the farmer is to uptake agricultural technologies (Kamba & Muchapondwa, 2018). Non-farm income is also important, as farmers typically use their total income, regardless of its origin, to finance their farm activities.

The monthly income variable depicts the projected amount of money a household or individual earns every month from all sources, and it is measured in South African rands (ZAR).

Full/Part-time farmer- this determines whether the farmer is a full-time farmer or not. Farmers' occupations reveal the extent to which they dedicate their time to farming activities. Off-farm activities may hinder the adoption of technology as they compete for the time needed for on-farm management (Ndambiri *et al.*, 2013).

Household size in this study, household size is defined as the number of individuals residing in the respondent's household. Household size significantly impacts labour availability, influencing a household's decision to participate in various activities (Ndambiri *et al.*, 2013). Croppenstedt *et al.*, (2003) argue that larger households have a greater labour pool, making them more likely to adopt agricultural technologies compared to smaller households.

Source of feed- in this study sources of feed indicated the type of livestock feed sources that the farmers use. The main feed resources for grazing ruminants are pastures and crop residues, commercially formulated feeds. Amole *et al.*, (2022) note that in the Sahel, in addition to the rangelands, many livestock farmers depend on crop residues.

Arable land- this variable refers to the actual size of arable land in hectares used by the farmer concerning crop production. Bello *et al.*, (2013) note that the larger the farm size, the more challenging the cultivation methods become, especially when the farmers rely on manual labour.

Sources of agricultural information- this variable pertains to the sources or carriers of information that fulfill the farmers' informational needs. According to Adio *et al.*, (2016), access to agricultural information enables farmers to adopt new technologies or farming systems, determine the optimal times for planting and harvesting, decide which crops to grow and which animals to rear, and identify where to sell their products.

Extension officer interaction- this variable indicates whether a farmer has contact with an extension officer. A binary variable was used to measure small-scale livestock farmers' access to extension services. Agricultural extension services provide farmers with essential knowledge (Kuehne *et al.*, 2017). Access to these services can greatly enhance farmers' awareness of agricultural technologies (Sennuga *et al.*, 2020).

3.6.4 Contingent Valuation Method (CVM)

The contingent valuation method (CVM) is a stated preference approach to the valuation of nonmarket goods. It has a 50+-year history beginning with a clever suggestion to simply ask people for their consumer surplus. The first study was conducted in the 1960s and over 10,000 studies have been conducted to date (Haab *et al.*, 2020). The CVM is used to estimate the use and non-use values of changes in the environment. It is one of the more flexible valuation methods, having been applied in many contexts and policies (Orlowski & Wicker, 2019). The CVM requires the construction of a hypothetical scenario that makes clear what will be received in exchange for payment.

The scenario must be realistic and consequential. The CVM proponents have found that it produces similar value estimates to those estimated from revealed preference methods such as the travel cost and hedonic methods. The CVM has produced a willingness to pay (WTP) estimates that exhibit internal validity (Haab *et al.*, 2020). This method uses interview techniques to ask individuals to place value on environmental goods and services. This technique is called the 'contingent' valuation method because people state their willingness to pay, contingent on a specific hypothetical scenario and description of the service or product.

The most common approach in the CVM is to ask individuals the maximum amount of money they are willing to pay (WTP) to use or preserve a good or service. Alternatively, the respondents could be asked the maximum amount of money they are willing to accept in compensation (WTA) to forgo the given environmental good or service. One of the most important concepts in CVM is a willingness to pay (WTP), which is defined as the maximum amount of money consumers are willing to pay for a good or service (Davis, 1963).

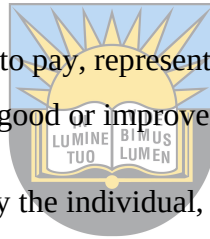
The CVM application can be split into six stages, namely, setting up the hypothetical market, obtaining bids, estimating the mean WTP and/or WTA, estimating bid curves, aggregating the data, and the evaluation of CVM (Hanley & Spash, 1993). The WTP value can be derived through a bidding game, closed-ended-questions referendum, payment card, and open-ended questions. Contingent valuation surveys should be opened with general questions and aim at making the respondent comfortable with participating in the survey and answering questions.

The CVM was employed in this study to elicit the small-scale livestock farmers' WTP for fodder seed technology. The Contingent Valuation Method for the willingness to pay (WTP) for fodder seed technology by small-scale livestock farmers can be described by the equation:

$$V(y - WTP, p, q; Z) = V(y, p, q_0; Z) \dots \dots \dots (12)$$

Where V denotes the indirect utility function, y is income, p is a vector of prices faced by the individual, and q_0 and q_1 are the alternative levels of the good or quality indexes (with $q_1 > q_0$, indicating that q_1 refers to improved fodder varieties); WTP willingness to pay; and Z respondents' characteristics (such as age, education, etc.).

- V : Represents the indirect utility function, which captures the overall well-being or satisfaction of the individual. In this context, it reflects the utility derived from income (y), prices (p), and the level of a specific good or quality index (q).
- y : Stands for income, which is a component of the individual's well-being.
- WTP : Denotes the willingness to pay, representing the additional amount an individual is willing to pay for a specific good or improvement in quality (q_1 compared to q_0).
- p : Is a vector of prices faced by the individual, indicating the cost of goods or services in the market.
- q_0 and q_1 : Represent the alternative levels of the good or quality indexes. Here, q_0 corresponds to the current level, and q_1 corresponds to the improved level (improved fodder varieties). The assumption is that $q_1 > q_0$, indicating an enhancement in quality.
- Z : Represents respondents' characteristics, such as age, education, and other relevant socio-economic factors.



University of Fort Hare
Together in Excellence

The equation suggests that the overall well-being (V) of an individual, considering income (y), prices (p), and the quality of a specific good (q), remains the same whether willingness to pay (WTP) is deducted or not. This equation captures the idea that individuals derive utility from the combination of their income, the prices they face, and the level of the good in question.

Dichotomous choice formats: The Dichotomous Choice Contingent Valuation Method (DC-CVM) has gained popularity among contingent valuation practitioners in recent years because it is easy to use for gathering data and is said to have advantages over other formats used in the contingent valuation (CV) method, which are known to contain biases (Cameron & Quiggin, 1994). The respondent is only asked to indicate whether (YES or NO) she or he is willing to pay a specific amount (bid) for the public good offered when using this elicitation method. Antoušková (2012) distinguishes between two types of dichotomous choices: single-bounded choices, which are binary choices (take-it-or-leave-it), and double-bounded choices, which are dichotomous (take-it-or-leave-it with follow-up).

Respondents are asked about WTP just once in single-bounded dichotomous choice, and they are expected to respond either yes or no. In this instance, the single bounded dichotomous choice format makes it easier for respondents to decide whether to pay than open-ended questions, and the probit model can be used to estimate WTP (Bennett & Carter, 1993). Nonetheless, there are at least three ways in which the double-bounded dichotomous choice format is superior to the single-bounded in terms of improving statistical efficiency and addressing strategic bias.

To begin with, it is comparable to the current market conditions, for example, in Ethiopia, where sellers set an initial price and offer buyers the opportunity to negotiate. Second, there is an efficiency gain because the yes-yes, no-no response in the double-bound dichotomous choice format sharpens the true WTP and establishes explicit bounds on unobservable WTP (Getachew, 2022). Finally, the double-bounded dichotomous choice format is more efficient than single-bounded dichotomous choice as more information is elicited about each respondent's WTP and a parametric mean could be elicited (Ajamo, 2019; Yu *et al.*, 2023).

It is used in a way that asks a follow-up question of a respondent-based on how they answer the first question. That is if the answer to the first question was no, a second question with a lower amount and a higher amount if the answer was yes asked (Getnet *et al.*, 2022). This indicates that the interval in the double-bound model is contained between two bids. According to Wegedie *et al.*, (2020), the interval is bounded by the second bid and the limit of the WTP distribution if one of the two answers is positive and the other is negative (double-bound). To gather more information about the support of the true WTP distribution, the initial bids varied among individuals.

To examine small-scale livestock farmers' willingness to pay (WTP) for fodder seed technology, the study employed the Contingent Valuation Method (CVM). Specifically, the dichotomous choice format of CVM was used, where farmers were presented with a binary (yes/no) question regarding their willingness to pay for fodder seed technology. This method is widely used for valuing non-market goods, such as agricultural technologies, by simulating a hypothetical market. In this approach, farmers were asked if they would be willing to pay a specified amount for the technology, with their responses serving as the basis for estimating the likelihood of WTP.

The technique allows for the analysis of the factors influencing farmers' decision-making, while also capturing the economic value they place on fodder seed technology. Socio-economic and farm-related characteristics were also collected to assess their influence on WTP, providing a comprehensive understanding of the drivers behind adoption decisions. Data analysis was conducted using a binary logistic regression model, suitable for examining the relationship between a binary dependent variable (WTP) and multiple independent variables. The study followed the Double- Bounded Dichotomous Choice format which follows this equation:

$\Pr(\text{Accept}) = F(\text{Bid}, \text{Respondent Characteristics})$ is a representation of a statistical model used in the context of the Contingent Valuation Method (CVM), specifically for the Double-Bounded Dichotomous Choice (DBDC) format. This equation helps to model the probability that a respondent accepted a given bid amount for a particular good or service, considering both the bid amount and characteristics of the respondent.

- **Pr(Accept):** This represents the probability that a respondent accepted the offered bid. In the context of DBDC, respondents are given a choice between accepting and rejecting a bid for a specified good or service.
- **(Bid, Respondent Characteristics) $F(\text{Bid}, \text{Respondent Characteristics})$:** This part of the equation represents a function, denoted as F , that relates the probability of accepting the bid to two sets of variables:
 - **Bid:** This variable represents the bid amount offered to the respondent. The bid is a crucial factor because it directly influences the respondent's decision to accept or reject the offer. Typically, as the bid amount increases, the probability of acceptance may decrease.

- **Respondent Characteristics:** This set of variables includes characteristics or attributes of the respondent that may influence their decision. These characteristics could encompass demographic factors (e.g., income, education) or other individual-specific attributes. The inclusion of respondent characteristics allows the model to account for heterogeneity among respondents.

3.6.4.1 Descriptive statistics

Descriptive statistics were used to summarize the basic features of the data, including the percentage of farmers willing to pay for fodder seed technology for each price increment.

3.6.4.2 Binary Logistic Regression Model

Binary logistic regression was employed to identify the factors influencing the WTP. The dependent variable is binary (1 if willing to pay, 0 otherwise). Independent variables include age, gender, employment status, educational level, sources of income, estimated monthly income, full-time farmer status, household size, arable land size, extension officer interaction, sources of agricultural information, cattle number, sheep number, and goat number. The mathematical presentation of this model is.

$$\text{logit}(P(Y = 1)) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n \dots \dots \dots (12)$$

University of Fort Hare
Together in Excellence

Where:

- $P(Y=1)$ is the probability of the event occurring (e.g., the willingness to pay for fodder seed technology).
- $\text{Logit}(P(Y=1))$ is the natural logarithm of the odds of the event occurring.
- β_0 is the intercept.
- $\beta_1, \beta_2, \dots, \beta_n$ are the coefficients for the independent variables $X_1, X_2, \dots, X_n$

In this context:

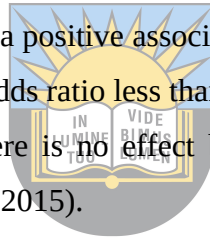
- The dependent variable (Y) is the willingness to pay (WTP) for the fodder seed technology, which is binary (Yes = 1, No = 0).
- The independent variables ($X_1, X_2, \dots, X_n$) are factors such as age, gender, employment status, educational level, sources of income, estimated monthly income, full-time farmer, household size, arable land, extension officer interaction, sources of agricultural information, cattle number, sheep number, and goat number.

Econometric Analysis

The logistic regression model estimates the odds ratios, which indicate the likelihood of willingness to pay associated with each independent variable.

Odds Ratio Interpretation:

An odds ratio greater than 1 indicates a positive association between the independent variable and the willingness to pay, while an odds ratio less than 1 indicates a negative association and when the odd ratio is equal to 1 there is no effect between the independent variable and willingness to pay (Temesgen &Tola, 2015).



3.7 Model diagnostic test

Test for multicollinearity

Multicollinearity occurs when two or more independent variables are highly linearly correlated. This issue can result in an inflated R^2 and few statistically significant p-values (Gujarati & Porter, 2010). In this study, the variance inflation factor (VIF) was used to detect the presence of multicollinearity. After running the ordered probit model and binary logistic regression, multicollinearity was assessed. As per Gujarati & Porter (2010), multicollinearity is considered a problem when the VIF exceeds 10.

3.8 Description of the selected forage seed varieties

The Agricultural Research Council (ARC) has been actively engaged in breeding and evaluating forage crops at the Cedara Research Station in Pietermaritzburg for over 70 years. Since 1993, this unit has successfully secured Plant Breeders' Rights (PBR) for 62 new forage cultivars across various species. The study focused on five forage seed varieties: Sukari, Endurance, Agriboost, Enhancer, and LS 35.

In South Africa, *Lolium multiflorum* is a vital cool-season forage grass, predominantly cultivated in high-rainfall regions. It is frequently used to overseed perennial pastures to boost winter production or under-sow annual summer crops, maximizing land utilization. When mixed with clover, it provides exceptionally high-quality grazing, making it a valuable forage crop, especially for small-scale farmers in high-rainfall areas. It is particularly beneficial when under-sown in maize fields.

Sukari is an Italian- ryegrass cultivar characterized by high sugar levels, substantial dry matter (DM) content, and strong winter production. Developed by the Cedara Animal Production Institute of the ARC, Sukari addresses the summer/early autumn fodder gaps often faced by ryegrass farmers. It is a diploid Italian ryegrass well-suited to withstand heat stress and acidic soils. With proper management, Sukari can be utilized for an extended period, lasting until the following autumn. If planted under irrigation early in August, it should be kept moist throughout the summer, allowing for light grazing in January. Proper care during the hot summer months ensures that the pasture will 'return' in autumn, providing fodder until spring (Van Rooyen, 2016).

The ARC has developed a new long-duration fodder radish called “Endurance” with soft leaves, which retains its quality longer and grows for almost seven months from planting while the other fodder radish varieties last for five, sometimes six months from planting with substantial leaf loss and bulb deterioration towards the end of the fifth month and into the sixth month. The main function of these forage crops is to provide feed during periods of feed shortage and to serve as a fodder bank, especially for the bulb species which can be utilized over a three to four-month period (Ammann *et al.*, 2015).

Endurance is a new variety of fodder radish produced by crossbreeding the ARC Cedara team's radish cultivars, Geisha and Sterling, with a late-flowering line provided by PGG Wrightson Seed Company (Pannar Seed, 2024). After eight years of selective breeding, focusing on desirable traits and eliminating undesirable ones, Endurance was developed and is now listed in the South African Variety List.

The variety is distinguished by its late flowering and soft leaves, producing high-quality tubers and leaf material until late August or even mid-September in some areas. Endurance begins flowering approximately six weeks later than other radish varieties, extending grazing time by more than half compared to conventional cultivars. Its large, productive bulb, heat and drought tolerance, and high yield potential make it an asset for dairy farmers, particularly for spring feeding (Nash and Ammann, 2015; Rakau, 2021).

Endurance thrives in well-drained, fertile soils and is typically established in January or February, with specific sowing rates depending on irrigation conditions. Endurance is ideal for regions receiving over 350mm of annual rainfall, making it suitable for most parts of South Africa. Other desirable features of Endurance include minimal ripening required, a large bulb size that results in a high proportion of plant material that grows above the soil and is highly palatable. It is also drought and heat-tolerant, with good leaf retention, bulb-keeping ability, and high yield potential. The smooth leaves make it an excellent option for supporting and improving milk production, particularly during the dry winter and spring seasons, which would enhance overall milk production in the country (Rakau, 2021).

Enhancer is an improved forage quality ryegrass released in 2003. This variety boasts higher dry matter and energy content than traditional varieties, leading to enhanced milk production. Enhancer is a high-sugar diploid Italian ryegrass developed for hay, silage production, and grazing. Extensive research conducted at the University of Kentucky over seven years demonstrated Enhancer's exceptional forage production capabilities (Lacrosseseed.com, 2019). The original variety bred by the ARC, Enhancer, showed significant improvements in cow milk yield in dairy trials conducted in both the Eastern Cape and KwaZulu-Natal (Capstone seeds, 2020).

Agriboost– is also an Italian Ryegrass variety, it is a very high sugar grass with excellent feed quality, a very densely tilled, and competitive cultivar that can cover the ground and has high grazing tolerance. Agriboost can be utilised as a new sowing option or as a tool to plant into exiting pastures (Agricol, 2024). Agriboost followed Enhancer as another high-quality forage variety developed to further increase milk production per cow (Meeske *et al.*, 2009; Alende, 2016).

Lastly, **LS 35** is a well-established forage cereal variety known for its rapid feed production. It is ideal for mixing with ryegrass pastures as a nurse crop or when feed or land availability is limited, requiring a quick fodder crop. LS 35 is a short-duration spring type that will seed quickly if not properly managed, and it does not require a cold spell or changes in light hours to initiate seeding (Hygrotech Forum, 2018).

3.9 Chapter Summary

This chapter describes the research methods used in the study, including the selection and description of the study areas. It covers the physical aspects of these regions, such as agroecological characteristics (climatic conditions and soils), governance, demographics, income levels, and infrastructure. It also examines non-farm activities and the agricultural economy, which reflect the main types of enterprises in the areas.

The information is essential for understanding the research findings. Primary data were collected from the OR Tambo District Municipality in the Eastern Cape Province, specifically from the King Sabata Dalindyebo, Port St Johns, and Ingquza Hill local municipalities. These municipalities are home to many smallholder livestock farmers and feature varied agro-ecological conditions. The chapter details the dependent and independent variables used in the analysis. A KAP (Knowledge, Attitudes, and Practices) index assessed small-scale farmers' knowledge, attitudes, and practices regarding fodder seed technology.

An ordered probit model was used to explore the relationship between farmers' socioeconomic characteristics and their KAP. The contingent valuation method measured farmers' willingness to pay for fodder seed technology, and logistic regression identified the factors influencing this willingness. The chapter also gives a brief description of the fodder seed varieties that are used in this study.

Chapter Four

Results and discussions

4.1 Introduction

In this chapter, the descriptive and empirical results of the study are presented. This section discusses the socio-economic characteristics of the sampled farmers. It also describes the socioeconomic characteristics of the farmers. This chapter also presents an analysis of the data collected on farmers' knowledge, attitudes, and practices (KAP) regarding fodder seed technology. Likert scale was used to capture the knowledge and attitude of the respondents. In addition, the chapter entails results for willingness to pay, which used a contingent valuation method with a double-bounded approach, where participants were presented with two bid levels one higher and one lower than the initial bid—depending on their responses to the first bid.

4.2 Socio-economic characteristics of the farmers

The section gives a descriptive analysis of the different socio-economic characteristics of the sampled farmers.

4.2.1 Age of the farmers

Table 4.1 below depicts the different age categories, the frequency of these categories, and the percentages of farmer's age categories.

University of Fort Hare
Together in Excellence

Table 4.1: Age of the farmers

Age groups (years)	Frequency	Percentage (%)
19-40	20	13.25
41-50	25	16.56
51-60	38	25.17
61-70	46	30.46
71-80	17	11.26
81-90	5	3.31
Total	151	100.00

Source: Own compilation from Survey Results (2024)

Table 4.1 shows that in this study 13.25% of the farmers were between the ages of 19 and 40 years, 16.56% were farmers between 41 and 50 years, 25.17% were farmers between 51-60 years, 30.46% and 11.26% were farmers between 61 and 70 years, 71 and 80 years respectively. The eldest group of farmers was 3.31% between the ages of 81 and 90 years. Most farmers were between the ages of 61 and 70 years, followed by those who were between 51 and 60 years.

The South Africa Community Survey (2016) indicates that many agricultural households are headed by individuals aged 45-54 years in South Africa. Additionally, 22.9% of agricultural households are headed by individuals aged 65 and older, which are commonly pensioners. This suggests that farming in the study area is predominantly undertaken by an aging population, with a notable presence of pensioners, highlighting potential challenges in long-term agricultural sustainability and the need for strategies to encourage younger generations to engage in farming.

Similarly, Chipfupa & Tagwi (2021); Mthi *et al.*, (2020), noted a lower involvement of youth in livestock farming in the Kwazulu-Natal province which is reflected by a higher percentage of older individuals in their study. While there is consensus that age influences farmers' potential to adopt new farming methods, there is debate about which age group is most likely to adopt these methods. Cheteni *et al.*, (2014) on one end discovered that older people were more open to adopting new farming techniques in a study that was conducted in the Eastern Cape Province. In contrast, de Souza Filho (2018) in a study conducted in Brazil, found that older people were more resistant to change than younger counterparts.



University of Fort Hare
Together in Excellence

4.2.2 Gender of the farmer

Table 4.2 below presents farmers' gender in the study area, in percentages and frequencies of farmers categorized into male and female.

Table 4.2: Gender of the farmers

Gender	Frequencies	Percentage (%)
Female	52	34.44
Male	99	62.56
Total	151	100.00

Source: Own compilation from Survey Results (2024)

Table 4.2 represents the gender of the farmers, and the results show that approximately, 62.56% of the farmers were men and about 34.44% were women. The predominance of males in livestock production is well-documented in South Africa (Maziya *et al.*, 2020; Mthi *et al.*, 2020). Traditionally, men, as household heads, are primarily responsible for managing grazing livestock, whereas women typically focus on poultry rearing (Gueye, 2000). Also, Koshe (2022) suggests that this may be linked to cultural values and beliefs.

The findings are consistent with those of Moyo and Ravhuhali (2023), who found that most respondents in their study on winter forage production in the Eastern Cape province with men accounting for 69% and women accounting for 31%. This is also like Bahta and Myeki's (2022) study conducted in the Northern Cape, where 61 (28%) of the respondents were women while 156 (72%) were men. The findings from these studies show that males dominate livestock farming.

4.2.3 Marital status of the farmers

Table 4.3 below shows the different marital statuses of farmers in the study, presented in frequencies and percentages.

Table 4.3: Marital status of the farmers

Marital status	Frequencies	Percentage (%)
Single	37	24.50
Married	91	60.26
Divorced	2	1.32
Widow/Widower	21	13.91
Total	151	100.00

Source: Own compilation from Survey Results (2024).

Table 4.3 presents the marital status of the farmers. The marital status was measured by considering farmers who were single, married, divorced, or widowed. According to the results presented in Table 4.3, most respondents (60.26%) were married, while about 24.50% were single, 13.91% were widowed, and 1.32% were divorced. Agbugba *et al.*, (2020) in a study conducted in the Eastern Cape province, suggested that a higher percentage of married farmers contributes to additional family farm labour.

The high percentage of married individuals can be attributed to the fact that most respondents were family-oriented and older. Married farmers may also be more stable and committed to their farming activities, potentially due to the combined responsibilities of supporting their families and managing farm operations. This demographic insight aligns with the findings of Nxumalo *et al.*, (2019), who stated that marital status can often be indicative of the age and life stage of individuals, influencing their farming practices and resource management.

4.2.4 Employment status

The figure below depicts the employment status of the farmers

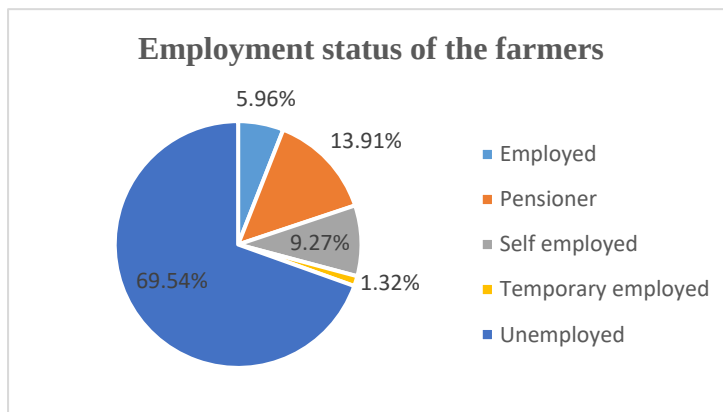


Figure 4.1: Employment status of the farmers

Source: Own compilation from Survey Results (2024)

Figure 4.1 represents the employment status of the farmers. As depicted in Figure 4.1, most respondents were unemployed, accounting for 69.54%. Additionally, about 13.91% of the farmers were pensioners, 9.27% were self-employed, and 5.96% and 1.32% were employed and temporarily employed, respectively. Employed individuals often lack the time to engage in agricultural activities due to their job commitments. Unemployed people, on the other hand, are more likely to participate in agricultural production because they believe it is more cost-effective and profitable (Bese, 2020; Abengude *et al.*, 2019).

These findings are consistent with existing literature, which indicates that the Eastern Cape province has a high unemployment rate (Meyers-Mashamba, 2021). Unemployment in the province is particularly high in rural areas, with O.R. Tambo district having the highest unemployment rate (70.76%). Cheteni (2017) also discovered that many smallholder farmers depended on subsistence farming for their livelihoods within the province.

4.2.5 Educational level

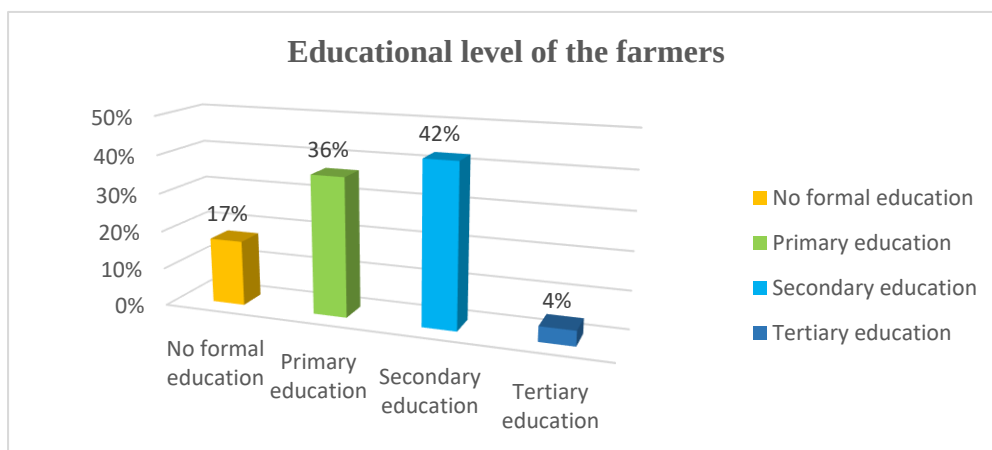


Figure 4.2: Educational level of the farmers

Source: Own compilation from Survey Results (2024)

Figure 4.2 shows the education level of the farmers. The level of education attained is a vital factor because it influences the farmer's knowledge and attitude toward the understanding and acceptance of new technologies (in this case, fodder seed technology). Figure 4.2 depicts the level of education of the farmers and shows that 17% of the farmers have no formal education, 36% have primary education, 42% have secondary education and 4% have tertiary education.

The results suggest that most farmers hold secondary education and lack some skills and knowledge concerning technology adoption. Therefore, farmers need to be able to find information and try new strategies to improve their livestock production, as highlighted by Bahta (2020), which would be influenced by their level of education. According to Botlhoko & Oladele (2013), illiterate farmers are not as likely to accept new ways of farming as literate farmers, hence their productivity decreases and eventually leads to reduced amount of farm returns.

Education is regarded as a basic human need, essential for meeting other basic needs and accelerating overall agricultural development through training skilled workers and enabling farmers to make fruitful use of existing farm resources and accurate assessment of new ones. Meaning, a farmer's education level affects how likely they are to adopt new farming methods.

Studies by Jumbe & Nyambose (2016); D’Souza & Gebremedhin (2019) show that educated farmers (at least hold tertiary education) are more likely to adopt new farming practices than less educated farmers. These findings match the results of studies by Pilarova, *et al.*, (2018), and Bese *et al.*, (2021) which reveal that educated farmers are more likely to adopt new farming innovations. The results of the KAP analysis will reveal whether the same is true in the context of this study.

4.2.6 Source of income of the farmers

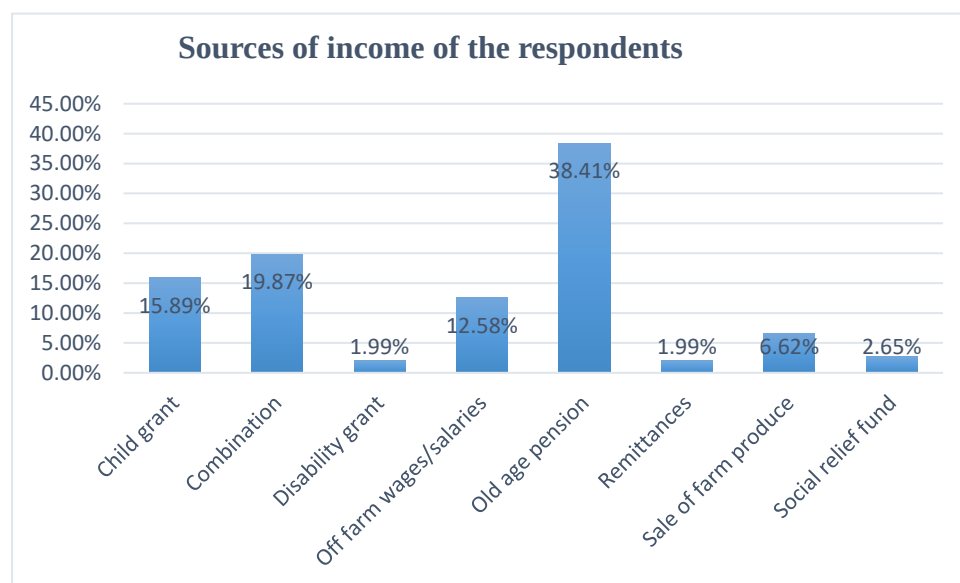


Figure 4.3: Sources of income of the farmers
Source: Own compilation from Survey Results (2024)

Figure 4.3 represents the sources of income of the farmers. As shown in the figure, about 38.41% of farmers have an old age pension grant as their main source of income, which aligns with the age of many of the farmers (61 to 70 years). This is followed by a combination of the other income sources (19.87%), for instance, some farmers responded and said their source of income comes from old age pensions and remittances, some with child grants and social relief funds.

It is rare to find households depending solely on one income source. Instead, rural households often combine a variety of income sources (Mathebula *et al.*, 2017). When it comes to employment, a total of about 69.54% of the farmers were unemployed (from the results above). This also explains the high percentage of the farmers having grants as a form of income. According to the Wye Group (2011), it is important when understanding the welfare of agricultural households not to take other sources of income as being unimportant.

4.2.7 Monthly income for a farmer's household

Table 4.4: Monthly income of the farmers

Variable	Respondents	Mean	Min	Max
Monthly income (Rands)	151	3295.497	350	40000

Source: Own compilation from survey data from Survey Results (2024)

Table 4.4 represents the estimated monthly income of the farmers. The table shows that the average monthly income for the farmers is R3 295.497. The lowest estimated monthly income of the respondents is R350, and the highest estimated monthly income of the respondents is R40 000. The average monthly income of the respondents gives a basic idea of their economic situation. The mean estimated monthly income helps in knowing whether the farmers might find fodder seed technology financially accessible, *ceteris paribus*. This is in line with the main source of income of the respondents being old age pension and child support grants. These findings are like Mashamaite (2014), who stated that many individuals in rural areas are unemployed and rely on farming and social grants for a living.

4.2.8 Household size and Arable land (ha) of the farmers

Table 4.5: Household size and Arable land (ha)

Variables	Respondents	Mean	Std. dev.	Min.	Max.
Household size	151	6.880795	3.183137	1	19
Arable land (ha)	151	1.714901	1.812795	0.25	15

Source: Own compilation from Survey Results (2024)

Table 4.5 represents the household size of the farmers for the study. The table shows that in this study a typical household has seven (7) members on average. The number of people ranged from a minimum of one to a maximum of nineteen people. The study's findings are consistent with those of Taruvinga *et al.*, (2022) in a study conducted in the Eastern Cape province, who discovered that the average household size was seven individuals, which provided an advantage in terms of free and easily available labor in the form of farm work.

Table 4.5 also shows that the average arable land size per farmer is about 1.71 hectares, but there is substantial variation among the farmers, with some owning as little as 0.25 hectares and others as high as 15 hectares. Farmers with minimal arable land may adopt forage seed varieties that work well in a small piece of land. These results are in line with those of Senyolo *et al.*, (2021) who note that smallholder farmers with large farm sizes were noted to adopt new technologies faster than smallholder farmers with smaller farm sizes.

For example, a smallholder farmer with a farm size of about four (4) hectares tended to adopt technology faster than another smallholder farmer who cultivated only one (1) ha. On the contrary, Cheteni *et al.*, (2014) noted that farmers with small farms were likely to adopt new farming techniques, particularly in the Eastern Cape province area where the current study was carried out.

4.2.9 Number of livestock of the respondents

Table 4.6: Number of livestock kept by farmers

Livestock species	Respondents	Mean	Std. dev	Min	Max
Cattle	113	13.67257	17.15395	1	130
Sheep	128	30.63281	39.18558	1	308
Goat	75	9.706667	9.423624	1	50

Source: Own compilation from Survey Results (2024)

Table 4.6 constitutes the total number of cattle, sheep, and goats owned by the farmers. The minimum number of cattle owned by smallholder farmers was one (1), and the maximum number was 130. The minimum number of sheep owned by the farmers was one (1) and the maximum was 308, and the minimum number of goats owned by the farmers was one (1) and the maximum was 50.

Planted forage is generally associated with large herds (Balehegn *et al.*, 2020), which means farmers with large herds may be more likely to adopt fodder seed technology than those with smaller herds. Higher livestock numbers may also be indicative of increased manure availability, implying that farmers with access to manure are more likely to meet the soil fertility requirements of improved fodder varieties and may adopt them

4.2.10 Source of feed for livestock

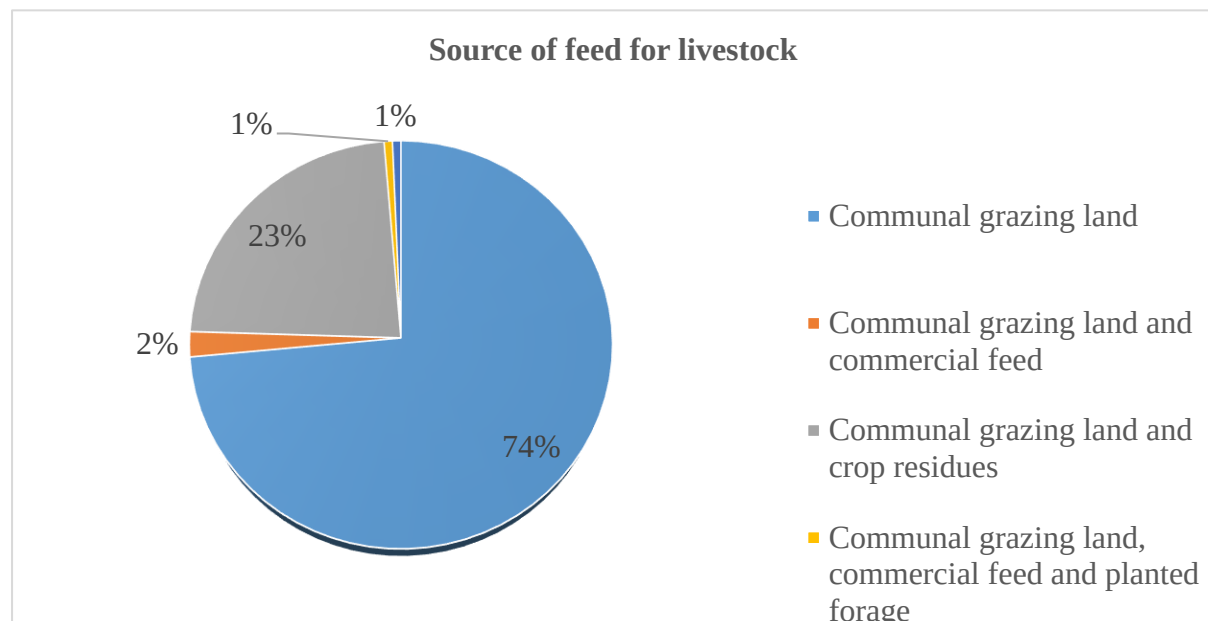


Figure 4.4: Source of feed for livestock in the study area

Source: Own compilation from Survey Results (2024)

Figure 4.4 shows different sources of livestock feed in this study. The results show that most small-scale livestock farmers solely depend on communal grazing land for livestock, and they account for 74%. Some of the farmers (23%) use communal grazing land and crop residues as sources of feed for their livestock. The rest of the farmers use a combination of communal grazing land, crop residues, and commercial feed or planted forage. This is in line with Moyo *et al.*, (2023) observation that poorly resourced farmers depend on the rangelands, while those who plant summer crops use the remaining post-harvest residues.

The results reveal a high reliance on communal grazing land for livestock feed, making farmers vulnerable to environmental changes. As of consequence, mixed feeding strategies are minimally used. In the context of a study on livestock farmers' Knowledge, Attitudes, and Practices (KAP) regarding fodder seed technology, this highlights a crucial need for awareness and adoption of diversified feed options to improve resilience and productivity. Promoting fodder seed technology could significantly reduce dependence on communal grazing land.

4.2.11 Land Ownership

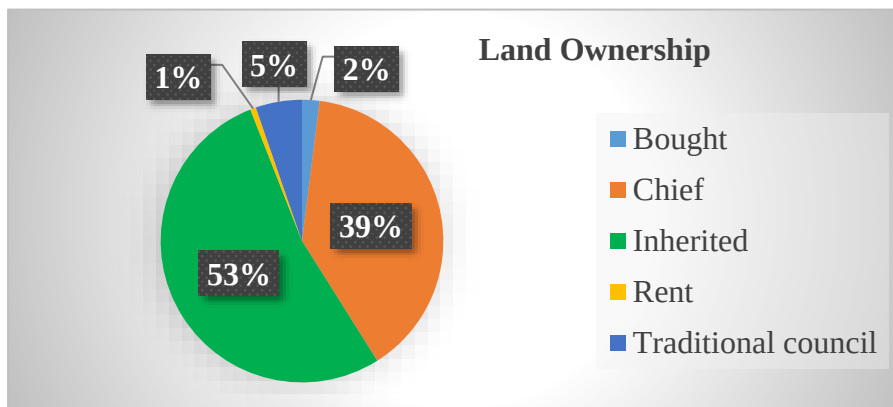


Figure 4.5: Land ownership of the farmers

Source: Own compilation from Survey Results (2024)

Figure 4.5 shows the type of land ownership for the farmers in this study. The results indicate that most of the farmers (53%) inherited the land, while 39% acquired the land from the chief, 5% acquired the land from a traditional council, 2% of the farmers bought the land and 1% of the respondents are renting out the land.

Zakar *et al.*, (2019), state that land ownership is widely believed to encourage the adoption of technologies because farmers who own land instead of renting are more likely to adopt technologies. This is the same with the current study that farmers who had ownership of land were more willing to accept the adoption of the fodder seed technology.

4.2.12 Source of Agricultural Information

Table 4.7: Source of agricultural information of the farmers

Source of agricultural information	Frequencies.	Percentage
Extension officer	58	38.41
Neighboring farmers	34	22.52
Research stations	1	0.66
Traditional knowledge and seed companies	11	7.28
Combination	47	31.13
Total	151	100.00

Source: Own compilation from Survey Results (2024)

Table 4.7 represents the source of agricultural information of the farmers. As shown in the results, the extension officers were the primary source of agricultural information among farmers, with about 38.41% of farmers relying on them. This underscores the critical role of extension services in disseminating agricultural knowledge. Neighbouring farmers were the second most common source, used by approximately 22.52% of farmers. This also highlighted the importance of community and peer networks.

Research stations, however, were a minor source, with only about 0.66% of farmers obtaining information from them, suggesting that these stations may not be easily accessible or well-integrated into farmers' information networks. Traditional knowledge and seed companies together serve as a source for approximately 7.28% of the farmers, indicating a moderate reliance on both traditional practices and commercial seed companies. Additionally, about 31.13% of respondents use a combination of multiple sources for their agricultural information, which combines extension officers, neighbouring farmers, traditional knowledge, etc.

The results concur with Bese *et al.*, (2021) who acknowledge that extension officers also play a key role in the adoption of new farming methods. It has been proven that extension officers are trusted by smallholders to bring valuable information and knowledge regarding the enhancement of their farming activities. Along the same line Cheteni *et al.*, (2014) established that extension officers had a positive influence on farmers' perceptions and many farmers are likely to utilize farming practices taught by officers.

4.2.13 Extension Officer Contact

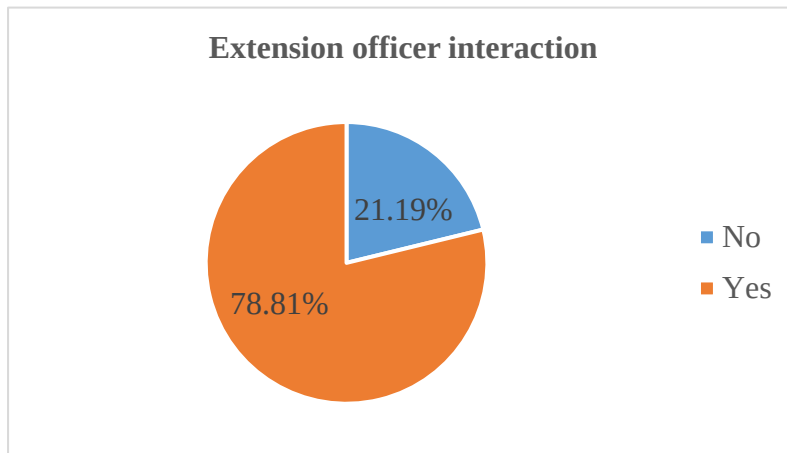


Figure 4.6: Extension Officer Interaction with farmers

Source: Own compilation from Survey Results (2024)

Figure 4.6 represents the results of the extension officer's interaction with the farmer. Farmers were asked whether they had any interaction with extension officers. The figure shows that 78.81% of the farmers interact with extension officers and 21.19% show that they do not have any form of interaction with extension officers. Agricultural extension officers play a crucial role in sharing knowledge, delivering technical expertise, and helping farmers connect with other economic stakeholders (Mbatha, 2024). Sebeho (2016) noted that continuous interaction builds a good relationship between the extension officer and the farmer.

4.2.14 Extension Officer educating farmers about fodder varieties

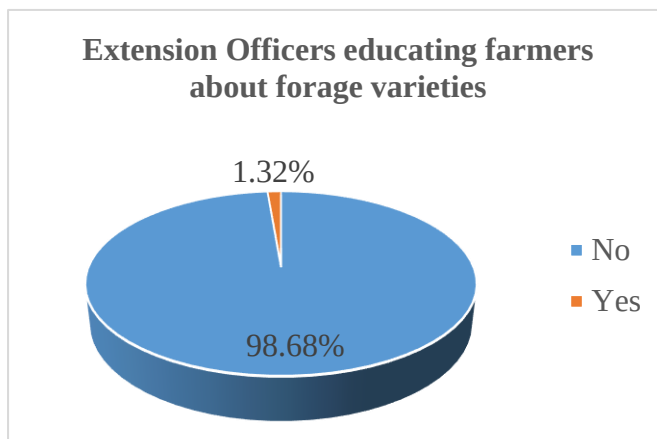


Figure 4.7: Extension officers and talking about forage varieties

Source: Own compilation from Survey Results (2024)

Figure 4.7 represents the results of extension officers educating farmers about forage varieties. The results show that 98.68% of farmers responded that extension officers have never told them or educated them about forage varieties, and 1.32% of the farmers responded that they got information about fodder varieties from extension officers only because they asked about it.

In the same line Ndah *et al.*, (2022), in Tanzania attributed a lack of knowledge about forage varieties among farmers to extension advice on forage planting, management, and harvesting that is often not available. This implies a significant gap in knowledge transfer, highlighting an urgent need for improved extension services to promote awareness and adoption of diverse forage options for better livestock management.

4.2.15 Membership in a project

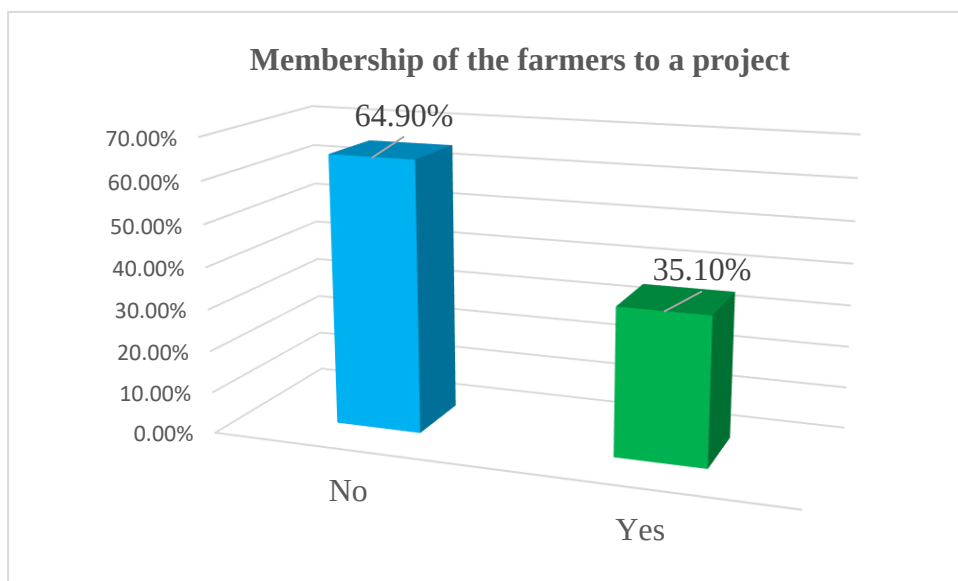


Figure 4. 8: Membership of farmers in a project

Source: Own compilation from Survey Results (2024)

Farming associations serve as a communication tool for many farmers. Therefore, membership in an association was considered for this study. Figure 4.8 depicts the membership of the farmers in a project. It shows that a total of about 35.10% of farmers stated that they are members of agricultural associations or societies. Being a member of an association serves as a network where valuable information about agriculture can be exchanged. Members can also learn new things, and this is a platform for discussing innovations and identifying constraints faced by members (Bese, 2021). Given the number of farmers who are members of farmer's associations, it is expected that they would be willing to participate in planting forage.

4.3 Knowledge, attitudes, and practices analysis

This section presents an analysis of the data collected on farmers' knowledge, attitudes, and practices (KAP) regarding fodder seed technology. In this section, results are presented in a table format, pie charts, and graphs. Likert scale was used to capture the knowledge, attitudes, and practices of the farmers.

4.3.1 Knowledge of fodder seed technology

To measure the knowledge of the farmers on fodder seed technology, farmers were asked six questions in a Likert scale survey. The total score of a farmer was determined by summing up all the scores obtained by the farmer against the six questions. For knowledge questions, a three-point scale was used, 1 = Know, 2 = Not sure, and 3 = Don't know. The study assumed that if a farmer is not sure, then it is regarded to be closer to not knowing than knowing. As a result, that was coded as 1 for "know" and 0 for "not sure or do not know" following Islam and Islam's (2020) approach.

Table 4.8 presents the questions and responses of the farmers about their knowledge of fodder seed technology. The results in Table 4.8 also show that most farmers (81%) did not know that fodder seed technology is a way of improving the genetic and physical features of forage seeds, while 17% of the farmers knew, and 1% of the farmers were not sure. Additionally, about 75% of the farmers did not know that fodder seed technology provides fodder-resilient varieties that are suitable for livestock feed, while 15% of the farmers knew and 9% of farmers were not sure.

The study also found that 26% knew that fodder seeds could be used to plant forage during feed shortages, and 64% of the farmers did not know. Only 9% of the farmers knew that the purpose of fodder seed technology was to increase agricultural production with high-yielding forage seeds, while 79% did not know. Furthermore, 83% of the farmers did not know that certain fodder cultivars can thrive in changing climates, and only 5% knew this. Lastly, 21% knew that fodder includes essential sprouted grains for animal feed, and a substantial 68% did not.

Table 4.8: Likert Scale for knowledge questions to the farmers

Knowledge questions	Know (%)	Not sure (%)	Don't know (%)	Total (%)
Do you know that fodder seed technology is a way to improve the genetic and physical features of seeds?	17	1	81	100
Do you know that fodder seed technology provides fodder-resilient varieties that are suitable for livestock feed?	15	9	75	100
Do you know that you can use fodder seeds to plant fodder when there is a shortage of livestock feed?	26	10	64	100
Do you know that the purpose of fodder seed technology is to increase agricultural production by spreading high-yielding seeds of excellent quality?	9	13	79	100
Do you know that there are fodder cultivars that can thrive in the midst of a changing climate?	5	12	83	100
Did you know that fodder is an essential input for animal feed, made up of sprouted grains such as barley, oats, wheat, and maize?	21	12	68	100

Source: Own compilation from Survey Results (2024)

These results highlight a significant knowledge gap among farmers regarding the benefits and applications of fodder seed technology, indicating a need for increased education knowledge, and awareness efforts in the study area. The results are consistent with the findings of Duguma & Janssens (2016) in a study carried out in Ethiopia. The authors reported that the major limitations for not growing improved forages included lack of knowledge and lack of awareness. Lukuyu *et al.*, (2021), in a study conducted in Uganda, observed that farmers are not aware of improved forage varieties and lack knowledge on forage establishment, yet they are faced with making the important decision about which forages to plant on their farms.

Table 4.9 shows farmers' knowledge categories on fodder seed technology. To create these categories the study calculated the knowledge index, which is the sum of all the coded responses by each farmer divided by the sum of all the designated questions multiplied by 100. Hakeem & Dipak (2013); and Farooq *et al.*, (2019) employed similar Knowledge Index (KI) methodologies.

The Knowledge Index was used to assess the knowledge levels of the sampled farmers as shown below:

$$KI = \left(\frac{X}{Y}\right) \times 100 \dots\dots\dots (1.1)$$

Where:

- KI was the Knowledge Index
- X was the knowledge score achieved by the farmers
- Y is the maximum achievable score.

The knowledge index was coded as low, medium, and high following the criteria below to categorize the farmer's level of knowledge:

- If KI was greater than 75%, it was regarded as a high level of knowledge,
- If KI was less than 50%, it was regarded as a low level of knowledge, and
- Anything between 50% and 75% was regarded as a medium level of knowledge. This is a similar approach to that of Jia *et al.*, (2017) used in a study in Guangdong and Zhejiang provinces on Biosecurity knowledge, attitudes, and practices of farmers culturing yellow catfish (*Pelteobagrus fulvidraco*).

Table 4.9: Distribution of the farmers according to their knowledge of fodder seed technology

Characteristics	Range	Categories	Farmers Number	Farmers' Percentage (%)
Knowledge	0-5	Low	142	94
		Medium	5	3
		High	4	3

Source: Own compilation from Survey Results (2024)

The results show that 94% of the farmers have a low level of knowledge regarding fodder seed technology, while 3% had medium and high levels of knowledge regarding fodder seed technology respectively. The main reasons for the low knowledge level on fodder seed technology are associated with knowledge scarcity about forage production, along with a communication gap between farmers and extension officers in the study area.

The main reasons for the low knowledge level in this study align with the findings of Farooq *et al.*, (2022), in a study conducted in Khyber Pakhtunkhwa, who identified that the primary causes of low knowledge levels regarding climate-smart agricultural production technologies were due to a lack of awareness and a communication gap between farmers and agricultural departments.

4.3.2 Attitude towards fodder seed technology

A five-point Likert scale was used for attitude questions i.e., 1= strongly disagree, 2= disagree, 3= Neutral, 4= Agree, 5= strongly agree. Farmers who agreed (4) or strongly agreed (5) to the statements from the Likert scale were considered to have a positive attitude (equated to 1), while disagree, strongly disagree, and neutral were considered to have a negative attitude (equal to 0). This approach is like that of Chuang *et al.*, (2020) study in Taiwan exploring farmers' knowledge, attitude, and adoption of Smart Agriculture Technology.

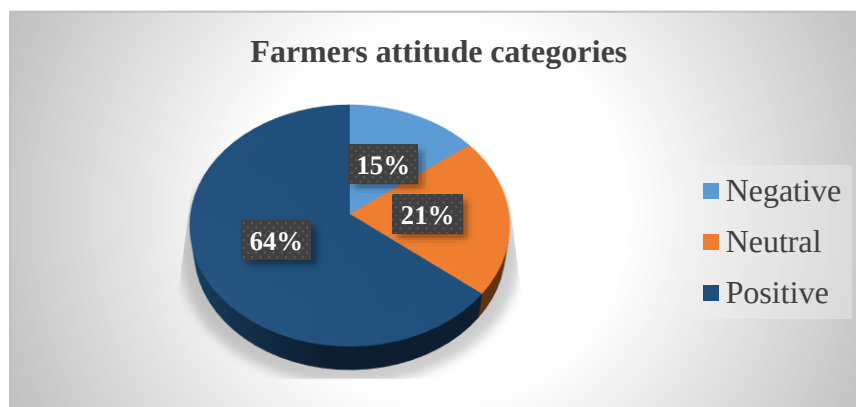


Figure 4.9: Farmers' Attitude Categories

Source: Own compilation from Survey Results (2024)

To code this to make an attitude index calculation, the study used the formula below, which was modified from the one used by Das *et al.*, (2019).

$$AI = \left(\frac{X}{Y} \right) \times 100 \dots\dots\dots (1.2)$$

Where:

- AI was the Attitude Index
- X was the Attitude score achieved by farmers
- Y was the Maximum achievable score.

The attitude indexes were then categorized as positive, neutral, and negative. To arrive at the composite attitude score, the scores obtained by each farmer for every attitude question were summed up, and based on their attitude scores, the farmers were classified into three categories namely, positive (Strongly agree and agree), negative (Disagree, strongly disagree) and neutral.

- If the attitude index was less or equal to 21%, the response was regarded as indicating a negative attitude.
- If the attitude index was less or equal to 47% the farmer was regarded as having a neutral attitude towards fodder seed technology.
- An attitude index that was above 47% was regarded as a positive attitude.

Figure 4.9 below shows that 64% of the farmers had a positive attitude toward fodder seed technology, while 21% and 15% had neutral and negative attitudes towards fodder seed technology respectively. These findings suggest a generally favourable outlook among many farmers towards adopting fodder seed technology, which can facilitate its broader acceptance and implementation, particularly in small-scale farmers.

However, the presence of neutral and negative attitudes highlights the necessity for focused educational and communication initiatives to mitigate uncertainties and overcome resistance. By increasing awareness and showcasing the advantages of fodder seed technology, these efforts could convert neutral and negative perceptions into positive ones. This is like Das *et al.*, (2019) who noted that when farmers were aware of the advantages of adopting the technology of nitrogen-fortified organic manure, their attitude became favourable.

Table 4.10 shows the farmer's attitudes towards fodder seed technology. The results show that most of the farmers were neutral (54.30%) about the availability of fodder seeds, with a significant number strongly disagreeing (22.52%) and disagreeing (16.56%) about the availability of fodder seeds. A large majority of farmers were neutral (70.20%) regarding the cost of fodder seeds. A small percentage strongly disagreed (11.26%) or disagreed (9.93%), suggesting that a minority of farmers find fodder seeds expensive. There was a positive attitude about the effect of fodder on livestock productivity.

A significant portion of farmers agreed (27.15%) or strongly agreed (27.81%) with the statement, while a notable proportion remained neutral (39.74%). Only a small fraction of farmers disagreed (3.31%) or strongly disagreed (1.99%) with the statement. The attitude of the farmers was divided on whether natural grazing is sufficient. A significant portion of farmers strongly disagreed (28.48%) or disagreed (21.85%), indicating that they do not believe natural grazing is enough.

Some farmers, however, agreed (19.87%) or strongly agreed (13.91%), suggesting that there is also a belief that natural grazing could be adequate. There was a strong belief that there is extra land available to plant forage, with most of the farmers agreeing (29.14%) and strongly agreeing (47.68%). A small percentage of the farmers strongly disagreed (10.60%) or disagreed (1.99%) with this.

Table 4.10: Farmers' attitude towards fodder seed technology

Attitude statements	Strongly disagree (%)	Disagree (%)	Neutral (%)	Agree (%)	Strongly agree (%)
Fodder seeds are always available	22.52	16.56	54.30	2.65	3.97
Fodder seeds are not expensive	11.26	9.93	70.20	5.96	2.65
Using fodder can increase livestock productivity	1.99	3.31	39.74	27.15	27.81
The government should always give out these fodder seeds	1.99	3.31	10.60	23.84	60.26
Natural grazing is enough for livestock	28.48	21.85	15.89	19.87	13.91
There is extra land to plant fodder	10.60	1.99	10.60	29.14	47.68

Source: Own compilation from Survey Results (2024)

Rehman *et al.*, (2007) submit that the attitude of farmers plays an important role in their behavior intent, which usually leads to actual adoption behavior (adoption of improved agricultural technologies). In addition, Martínez-García *et al.*, (2013) also allude that, farmers' attitudes towards technology have a strong influence on whether farmers intend to use it.

Positive attitudes towards fodder seed technology emerged from the beliefs that using improved fodder varieties increases fodder production, provides fodder of good nutritive quality, provides fodder availability throughout the year, decreases animal feeding expenses, provides a cheap way to feed the herd, and increases milk production. A favourable attitude raises the probability of technology adoption while a negative attitude depresses it (Meijer *et al.*, 2015).

4.3.3 Practices in Fodder Seed Technology

Figure 4.10 shows the farmer's practice categories on fodder seed technology. To measure practices, the study used a binary response. Denoting: 1 if the farmer uses fodder seed technology for growing supplementary feed and doing any practices that form part of the processes that are involved in the planting of forage. Zero (0) was given if the farmer did not plant forage or did not do any of the processes that form part of the processes that are there in forage planting.

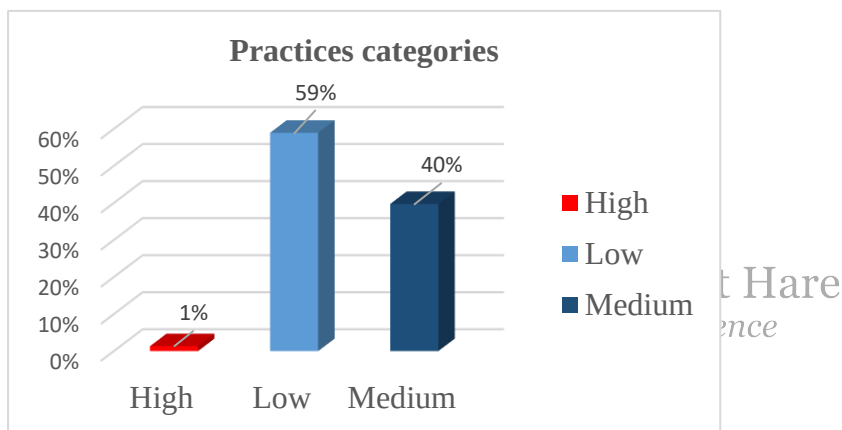


Figure 4.10: Farmers' practice categories

Source: Own compilation from Survey Results (2024)

To calculate the practice index (PI) the formula below was followed.

$$PI = \left(\frac{X}{Y} \right) \times 100 \dots\dots\dots(1.3)$$

Where:

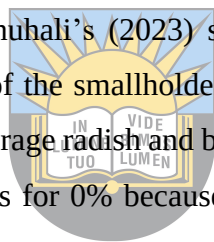
- PI was the Practice Index
- X was the Practice score achieved by farmers
- Y was the Maximum achievable score

The practice index was calculated and categorised;

- If a farmer had a practice index that is greater than 66%, it was regarded as having a high practice level.
- If the practice index was less than 28%, the farmer was regarded as having a low practice level.
- Any practice index between 29% and 65% was regarded as medium practice level.

Figure 4.10 shows that 59% of the farmers had a low practice level of planting forage, 40% of the farmers had a medium practice level of planting forage and 1% (the minority) of the farmers had a high level of practice for planting forage. Table 4.11 depicts the practice questions that were posed to the farmers regarding the planting of forage. The results in the table show that only 5% of the farmers were planting forage. However, even that minority did not use the varieties in question which are Sukari, Agriboost (Q), Endurance, Enhancer, and LS 35.

The farmers indicated that they plant oats, lucerne, barley, fodder radish, and other ryegrass varieties. This echoes Moyo & Ravhuhali's (2023) study carried out in the Eastern Cape province, which observed that most of the smallholder farmers in their study planted forage oats for winter feeding, followed by forage radish and barley. Very few farmers planted wheat, turnips annual ryegrass. This accounts for 0% because the farmers did not know any of the varieties that were listed for them.



University of Fort Hare
Together in Excellence

About 26% of the farmers used formal markets to purchase seeds, but the rest of the farmers used informal markets and indigenous seeds that were kept from the last harvest. Several reasons might be responsible for less planting of other species, such as lack of exposure, knowledge, and skill to cultivate them (Nzogela, 2021). Furthermore, the limited natural rainfall, which makes it difficult to sustain perennial species like ryegrass, combined with farmers' preference for annual pastures that allow land to be freed up for more profitable summer crop production, discourages the cultivation of perennial pasture species (Casler *et al.*, 2020; Moyo & Ravhulani, 2023).

Table 4.11: Practices of the farmers towards fodder seed technology

Practice Questions	Forage related planting	Not related to forage planting
Do you plant fodder seed?	5%	95%
Which company seed cultivars do you use?	26%	74%
Which water sources do you use?	100%	0%
Which nutrient solution do you use?	19%	74%
Which irrigation method do you use?	81%	19%
Which seed companies do you know?	23%	77%
Choose fodder varieties you know from the list	0%	100%
Which fodder varieties do you prefer, from the list?	1%	99%
Why do you prefer that variety?	1%	99%

Source: Own compilation from Survey Results (2024)

Table 4.11 depicts the practices of the farmers towards fodder seed technology. The table shows that 5% of the farmers in this study plant forage and 95% of the farmers reasoned to say they see it in commercial farms, but they have never practiced it and further suggested that they need to be educated about the planting of forage. The farmers also stated not having any forage seed companies available locally hinders their practice of forage planting.

Farmers reported that the main reasons for not establishing improved forage were a shortage of land for grazing or forage production and the absence of nearby adaptable improved forage seeds or seedlings. Additionally, farmers reported insufficient extension service supplies and a shortage of human labour, as some farmers are old and can no longer engage in intensive production.

In Moyo & Ravhuhali (2023) study in the Eastern Cape Province, about half of the small-scale farmers suggested a need to educate some of the farmers on the benefits of planting winter forages to improve their livestock production. Furthermore, in the same study by Moyo & Ravhuhali (2023) government support in the form of seeds, land preparation equipment, and fencing of fields was reported to be crucial for the wider adoption of the forage production farming practice.

4.4 Relationship between farmers' socioeconomic characteristics and KAP

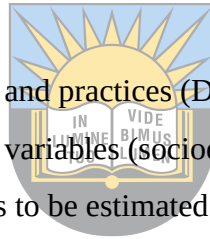
To determine the relationship between farmers' socioeconomic characteristics and KAP, an ordered probit model was used. Variables with a z-statistic of ± 1.96 or greater significantly affect the farmer's KAP at a 95% level or more. Variables with a z-statistic of ± 1.64 or greater but less than ± 1.96 are significant between 90% and 95% confidence levels. The coefficients represent the relationship between the independent variables (socioeconomic characteristics) and the dependent variable, which is the ordered categorical outcome (farmers' Knowledge, Attitudes, and Practices (KAP) categories for fodder seed technology).

A positive coefficient indicates that as the value of the independent variable increases, the probability of the dependent variable being in a higher category also increases. The mathematical expression of the model used was expressed using the equation below.

$$KAP_i = \beta_0 + \beta_1 X_{i1} + \beta_2 X_{i2} + \dots + \beta_k X_{ik} + \epsilon_i$$

Where:

- KAP was knowledge, attitude, and practices (Dependent variables)
- X was a matrix of independent variables (socioeconomic characteristics of farmers)
- β was the vector of coefficients to be estimated
- ϵ was the error term assumed to follow a standard normal distribution.



University of Port Harcourt
Together in Excellence

Table 4.12: Ordered Probit Model results for the relationship between farmers' socioeconomic characteristics and their knowledge of fodder seed technology

Variables	Coefficient	z	P> z
Age (years)	-.5723174	-2.06	0.039**
Gender	-.4261129	-0.82	0.410
Employment status	.019076	0.08	0.933
Educational level	.85764	1.82	0.069***
Sources of income	-.1020337	-0.74	0.462
Monthly income (Rands)	-8.09e-06	-0.17	0.868
Full-time/Part-time	-5.402582	-0.01	0.992
Household size	.1117914	1.32	0.187
Source of feed	.2452548	2.18	0.030**
Arable land (ha)	.2019098	1.32	0.187
Sources of agricultural information	.1701437	1.41	0.158
Extension Officer interaction	-.0305537	-0.05	0.962

Source: Own compilation from Survey Results (2024)

Significance levels: *** p<0.01: **p<0.05

The results of the ordered probit regression analysis indicate the relationship between farmers' socioeconomic characteristics and their knowledge regarding fodder seed technology. The following variables were found to be significant in determining the relationship between the farmer's socioeconomic characteristics and their knowledge regarding fodder seed technology in this study, are age, education level, and source of feed for their livestock.

The results show that **age** has a statistically significant negative effect on the dependent variable at the 5% significance level (p=0.039). This means that as age increases by one unit, farmer's knowledge regarding fodder seed technology decreases by approximately 0.5723 units, holding all other factors constant. This indicates that older farmers are less likely to have higher knowledge categories.

The finding that older farmers are less likely to have higher knowledge echoes Sun *et al.*, (2022) in a study conducted in Anhui that the proportion of farmers over 55 years old willing to adopt Integrated Pest Management (IPM) technology decreases as their age increases, indicating that elder farmers are more reluctant to adopt IPM technology.

Educational level has a marginally significant positive effect on the dependent variable at the 10% significance level ($p=0.069$), indicating that as educational level increases by one unit, farmer's knowledge of fodder seed technology increases by approximately 0.8576 units. This means that higher education may relate to greater knowledge of fodder seed technology, however, this effect is not strong.

Educational levels increase the ability to obtain, process, and use information relevant to the adoption of a new technology. This result confirms the previous literature on the positive influence of the education farmer on the knowledge and adoption of technologies. According to Sennuga, *et al.*, (2020), it is expected that more knowledgeable farmers could adopt more improved technologies than those less knowledgeable.

Additionally, the **source of feed** has a statistically significant positive effect on the farmer's knowledge regarding fodder seed technology at the 5% significance level ($p=0.030$), suggesting that as the source of feed increases by one unit, the farmer's knowledge regarding fodder seed technology increases by approximately 0.2453 units. The results suggest that farmers with a reliable feed source tend to have higher knowledge levels. On the other hand, gender, employment status, sources of income, estimated monthly income, full-time/part-time status, household size, arable land, sources of agricultural information, and interaction with extension officers do not have statistically significant effects on the dependent variable, as their p -values are greater than 0.1.

Extension Officer Interaction: The negative coefficient (-0.0305537) is insignificant ($p=0.962$), suggesting that, statistically, extension officer interaction does not significantly impact farmers' knowledge in this model. However, despite this insignificance, the role of extension officers in disseminating information and providing guidance remains critical. They serve as key sources of agricultural education, bridging the gap between research institutions and farmers, especially in rural areas.

The interactions can enhance farmers' understanding and adoption of new technologies, such as fodder seed technology, by offering practical support, training, and tailored advice. Similarly, Hossain *et al.*, (2021), in a study from Bangladesh, recognize that while private sectors, NGOs, and research organizations play a role in the technology transfer process, the Department of Agricultural Extension (DAE) plays a key part. The DAE familiarizes farmers with modern technologies for both rice and non-rice crops by offering training, conducting technology demonstrations, organizing field days, and providing essential information about these modern technologies.

Table 4.13: Ordered Probit Model results for the relationship between farmers' socioeconomic characteristics and their attitude toward fodder seed technology

Variables	Coefficient	z	P> z
Age (years)	-.1139191	-1.26	0.206
Gender	-.0963099	-0.48	0.630
Employment status	-.1426926	-1.38	0.166
Educational level	.098915	0.73	0.463
Sources of income	.095379	1.64	0.100*
Monthly income (Rands)	5.12e-06	0.24	0.813
Full-time/Part-time	-.5949755	-2.00	0.045**
Household size	.0052338	0.19	0.852
Source of feed	-.1749119	-3.46	0.001***
Arable land (ha)	.0765179	1.14	0.254
Sources of agricultural information	-.0037396	-0.08	0.938
Extension Officer interaction	-.0721905	-0.32	0.746

Source: Own compilation from Survey Results (2024)

Significance levels: *** p<0.01: **p<0.05

The Ordered Probit Model results indicate that two socioeconomic characteristics of farmers that were included in the model significantly influence their attitude toward fodder seed technology. The **full-time/part-time** status of the farmer has a statistically significant negative effect at the 5% significance level (p=0.045), suggesting that being a part-time farmer decreases

the likelihood of a positive attitude towards fodder seed technology by approximately 0.595 units.

The **source of feed** also shows a highly significant negative effect at the 1% significance level ($p=0.001$), indicating that changes in the source of feed are associated with a decrease of approximately 0.175 units in the likelihood of a positive attitude. This indicates that reliance on less reliable sources of feed is associated with less favorable attitudes toward fodder seed technology. Contrary to Mutavi (2017) a study conducted in Southern Eastern Kenya found that the type of feed for livestock positively influenced the adoption of fodder crops.

Other variables, including age, gender, employment status, educational level, estimated monthly income, household size, arable land, sources of agricultural information, and interaction with extension officers, do not show statistically significant effects on farmers' attitudes toward fodder seed technology, as their p -values are greater than 0.1. Additionally, **sources of income** are marginally significant ($p=0.100$), implying that more diverse income sources may contribute to a more favorable attitude.

Extension Officer Interaction: The negative coefficient (-0.0721905) is insignificant ($p=0.746$), suggesting that, statistically, interaction with extension officers does not significantly impact farmers' attitudes toward fodder seed technology in this model. However, despite its statistical insignificance, the role of extension officers remains crucial. Extension officers provide farmers with guidance, knowledge, and technical support, which can shape attitudes over time.

The engagement helps bridge the gap between farmers and new technologies by offering education and practical insights, making it easier for farmers to adopt and integrate innovative practices. Regular interaction with extension officers could lead to more informed and positive attitudes, even if this effect is not captured significantly in the current data.

Table 4.14: Ordered Probit Model results for the relationship between farmers' socioeconomic characteristics and their practice toward fodder seed technology

Variables	Coefficient	z	P> z
Age(years)	.0072712	0.06	0.948
Gender	-.0520452	-0.21	0.835
Employment status	-.0188336	-0.15	0.878
Educational level	.2403364	1.43	0.152
Sources of income	-.0268788	-0.39	0.699
Monthly income (Rands)	.000048	1.80	0.072*
Full-time/ Part-time	.4379247	1.21	0.227
Household size	.0216576	0.62	0.536
Source of feed	.1252661	2.11	0.035**
Arable land (ha)	.1021174	1.28	0.199
Sources of agricultural information	.1969252	3.36	0.001***
Extension Officer interaction	-.0196175	-0.07	0.944

Source: Own compilation from Survey Results (2024)

Significance levels: *** p<0.01: **p<0.05: *p<0.1

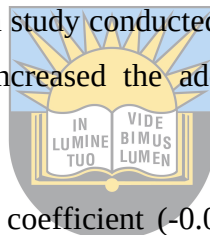
The results of the ordered probit regression analysis indicate the factors influencing the practice category of farmers on fodder seed technology. The following variables were found to be significant in determining the relationship between the farmer's socioeconomic characteristics and their practice of fodder seed technology in the study area: Monthly income, source of feed, and source of agricultural information.

Monthly income was significant at the 10% level ($p=0.072$), indicating a positive relationship between income and the probability of adopting fodder seed technology. The positive coefficient (0.000048) implies that as farmers' monthly income increases, their likelihood of adopting fodder seed technology also rises. These findings are like those of Sikundla *et al.*, (2018) in a study conducted in South Africa, where farmer's monthly income was significant at 10% with a positive relationship on the adoption of mobile phones in agricultural marketing.

In essence, the result suggests that as farmers' income increases, they are more willing to invest in agricultural technologies, such as fodder seed technology. This makes logical sense, as higher income enables farmers to allocate more resources to farming activities, with the expectation of higher returns. Farmers with more financial means may perceive technology adoption to increase productivity and improve their overall livelihoods, motivating them to invest in fodder seed technology.

The **source of feed** has a statistically significant positive effect on the practice category, it affects the probability of a high level of practice of forage planting at a 5% significant level. This indicates that farmers who have a reliable source of feed are more likely to be in the higher practice category of fodder seed technology.

Sources of agricultural information had a positive relationship with the practice level of fodder seed technology at a 1% significant level. This implies that farmers with better access to agricultural information are more likely to be in higher practice categories of planting forage. This echoes Dhraief *et al.*, (2018) in a study conducted in Tunisia, which found that having a source of agricultural information increased the adoption of innovative technologies by livestock farmers.



Extension Officer Interaction: The coefficient (-0.0196175) is negative and insignificant ($p=0.944$), suggesting that interaction with extension officers does not have a significant direct impact on farmers' practices regarding fodder seed technology in this study. However, despite the lack of statistical significance, extension officers play a crucial role in disseminating knowledge and information about agricultural technologies. Their interaction can influence farmers' attitudes and practices by providing practical advice, and technical assistance, and promoting the benefits of new technologies.

In the broader context, regular contact with extension officers can enhance farmers' understanding and trust in new technologies, leading to better adoption and implementation practices over time. This is in line with Beshir's (2013) study conducted in Ethiopia, which found that agricultural extension services are a main source of information concerning forage technologies for farmers. If the household has access to extension services, the chance of adoption of improved forage varieties is enhanced by 42%.

4.5 Farmer's willingness to pay for fodder seed technology

This section presents farmers' WTP for fodder seed technology. Contingent valuation experiments and primary survey data were used to estimate farmers' WTP for fodder seed technology. A double-bounded CV approach was used. This entailed study participants responding to a follow-up bid that was higher (lower) than the initial bid if the latter was accepted (rejected).

4.5.1 Binary response for farmers' willingness to pay for fodder seed technology

Table 4.15: Farmer's willingness to pay for fodder seed technology

Farmers response	Frequency	Percentage (%)
Yes	144	4.64
No	7	95.36
Total	151	100.00

Source: Own compilation from Survey Results (2024)

Table 4.15 summarizes farmers' responses to their willingness to pay (WTP) for fodder seed technology. Out of a total of 151 farmers sampled, 144 farmers (95.36%) indicated that they were willing to pay for the fodder seed technology. Conversely, only 7 farmers (4.64%) stated that they were not willing to pay for it. This indicates a strong positive response towards the adoption of fodder seed technology among the surveyed farmers, suggesting high interest and perceived value in this technology. These findings are like those of Ouédraogo *et al.*, (2022), in a study conducted in Burkina Faso, where 79% of the interviewed livestock producers were willing to pay or improve forages for their livestock.

4.5.2 Binary Responses of the farmers' willingness to pay for five different fodder Seed varieties

Table 4.16 presents a binary response analysis of the farmers' willingness to pay (WTP) for five different fodder seed varieties (Agriboost, Enhancer, Sukari, Endurance, LS 35) at two different bid levels. For Agriboost, at the first bid level, 29.14% of farmers were willing to pay, while this slightly decreased to 27.15% at the second bid level. Many of the farmers, however, were not willing to pay (70.86% and 72.85% for the first and second bid levels, respectively).

Enhancer shows a similar trend with 21.19% and 19.21% of respondents willing to pay at the first and second bid levels, respectively, and a substantial majority (78.81% and 80.79%) unwilling to pay. In contrast, Sukari had a higher willingness to pay, with 54.30% of farmers willing to pay at the first bid level, though this decreased to 42.38% at the second bid level. Still, a significant portion of farmers were unwilling to pay (45.70% at the first bid level, increasing to 57.62% at the second bid level).

For Endurance, about 33.77% of farmers were willing to pay at the first bid level, dropping to 28.48% at the second bid level, while the majority were not willing to pay (66.23% and 71.52% for the first and second bid levels, respectively). Finally, LS 35 had the lowest willingness to pay, with only 19.21% of farmers willing to pay at the first bid level and 16.56% at the second bid level. The vast majority were unwilling to pay (80.79% at the first bid level and 83.44% at the second bid level). Overall, Sukari showed the highest willingness to pay among the varieties, while LS 35 had the lowest.

Across all varieties, there was a noticeable decline in willingness to pay from the first bid level to the second bid level, indicating a sensitivity to increased bid amounts. For the five types of forage Agriboost (Q), Enhancer, Sukari, Endurance, and LS 35, 151 small-scale livestock farmers were asked about their willingness to pay for the bids presented. After stating how much they were willing to pay per kilogram (KG) for each fodder seed, the bid amounts were then increased by 25% and 50% to assess their responses.

Based on the summary of results for the binary response to Agriboost, Enhancer, Sukari, Endurance, and LS 35, approximately 29.14%, 21.19%, 54.30%, 33.77%, and 19.21% of farmers were willing to pay for the first bid level. For the second bid level, the willingness to pay decreased to 27.15%, 19.21%, 42.38%, 28.48%, and 16.56% for each respective forage seed.

Table 4.16: Binary response to the farmer's willingness to pay for fodder seeds

Response to WTP Question		Agriboost		Enhancer		Sukari		Endurance		LS 35	
		1 st Bid level	2 nd Bid level	1 st Bid level	2 nd Bid level	1 st Bid level	2 nd Bid level	1 st Bid level	2 nd Bid level	1 st Bid level	2 nd Bid level
Yes	Freq	44	41	32	29	82	64	51	43	29	25
	%	29.14	27.15	21.19	19.21	54.30	42.38	33.77	28.48	19.21	16.56
No	Freq	107	110	119	122	69	87	100	108	122	126
	%	70.86	72.85	78.81	80.79	45.70	57.62	66.23	71.52	80.79	83.44
Total	Freq	151	151	151	151	151	151	151	151	151	151
	%	100	100	100	100	100	100	100	100	100	100

Source: Own compilation from Survey Results (2024)

Respondents' "Yes" responses to the first bid level to all five fodder seeds have shown a decrease with increased second bid values. For example, on the first bid of agriboost about 29.14% of the respondents gave a "yes" response but the "yes" response of the second bid was less than that of the first bid level (27.15%). These trends are also persistent in the follow-up bid levels. This is in line with the law of demand and supply, which states that 'as price increases for the normal goods, demand decreases. These results are like those of Gonfa (2015) study on improved forage varieties in Ethiopia.

4.5.3 Farmers' maximum amount they are willing to pay for forage varieties

Table 4.17: Minimum and maximum willingness to pay amounts for the forage varieties by small-scale farmers

Fodder Variety	Minimum amount (Rands)	Maximum amount (Rands)
Agriboost (Q)	R60	R2000
Enhancer	R30	R2500
Sukari	R30	R1250
Endurance	R30	R2000
LS 35	R30	R2000

Source: Own compilation from Survey Results (2024)

Table 4.17 represents the range of amounts that farmers indicated to be willing to pay for different forage varieties. For the Agriboost variety, farmers indicated a willingness to pay off between R60 and R2000. The Enhancer variety had a slightly broader range, with farmers willing to pay from R30 to R2500. Sukari had a range from R30 to R1250, which is narrower compared to the previous two. Both Endurance and LS 35 had similar ranges, with the minimum amount at R30 and the maximum amount at R2000.

The findings indicate that there is a significant variation in the maximum amount farmers are willing to pay for different forage varieties, reflecting differing perceptions of value and affordability among the farmers. Based on the follow-up response, respondents were requested to decide the maximum amount they were willing to pay for the presented qualities of forage seed and the reason for their decision on the amount.

4.5.4 Reasons for farmers' maximum amount to pay for the fodder varieties

Table 4.18 presents farmers' reasons for the maximum amount they were willing to pay for five different fodder seed varieties: Agriboost, Enhancer, Sukari, Endurance, and LS 35.

Table 4.18: Farmers' reasons for the maximum amount to pay for the fodder varieties

Reasons	Agriboost		Enhancer		Sukari		Endurance		LS 35	
	Freq	%	Freq	%	Freq	%	Freq	%	Freq	%
The variety is worth that amount	1	0.66	0	0	4	2.65	1	0.66	1	0.66
Because I can afford it	18	11.92	19	12.58	51	33.77	26	17.22	17	11.26
I want to access good fodder seeds	22	14.57	12	7.95	23	15.23	27	17.88	9	5.96
Because I have no more information about it	3	1.99	2	1.32	1	0.66	2	1.32	0	0
The government should pay the rest	1	0.66	1	0.66	5	3.31	0	0	0	0
Other reasons (I don't like)	106	70.20	0	0	67	44.37	95	62.91	124	82.12
Total	151	100	151	100	151	100	151	100	151	100

Source: Own compilation from Survey Results (2024)

For Agriboost, the predominant reason (70.20%) for farmers' willingness to pay is classified under "Other reasons (I don't like)," indicating a high level of dissatisfaction or other unspecified factors influencing their decision. A notable proportion (14.57%) of the farmers selected Agriboost because they want access to "good fodder seeds", while 11.92% can afford it. Similarly, Enhancer sees no significant dissatisfaction, with affordability (12.58%) and access to good fodder seeds (7.95%) being the primary reasons for willingness to pay. Interestingly, 33.77% of the farmers chose Sukari because they can afford it, and another 15.23% want access to good fodder seeds. However, there is still a substantial 44.37% who indicated "Other reasons (I don't like it)" for this variety.

For Endurance, approximately, 62.91% of the farmers cited "Other reasons (I don't like)," indicating notable disinterest or dissatisfaction, despite 17.88% of farmers wanting access to good fodder seeds and 17.22% choosing it because they can afford it. LS 35 has the highest level of dissatisfaction, with about 82.12% of the farmers selecting "Other reasons (I don't like)." Only about 11.26% chose LS 35 because they can afford it, and approximately 5.96% want access to good fodder seeds.

Across all varieties, the least cited reasons include the belief that the variety is worth the amount, lack of information, and the expectation that the government should pay the rest, highlighting that dissatisfaction or affordability were the dominant factors influencing respondents' willingness to pay for these fodder seed varieties.

4.5.5 Determinants of the farmer's willingness to pay for fodder seed technology

Table 4.19: Binary Logistic regression results for the determinants of the farmer's willingness to pay for fodder seed technology

Variables	Odds ratio	z	p> z
Age (years)	7027503	-2.20	0.028**
Gender	5.159574	1.92	0.055 *
Employment status	.4770772	-0.78	0.433
Educational level	2.579886	0.91	0.363
Sources of income	.5524341	-1.12	0.263
Monthly income(Rands)	1.002416	2.13	0.033**
Fulltime farmer	.0277609	-1.48	0.139
Household size	3.571936	2.36	0.018***
Arable land(ha)	.2135523	-1.84	0.066*
Extension Officer interaction	.034004	-1.84	0.066*
Sources of agricultural information	1.847774	1.33	0.183
Cattle number	.9298907	-1.63	0.102
Sheep number	1.02402	0.74	0.461
Goat number	.7738802	-2.00	0.045**
Source of feed	.0646359	-1.85	0.064*

Source: Own compilation from Survey Results (2024)

Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. The binary logistic regression analysis revealed several significant determinants of farmers' willingness to pay (WTP) for fodder seed technology.

Age is negatively associated with WTP, as indicated by an odds ratio of 0.703 ($p = 0.028$), meaning older farmers are less likely to pay for fodder seed technology. This is like the findings by Acquah (2011), where age and farm size negatively influenced willingness to pay for climate change mitigation. This could be attributed to older farmers being more conservative and less willing to adopt new technologies, possibly due to their lower perceived benefits of long-term investments compared to younger farmers, who might be more open to innovation and experimentation

Gender also plays a significant role, with male farmers being over five times more likely to be willing to pay compared to female farmers (odds ratio of 5.160, $p = 0.055$), although this result is marginally significant. This echoes Shee *et al.*, (2019) findings where females on average were willing to pay relatively less for fertilizer than their male counterparts, while male WTP was lower for hybrid maize seed than females. This suggests that male farmers may have greater access to financial resources and decision-making authority, giving them a higher propensity to adopt and invest in new technologies.

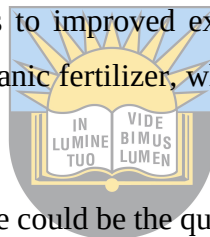
Monthly income positively influences WTP, with a slight increase in likelihood as income rises (odds ratio of 1.002, $p = 0.033$). Like Kidane *et al.*, (2019) findings where income from irrigation farming was found to have a positive and significant effect on farmer's WTP. This supports the argument that wealthier farmers have greater financial capacity to invest in new agricultural technologies. This is logical as farmers with higher incomes are more willing to allocate their resources to innovations that promise higher returns and farm efficiency from previous studies.

Household size is a strong positive determinant, with each additional member increasing the likelihood of willingness to pay (WTP) (odds ratio of 3.572, $p = 0.018$). These findings are in line with Gonfa (2015), who found that household size had a highly significant positive effect on the likelihood of WTP for improved forage seed varieties. This trend is likely because large household sizes are said to have greater resources compared to others (Ningi *et al.*, 2020). It

can be argued that larger households often have more labour and may generate more income, making it easier for them to adopt and invest in fodder seed technology.

Conversely, **arable land size** and **interaction with extension officers** are marginally associated with a decreased likelihood of WTP, as shown by odds ratios of 0.214 ($p = 0.066$) and 0.034 ($p = 0.066$), respectively. The finding that arable land size is marginally associated with a decreased likelihood of WTP (odds ratio of 0.214, $p = 0.066$) contrasts with expectations, as larger landholdings often enable farmers to benefit more from technology due to economies of scale. However, smaller farmers may be more motivated to adopt technologies like fodder seed to maximize production from limited land resources. This suggests that farmers with larger landholdings may prioritize other inputs or have less perceived need for fodder seed technology.

The negative association between interaction with extension officers and WTP (odds ratio of 0.034, $p = 0.066$) is surprising, as it contradicts findings by Shee *et al.*, (2019) in a study conducted in Tanzania, where access to improved extension services positively influenced WTP for hybrid maize seed and inorganic fertilizer, which are also categorized as technology in farming.



One potential reason for this difference could be the quality or frequency of extension services in the study area. In this study, results found that only 1.32% of farmers received education from extension officers about fodder seed varieties, while the majority (98.68%) of the farmers indicated that they never received such information. This lack of engagement may have contributed to a reduced understanding of the benefits of fodder seed technology, resulting in lower WTP.

The **number of goats** also significantly decreases the likelihood of WTP, with an odds ratio of 0.774 ($p = 0.045$). The results indicate that for each additional goat a farmer owns, the odds of being willing to pay for the technology decrease by about 22.6%, with this effect being statistically significant ($p = 0.045$). This suggests that farmers with more goats may be less inclined to invest in the technology, possibly due to having other feed resources to support their livestock.

The **Source of Feed** variable in the model refers to the diversity of feed sources that farmers use to feed their livestock. An odds ratio of 0.065 ($p = 0.064^*$) suggested that farmers who rely on a variety of feed sources are less likely to be willing to pay (WTP) for fodder seed technology. This relationship is statistically marginal. This suggests that farmers who already have access to a variety of feed sources may not feel the need to invest in fodder seed technology, as they likely believe their existing feed strategies are sufficient to meet their livestock's needs.

Other variables, such as employment status, educational level, sources of income, full-time farmer status, sources of agricultural information, number of cattle, and number of sheep, do not significantly influence WTP. Lusk (2003), in a study conducted in the United States—Mississippi, also found an insignificant association of education with WTP in the analysis for golden rice. Overall, the analysis highlights the importance of demographic and economic factors in determining farmers' willingness to invest in fodder seed technology.

4.6 Chapter Summary

This chapter provided an overview of the socio-economic characteristics of 151 small-scale livestock farmers. It finds that most farmers are older, predominantly male, and married, with many unemployed and reliant on pensions and grants. Educational levels vary, with most having secondary education. The average monthly income is relatively low, and farmers have small arable land sizes and varied livestock numbers. Feed primarily comes from communal grazing.

Land is mostly inherited, and while extension officers are the main source of agricultural information, there is a notable gap in knowledge about forage varieties. Membership in agricultural associations is relatively low, suggesting room for improved information exchange and support. The chapter also provided a comprehensive analysis of small-scale farmers' knowledge, attitudes, and practices towards fodder seed technology.

The study revealed a significant gap in farmers' knowledge, with the majority lacking awareness about the benefits and applications of fodder seed technology. The analysis of attitudes showed that while a majority of farmers had a positive view towards fodder seeds, there remained a notable proportion with neutral or negative attitudes. Practices related to fodder seed technology were found to be generally limited, with most farmers engaging in minimal use and relying on informal markets and indigenous seeds.

The relationship between socioeconomic characteristics and KAP was explored using an ordered probit model, indicating that factors such as age, education level, and the source of feed significantly influence farmers' knowledge and attitudes. The chapter also presented an analysis of small-scale livestock farmers' willingness to pay for fodder seed technology. The findings revealed a high overall willingness to pay, with varying responses to different fodder seed varieties and bid levels. The chapter also highlighted significant determinants of WTP, including age, gender, and household size, and provided insight into farmers' maximum amount they were willing to pay and their reasons for these amounts.



University of Fort Hare
Together in Excellence

Chapter Five

Summary, Conclusions, and Recommendations

5.1 Introduction

This chapter provides an overview of the study by presenting a summary, conclusion, and recommendations. The recommendations aim to guide policymakers and relevant stakeholders on how the study's findings can be applied to inform their decisions and strategies.

5.2 Summary

In South Africa, like in most countries in the world, livestock farming plays a very important role in the agricultural sector owing to its great potential to provide sustenance for most rural communities. Livestock farming is practiced in all nine provinces of South Africa, both at smallholder and commercial levels. The literature reviewed in this study identified several key issues affecting small-scale farmers, including poor knowledge of forage sources, restricted access to improved forage varieties, which includes the lack of forage seed companies locally, and reliance on traditional agricultural techniques. These challenges are compounded by climate change, land degradation, and highly seasonal rainfall patterns, which exacerbate the variability in livestock forage availability.

Despite the benefits of improved fodder varieties, there has been limited adoption among small-scale farmers due to a lack of awareness and limited public sector involvement. Therefore, this study has sought to fill this knowledge gap, by analysing small-scale livestock farmers' knowledge, attitude, practices (KAPs), and willingness to pay (WTP) for fodder seed technology in OR Tambo District in the Eastern Cape. The study's specific objectives were listed as follows:

- To profile small-scale livestock farmers based on their demographic and socio-economic characteristics.
- To assess the KAPs of small-scale livestock farmers on fodder seed technology.
- To determine the relationship between small-scale livestock farmers' KAP of fodder seed technology and their socio-economic characteristics; and
- To assess small-scale livestock farmers' willingness to pay for fodder seed technology.

To address the objectives, the study focused on small-scale livestock farmers in three local municipalities within the OR Tambo District in the Eastern Cape: King Sabata Dalindyebo, Port St Johns, and Ingquza Hill. Data was collected from 151 small-scale livestock farmers. This data was collected in the form of interviews using questionnaires.

The study focused on five forage seed varieties in the willingness to pay section, and the seed varieties are Sukari, Endurance, Agriboost, Enhancer, and LS 35. Sukari, a high-sugar Italian ryegrass, is particularly suited to bridging summer and autumn fodder gaps. Endurance, a newly developed fodder radish, which offers extended grazing periods due to its late flowering and robust bulb quality, making it ideal for drought and heat-prone regions.

Enhancer and Agriboost are Italian ryegrass varieties, both contributing to improved forage quality and increased milk production, with Agriboost excelling in grazing tolerance. Lastly, LS 35, a fast-growing forage cereal, is ideal for regions needing rapid feed production, often used as a nurse crop. These varieties provide valuable solutions for enhancing fodder production, particularly in high-rainfall regions and during periods of feed scarcity.

5.3 Limitations of the Study

The study faced several limitations that may affect the generalizability and depth of its findings. First, it was geographically confined to small-scale livestock farmers in OR Tambo District, Eastern Cape, which may limit the applicability of the results to other regions with different environmental, economic, and cultural conditions. Additionally, the data relied on self-reported responses, which may introduce biases such as recall or social desirability bias, potentially skewing the accuracy of farmers' reported knowledge, attitudes, practices, and willingness to pay (WTP). The sample size, while appropriate for the study area, may not have captured the full diversity of small-scale farmers, particularly those in remote or underserved regions.

Moreover, the cross-sectional nature of the study only provides a snapshot of farmers' knowledge, attitudes, practices (KAPs), and WTP at a single point in time, limiting the ability to observe changes over time. Furthermore, external factors such as market access, government policies, and environmental conditions were not deeply explored, even though they may significantly influence farmers' adoption of fodder seed technology. Finally, the exclusive focus on small-scale farmers means the findings may not apply to larger commercial farmers who operate under different circumstances. Despite these limitations, the study offers valuable insights into the challenges faced by small-scale livestock farmers in adopting fodder seed technology.

5.4 Conclusions and Recommendations

Socioeconomic characteristics of the small-scale livestock farmers

The study found that most farmers were older, and males with many relying on communal grazing land for livestock feed. Most farmers were unemployed and depended on social grants for income, with education levels primarily at the secondary level. Efforts should be made to engage younger generations in livestock farming to ensure long-term sustainability.

The majority of farmers inherited their land. Agricultural information was primarily sourced from extension officers, who are trusted to provide valuable guidance. However, there is a significant gap in knowledge transfer regarding fodder seed varieties, as most farmers indicated they had not received sufficient information unless they specifically inquired. This points to the need for more proactive efforts by extension services to educate farmers on diverse forage options and their benefits for livestock management.

Only a portion of farmers reported being part of farmers' associations. Initiatives should be taken to encourage farmers to join agricultural associations or cooperatives. These associations can serve as platforms for information exchange, capacity building, and collective bargaining, making it easier for farmers to access resources and adopt new technologies like fodder seed.

Small-scale livestock farmer's KAP on fodder seed technology

The study found that small-scale livestock farmers in OR Tambo District have limited knowledge and practice of fodder seed technology, despite recognizing its benefits for consistent and high-quality livestock feed. To bridge this knowledge gap, educational programs through farmer's associations, workshops, and strengthened extension services are essential. Collaboration with agricultural institutions could also help disseminate research and practical knowledge.

The government could also enhance small-scale farmers' access to technical information, extension services, and training by providing extension officers and research stations with the necessary resources, support, and physical capacity to introduce small-scale livestock farmers to fodder seed technology through demonstrations and training sessions. Farmers showed positive attitudes towards fodder seed technology when informed about its advantages.

To reinforce this, sharing success stories, promoting farmer-to-farmer learning, and creating knowledge exchange platforms are recommended. Only 5% of farmers practiced planting forage at a high level. Improving access to high-quality seeds and resources, providing financial incentives, and setting up demonstration plots can enhance the adoption of fodder seed technology.

Relationship between farmers' socioeconomic characteristics and their KAP on fodder seed technology

For the third objective, the study used an ordered probit model. The ordered probit model results highlighted that older farmer had lower knowledge levels, while higher education and reliable feed sources improved knowledge. Part-time farming status and unreliable feed negatively affected attitudes, whereas income showed a marginal positive influence. Higher-income, reliable feed sources, and access to agricultural information significantly boosted practices for fodder seed technology. Based on these findings, it is recommended that targeted educational and support programs be introduced to enhance farmers' knowledge and practical use of fodder seed technology. Extension services should prioritise younger and less educated farmers, providing tailored training on forage, seed varieties, planting techniques, and the benefits of improved forage. Additionally, government and non-governmental organisations should focus on increasing access to reliable feed sources and agricultural information, particularly for part-time farmers. Improved access to agricultural inputs and consistent knowledge-sharing platforms can empower small-scale livestock farmers to adopt fodder seed technology as a viable strategy to mitigate the effects of climate change and enhance livestock productivity. These findings are valuable for policymakers and researchers supporting agricultural technology adoption.

Farmers' willingness to pay for fodder seed technology

This study employed a contingent valuation method to estimate the willingness to pay (WTP) for fodder seed technology among small-scale livestock farmers in the OR Tambo district. Descriptive statistics were used to analyse the WTP of the farmers. Findings demonstrate a strong willingness to pay (WTP) for fodder seed technology among small-scale livestock farmers in the study areas. With 95.36% of the farmers indicating a positive response towards paying for this technology, it is evident that there is a high level of interest and perceived value associated with fodder seed varieties.

Given the high WTP, policymakers should consider providing subsidies or financial incentives to make fodder seed technology more affordable for small-scale farmers. This can help in accelerating adoption rates and ensuring sustained use. The analysis revealed several key insights. Firstly, there was significant variation in WTP across the five fodder seed varieties (Agriboost, Enhancer, Sukari, Endurance, and LS 35). Sukari has the highest WTP, with 54.30% of respondents willing to pay at the first bid level, though this decreased to 42.38% at the second bid level.

In contrast, LS 35 showed the lowest WTP, with only 19.21% willing to pay at the first bid level, decreasing to 16.56% at the second bid level. There was a general trend of decreasing WTP as the bid amount increased, consistent with the law of demand, which states that as price increases, the demand for a normal good decreases. Given the varying WTP for different fodder varieties, targeted interventions and marketing strategies should be developed for each variety. For example, Sukari, which had the highest WTP, can be promoted more aggressively, highlighting its benefits and suitability for farmers' needs.

Secondly, the maximum amounts farmers were willing to pay varied significantly among the fodder varieties, reflecting differing perceptions of value and affordability. Enhancer had the broadest range of maximum amounts (R30 to R2500), while Sukari had the narrowest range (R30 to R1250). These variations indicate that farmers place different values on each variety based on their specific needs and perceived benefits. To increase WTP, efforts should be made to make fodder seed technology more affordable. This could involve subsidizing the cost of fodder seeds, providing credit facilities, or offering bulk purchase discounts. Additionally, enhancing the perceived value of the seeds through demonstrations of their benefits could justify higher prices.

Thirdly, the reasons behind farmers' WTP were primarily related to affordability and the desire to access good fodder seeds. However, a substantial portion of respondents cited dissatisfaction or unspecified reasons for their reluctance to pay, particularly for Agriboost, Endurance, and LS 35. This indicates that while affordability and quality are significant factors, other concerns need to be addressed to increase WTP for certain varieties. A significant number of farmers cited dissatisfaction or lack of information as reasons for their reluctance to pay. Improving information dissemination through extension services, farmer training programs, and demonstration plots can help address these concerns.

Determinants for farmers' willingness to pay

Lastly, a binary logistic regression analysis was used to identify several significant determinants of WTP. It revealed that age was a negative determinant, with older farmers less likely to pay for the technology. Gender also played a significant role, with male farmers being more likely to pay compared to female farmers. Since male farmers are more likely to pay for fodder seed technology, therefore, gender-sensitive approaches should be implemented to encourage female farmers to adopt the technology.

The suggested training could include women-specific training programs, support groups, and ensuring that extension services are accessible and relevant to female farmers. Estimated monthly income and household size were positive determinants, with higher income and larger household size increasing the likelihood of WTP. The positive association between household size and WTP indicates that larger households may have more labour and resources to invest in fodder seed technology. Programs should consider household dynamics and provide support that leverages the strengths of larger households while also addressing the unique challenges faced by smaller households.

Conversely, the size of arable land, interaction with extension officers, and the number of goats were negatively associated with WTP. The negative association between interaction with extension officers and WTP suggests that the quality and effectiveness of extension services need improvement. Training extension officers to provide better support and advice tailored to farmers' specific needs can enhance the perceived value of the technology and increase WTP.

5.5 Policy recommendations

The study found that many farmers who are unaware of or do not plant forage in the study areas lack access to extension services and have never been informed by an extension officer about forage planting or available fodder varieties. Access to extension services is vital, as it can empower farmers with essential knowledge, techniques, and skills. Improved access to these services will likely increase the adoption of fodder seed technology, thereby enhancing feed security for small-scale livestock farmers, particularly during dry seasons when natural grazing is insufficient.

Furthermore, some farmers indicated that the cost of fodder seeds might be prohibitive, as there are no local fodder seed companies, necessitating travel to access these seeds. To mitigate this, the government could consider providing incentives such as subsidized seed supplies and

farming inputs. Certified seeds could also be made readily available to small-scale farmers, as many currently rely on seeds from informal markets or previous harvests, which may not meet quality standards. Ensuring the availability of forage-certified seeds will improve forage quality and yield.

Additionally, smallholder farmers require access to financial resources to invest in basic inputs like improved seeds and fertilizers, which are essential for boosting farm productivity and generating profits. However, these farmers often face challenges in accessing finance due to the absence of financial institutions in rural areas or stringent loan requirements from banks, such as having registered their farm as a business, which small-scale farmers may not possess. Therefore, the government could introduce or strengthen agricultural finance institutions in rural areas, specifically designed to assist small-scale farmers.

Additionally, some farmers reported limited access to hired labour, which is a critical issue given that fodder seed technology can be labour-intensive, given that these farmers are still using traditional techniques to plough. Encouraging small-scale farmers to work together as cooperatives or associations can help mitigate labour constraints by enabling mutual support during various production stages. This collaborative approach will positively impact the adoption of fodder seed technology and improve livestock feed security among small-scale livestock farmers.



5.6 Areas for further research

This study analysed small-scale livestock farmer's knowledge, attitudes, practices, and willingness to pay for fodder seed technology, at OR Tambo District in the Eastern Cape. For further research, it would be valuable to explore the long-term impact of adopting fodder seed technology on the livelihoods of small-scale livestock farmers in OR Tambo District Municipality. This could include examining the sustainability and scalability of this technology in diverse agro-ecological zones within the region.

Additionally, investigating the role of government and non-governmental organizations in facilitating access to fodder seed technology, and their effectiveness in addressing barriers to adoption, could provide insights into improving support systems for these farmers. Finally, the impact of climate change on the effectiveness of fodder seed technology in improving livestock productivity could be studied to enhance the resilience of small-scale farmers in the face of environmental challenges.

References

- Abegunde, V.O., Sibanda, M. and Obi, A., 2019. Determinants of the adoption of climate-smart agricultural practices by small-scale farming households in King Cetshwayo District Municipality, South Africa. *Sustainability*, 12(1), pp.195.
- Acquah, H.D.G., 2011. Farmers' perception and adaptation to climate change: A willingness to pay analysis. *Journal of Sustainable Development in Africa*, 13(5), pp. 157-159.
- Adio, E.O., Abu, Y., YUsuf, S.K. and Nansoh, S., 2016. Use of agricultural information sources and services by farmers for improve productivity in Kwara State. *Library Philosophy and Practice*, 1456, pp.1-16.
- Agbugba, I.K., Christian, M. and Obi, A., 2020. Economic analysis of smallholder maize farmers: implications for public extension services in Eastern Cape. *South African Journal of Agricultural Extension*, 48(2), pp.50-63.
- Ahamed, M.S., Sultan, M., Shamshiri, R.R., Rahman, M.M., Aleem, M. and Balasundram, S.K., 2023. Present status and challenges of fodder production in controlled environments: A review. *Smart Agricultural Technology*, 3, pp.1-4.
- Ajamo, S.S., 2019. *Household's willingness to pay for soil conservation practices: a contingent valuation study at Abaro Zone, Southern Ethiopia* (Doctoral dissertation, Hawassa University, Ethiopia).
- Alende, M., 2016. *Evaluation of high sugar ryegrass varieties* (Doctoral dissertation, Clemson University, South Carolina).
- Alexander, P.A. and Dochy, F.J., 1995. Conceptions of knowledge and beliefs: A comparison across varying cultural and educational communities. *American Educational Research Journal*, 32(2), pp.413-442.
- Amasi, A.S., 2021. *Assessment of Awareness, Knowledge and Attitude on Impacts of Fire Outbreak to Standard Seven Pupils at Morogoro Municipal and Mvomero District, Tanzania* (Doctoral dissertation, The Open University of Tanzania, Tanzania).
- Ammann, S., Nash, D. and Goodenough, D. 2015. *Together we have made KwaZulu-Natal a better province to live in fodder radish and other forage brassicas*. [online]

Available at:
https://www.kzndard.gov.za/images/Documents/researchandtechnologydevelopment/publications/Research_and_Technology_Bulletins/2015.17-Fodder-Radish-and-other-forage-brassicus.pdf.

Amole, T., Augustine, A., Balehegn, M. and Adesogoan, A.T., 2022. Livestock feed resources in the West African Sahel. *Agronomy Journal*, 114(1), pp.26-45.

Amuge, M. and Osewe, D., 2017. Socio-economic factors influencing adoption of feed based dairy technologies among smallholder farmers in ekerenyo sub-county, Kenya. *Asian Journal of Agricultural Extension, Economics & Sociology*, 16(2), pp.1-8.

Anang, B.T., 2018. Farm technology adoption by smallholder farmers in Ghana. *Review of Agricultural and Applied Economics (RAAE)*, 21(2), pp.41-47.

Antoušková, M., 2012. Comparison of take-it-or-leave-it and take-it-or-leave-it with follow-up elicitation formats—case study of Czech national parks. *Acta Universitatis Agriculturae Et Silviculturae Mendelianae Brunensis*, 60(7), pp.19-24.

Antwi, M.A., Mazibuko, N.V.E. and Chagwiza, C., 2017. Determinants of smallholder cattle farmers' access to high-value cattle markets in the Ngaka Modiri Molema District, South Africa. *Indian Journal of Animal Research*, 51(4), pp.764-770.

ARC (Agricultural Research Council-SCW), (ARC-SCW), 2020. Pretoria, South Africa. [online] Available at: <https://www.arc.agric.za/arc-iscw/CSA-Toolbox/CSA%20Agrometeorology%20Production/Presentations/Walker-%202020%20AAT-ClCh%20ARC%20experience%20-16%20Jan%202020=no%20Video-compress.pdf> [Accessed 17 September 2023].

Asrat, P., Belay, K. and Hamito, D., 2004. Determinants of farmers' willingness to pay for soil conservation practices in the southeastern highlands of Ethiopia. *Land Degradation & Development*, 15(4), pp.423-438.

Ayamga, M.B., 2018. Access to Hybrid Seeds in Ghana: A case of Smallholder Farmers in Tamale. *International Institute of Social Studies, The Hague, Netherlands* (Master's dissertation, International Institute of Social Studies, Netherlands).

- Ayenew, W., Lakew, T. and Kristos, E.H., 2020. Agricultural technology adoption and its impact on smallholder farmers welfare in Ethiopia. *African Journal of Agricultural Research*, 15(3), pp.431-445.
- Bahta, Y.T. and Myeki, V.A., 2022. The Impact of Agricultural Drought on Smallholder Livestock Farmers: Empirical Evidence Insights from Northern Cape, South Africa. *Agriculture*, 12(442), pp.1-24
- Bahta, Y.T., 2020. Smallholder livestock farmers coping and adaptation strategies to agricultural drought. *AIMS Agriculture and Food*, 5(4), pp.964-982.
- Balehegn, M., Ayantunde, A., Amole, T., Njarui, D., Nkosi, B.D., Müller, F.L., Meeske, R., Tjelele, T.J., Malebana, I.M., Madibela, O.R. and Boitumelo, W.S., 2022. Forage conservation in Sub-Saharan Africa: Review of experiences, challenges, and opportunities. *Agronomy Journal*, 114(1), pp.75-99.
- Balehegn, M., Duncan, A., Tolera, A., Ayantunde, A.A., Issa, S., Karimou, M., Zampaligré, N., André, K., Gnanda, I., Varijakshapanicker, P. and Kebreab, E., 2020. Improving adoption of technologies and interventions for increasing supply of quality livestock feed in low-and middle-income countries. *Global Food Security*, 26, pp.2-6.
- Baltenweck, I., Cherney, D., Duncan, A., Eldermire, E., Lwoga, E.T., Labarta, R., Rao, E.J.O., Staal, S. and Teufel, N., 2020. A scoping review of feed interventions and livelihoods of small-scale livestock keepers. *Nature Plants*, 6(10), pp.1242-1249.
- Bantie, Y., 2011. *The value of improved water supply service in Motta town, Ease Gojjam, Ethiopia: Appliaction of contingent valuation method (CVM)* (Doctoral dissertation, MSc thesis), Addis Ababa University, Ethiopia).
- Beke, T.E., 2011. Institutional constraints and adoption of improved rice varieties: Econometric evidence from Ivory Coast. *Review of Agricultural and Environmental Studies-Revue d'Etudes en Agriculture et Environnement (RAEStud)*, 92(2), pp.117-141.

- Bello, H.S., Isa, T., Isa, M.A. and Akinmuisere, K., 2013. Effects of land use on the nature and population of microorganisms in the semi-arid region of north-eastern Nigeria. *International journal of environment*, 2(1), pp.224-230.
- Bennett, J., Ainslie, A. and Davis, J., 2013. Contested institutions? Traditional leaders and land access and control in communal areas of Eastern Cape Province, South Africa. *Land Use Policy*, 32, pp.27-38.
- Bennett, J.W. and Carter, M., 1993. Prospects for contingent valuation: lessons from the SOUTH-EAST forests 1. *Australian Journal of Agricultural Economics*, 37(2), pp.79-93.
- Bese, D., Zwane, E. and Cheteni, P., 2021. The use of sustainable agricultural methods amongst smallholder farmers in the Eastern Cape province, South Africa. *African Journal of Science, Technology, Innovation and Development*, 13(3), pp.261-271.
- Bese, D., Zwane, E. and Cheteni, P., 2021. The use of sustainable agricultural methods amongst smallholder farmers in the Eastern Cape province, South Africa. *African Journal of Science, Technology, Innovation and Development*, 13(3), pp.261-271.
- Bese, D., Zwane, P.E. and Cheteni, P., 2021. Adoption of Sustainable Agricultural Practices by Smallholder Farmers in Mbhashe Municipality in the Eastern Cape Province, South Africa. *African Journal of Development Studies*, 2021, pp.11-33.
- Bese, D.F., 2020. *Sustainable farmer livelihoods and enhancement of food security in Mbhashe Municipality, Eastern Cape Province, South Africa* (Doctoral dissertation, University of the Free State, South Africa).
- Bese, D.F., 2020. *Sustainable farmer livelihoods and enhancement of food security in Mbhashe Municipality, Eastern Cape Province, South Africa* (Doctoral dissertation, University of the Free State).
- Beshir, H., 2013. Factors affecting the adoption and intensity of use of improved forages in North East Highlands of Ethiopia. *American Journal of Experimental Agriculture*, 4(1), pp.12-27.

- Betek, C.K.E. and Jumbam, N.D., 2015. Small scale vegetable production: A case study of Port St Johns, Eastern Cape Province, South Africa. *Transactions of the Royal Society of South Africa*, 70(1), pp.41-45.
- Bettencourt, E.M.V., Tilman, M., Henriques, P.D.S., Narciso, V. and Carvalho, M.L.S., 2013. The Economic and Sociocultural Role of Livestock in the Wellbeing of Rural Communities of Timor-Leste. *CEFAGE-UE Working Papers*. [online] Available at: https://ideas.repec.org/p/cfe/wpcefa/2013_01.html [Accessed 4 April. 2023].
- Bless, C., Higson-Smith, C. and Kagee, A., 2011. *Fundamentals of social research methods: An African perspective*. Juta and Company Ltd.
- Bonabana-Wabbi, J., Kirinya, J., Kasenge, V., Semalulu, O. and Mugonola, B., 2015. Smallholder farmers' access to improved groundnut production and value addition technologies in Eastern Uganda. *Journal of Agricultural Extension and rural development*, 7(8), pp.247-256.
- Bonabana-Wabbi, J., Mogoka, H., Semalulu, O., Kirinya, J. and Mugonola, B., 2016. Adoption of integrated soil fertility management by groundnut farmers in Eastern Uganda. *Journal of Development and Agricultural Economics*, 8(4), pp.86-94.
- Bontsa, N.V., Mushunje, A. and Ngarava, S., 2023. Factors influencing the perceptions of smallholder farmers towards adoption of digital technologies in Eastern Cape Province, South Africa. *Agriculture*, 13(8), pp.2-16.
- Boonchan, B., 2020. The Relationship between Factors Affecting the Public Mind: Developing a Model for University Students. *Human Behavior, Development & Society*, 21(4), pp.17-23.
- Botlhoko, G.J. and Oladele, O.I., 2013. Factors affecting farmers' participation in agricultural Projects in Ngaka Modiri Molema district North West province, South Africa. *Journal of Human Ecology*, 41(3), pp.201-206.
- Busk, P.K., 2014. A tool for design of primers for microRNA-specific quantitative RT-qPCR. *BMC bioinformatics*, 15(29), pp.1-9.
- Capstone seeds. 2020. *Italian Ryegrass* | capstone seeds. [online] Available at: <https://www.capstone seeds.com/italian-ryegrass>.

- Carelsen, C.P.R., Ncube, B. and Fanadzo, M., 2021. Classification and characterisation of smallholder farmers in South Africa: a brief review. *South African Journal of Agricultural Extension*, 49(2), pp.97-106.
- Casler, M.D., Kallenbach, R.L. and Brink, G.E., 2020. Cool-Season Grasses for Humid Areas. *Forages: The science of grassland agriculture*, 2, pp.297-311.
- Chakoma, I. and Chummun, B.Z., 2019. Forage seed value chain analysis in a subhumid region of Zimbabwe: perspectives of smallholder producers. *African Journal of Range & Forage Science*, 36(2), pp.95-104.
- Chakoma, I.C., 2012. Sustainable forage production strategies for small scale livestock production in Zimbabwe. *International Journal of Agriculture Innovations and Research*, 1(3), pp.85-89.
- Challa, M. and Tilahun, U., 2014. Determinants and impacts of modern agricultural technology adoption in west Wollega: the case of Gulliso district. *Journal of Biology, Agriculture and Healthcare*, 4(20), pp.63-77.
- Cheteni, P., 2017. Sustainability development: Biofuels in agriculture. *Environmental Economics*, 8(2), pp.83-91.
- Cheteni, P., Mushunje, A. and Taruvinga, A., 2014. Barriers and Incentives to Potential Adoption of Biofuel Crops by Smallholder Farmers in the Eastern Cape Province, South Africa. *Journal Environmental Economics*, 5(3), pp. 71-77.
- Chin, K.K., Mahanta, J. & Nath, T.K., 2023. Knowledge, attitude, and practices toward plastic pollution among Malaysians: Implications for minimizing plastic use and pollution. *Sustainability*, 15(2), pp.11-64. Available at: <https://doi.org/10.3390/su15021164> [Accessed 14 August 2023].
- Chipfupa, U. and Tagwi, A., 2021. Youth's participation in agriculture: A fallacy or achievable possibility? Evidence from rural South Africa. *South African Journal of Economic and Management Sciences*, 24(1), pp.1-12.
- Christian, M., Obi, A. and Agbugba, I.K., 2019. Adoption of irrigation technology to combat household food insecurity in the resource-constrained farming systems of the

Eastern Cape Province, South Africa. *South African Journal of Agricultural Extension*, 47(2), pp.94-104.

Chuang, J.H., Wang, J.H. and Liou, Y.C., 2020. Farmers' knowledge, attitude, and adoption of smart agriculture technology in Taiwan. *International Journal of Environmental Research and Public Health*, 17(19), pp.26-36.

Croppenstedt, A., Demeke, M. and Meschi, M.M., 2003. Technology adoption in the presence of constraints: the case of fertilizer demand in Ethiopia. *Review of Development Economics*, 7(1), pp.58-70.

Current, D., Motschke, C., Serra Jr, A., Wyatt, G. and Zamora, D., 2019. *Expanding landowner adoption of snow control measures through a better understanding of landowner knowledge, attitudes, and practices* (No. MN/RC 2019-44). Minnesota. Department of Transportation. Office of Research & Innovation.

D'Souza, G.E. and Gebremedhin, T.G., 2019. *Sustainability in agricultural and rural development*. Routledge. Available at: [https://books.google.com/books?hl=en&lr=&id=ETr3DwAAQBAJ&oi=fnd&pg=PP1&dq=D%E2%80%99Souza+%26+Gebremedhin+\(2019\)+&ots=H7LBDWno u4&sig=cOCn0P670_on7WnufkHguzMoIUy](https://books.google.com/books?hl=en&lr=&id=ETr3DwAAQBAJ&oi=fnd&pg=PP1&dq=D%E2%80%99Souza+%26+Gebremedhin+(2019)+&ots=H7LBDWno u4&sig=cOCn0P670_on7WnufkHguzMoIUy) [Accessed 25 July 2024].

Dahir Abdi, A., 2016. *Assessment of feed resources and identification of coping strategies during drought by pastoralists and agro-pastoralists at Gode district of Somali Region, Ethiopia* (Doctoral dissertation, Haramaya University).

DALRRD (Department Agriculture, Land Reform and Rural Development), 2020. Abstract of Agricultural statistics, Pretoria, South Africa. Available at: https://www.dalrrd.gov.za/phocadownloadpap/Statistics and Economic Analysis/Statistical Information/Abstract%202020_organized.pdf [Accessed 15 July 2023].

DALRRD (Department Agriculture, Land Reform and Rural Development), 2023. *Department of Agriculture, Land Reform and Rural Development > Branches > Agricultural Production, Health & Food Safety > Animal Production > Veld, Forage and Wildlife Ranching Division*. [online] Available at: <https://old.dalrrd.gov.za/Branches/Agricultural-Production-Health-Food->

Safety/Animal-Production/Veld-Forage-and-Wildlife-Ranching-Division
[Accessed 23 March 2023].

Daniel, S., 2011, April. The Role of the international finance corporation in promoting agricultural investment and large-scale land acquisitions. [online] Available at: <https://www.future-agricultures.org/wp-content/uploads/pdf-archive/Shepard%20Daniel.pdf> [Accessed 22 August 2023].

Das, M.K., Islam, M.M. and Billah, M.M., 2019. Farmers' knowledge, attitude and practice (KAP) regarding nitrogen-fortified organic manure in crop production. *Asian Journal of Agricultural Extension, Economics & Sociology*, 33(3), pp.1-12.

Davis, R.K., 1963. Recreation planning as an economic problem. *Natural Resources Journal*, 3(2), pp.239-250.

de Souza Filho, H.M., 2018. *The adoption of sustainable agricultural technologies: a case study in the State of Espirito Santo, Brazil*. Routledge.

De Wolf, J.J., 2010. Innovative farmers, non-adapting institutions: a case study of the organization of agroforestry research in Malawi. *Beyond the Biophysical: Knowledge, Culture, and Politics in Agriculture and Natural Resource Management*, pp.217-239.



University of Fort Hare
Together in Excellence

Deh-Haghi, Z., Bagheri, A., Fotourehchi, Z. and Damalas, C.A., 2020. Farmers' acceptance and willingness to pay for using treated wastewater in crop irrigation: A survey in western Iran. *Agricultural Water Management*, 239, pp. 2-8.

Department of Agriculture Forestry and Fisheries, (DAFF). Abstract of Agricultural Statistics; Department of Agriculture, Forestry and Fisheries: Pretoria, South Africa, 2019. Available at: <https://pmg.org.za/committee-meeting/31549/> [Accessed 1 March 2024].

Department of Agriculture Forestry and Fisheries, (DAFF). Abstract of Agricultural Statistics; Department of Agriculture, Forestry and Fisheries: Pretoria, South Africa, 2018. Available at: https://www.gov.za/sites/default/files/gcis_document/201811/arfinal28-septembera.pdf. [Accessed 15 June 2023].

- Dhraief, M.Z., Bedhiaf-Romdhania, S., Dhehibib, B., Oueslati-Zlaouia, M., Jebali, O. and Ben Youssef, S., 2018. Factors affecting the adoption of innovative technologies by livestock farmers in arid area of Tunisia. *FARA Research Report*, 3(5), pp.22.
- Duguma, B. and Janssens, G.P., 2016. Smallholder dairy farmers' breed and cow trait preferences and production objective in Jimma Town, Ethiopia. *European Journal of Biological Sciences*, 8(1), pp.26-34.
- Eastern Cape Socio Economic Consultative Council (ECSECC). 2017. *ECSECC - Eastern Cape Socio Economic Consultative Council*. [online] Available at: <https://www.ecsecc.org/>.
- Elias, A., Nohmi, M., Yasunobu, K. and Ishida, A., 2016. Farmers' satisfaction with agricultural extension service and its influencing factors: a case study in North West Ethiopia. *Journal of Agricultural Science and Technology*, 18(1), pp.39-53.
- Ericksen, P., de Leeuw, J., Thornton, P., Said, M., Herrero, M. and Notenbaert, A., 2013. Climate change in sub-Saharan Africa. *Pastoralism and development in Africa: Dynamic change at the margins*. Available at: <https://library.oapen.org/bitstream/handle/20.500.12657/53003/9781136255854.pdf?sequence=1#page=97>. [Accessed 12 April 2023]
- Eyinade, G.A., Mushunje, A. and Yusuf, S.F.G., 2021. The willingness to consume organic food: A review. *Food and Agricultural Immunology*, 32(1), pp.78-104.
- Fanadzo, M. and Dube, E., 2018. Recognising the differences between farmers key to smallholder development. *Water Wheel*, 17(6), pp.12-15.
- Fanadzo, M. and Ncube, B., 2018. Challenges and opportunities for revitalising smallholder irrigation schemes in South Africa. *Water SA*, 44(3), pp.436-447.
- Farooq, A., Hassan, A., Ishaq, M., Nawaz, A., Ullah, I. and Ullah, H., 2022. Farmers' knowledge level regarding climate smart agricultural production technologies in Central Plain Valley of Khyber Pakhtunkhwa. *Sarhad Journal of Agriculture*, 38(1), pp.331-341.

- Farooq, A., Khan, M.Z., Hassan, A., Ishaq, M. and Nawaz, A., 2019. Knowledge gap analysis of sugarcane growers in recommended sugarcane production technology in Khyber Pakhtunkhwa, Pakistan. *Int. J. Biosci*, 15(1), pp.87-98.
- Feder, G., Just, R.E. and Zilberman, D., 1985. Adoption of agricultural innovations in developing countries: A survey. *Economic development and cultural change*, 33(2), pp.255-298.
- Funde, S. and Oyelana, A.A., 2018. The Role of Aspirations and Goals in the Management of Smallholder Agriculture in Crop Production in Kwa-Nobuhle in the Eastern Cape. *Anthropologist*, 31(1-3), pp.94-104.
- García, C.G.M., Dorward, P. and Rehman, T., 2012. Farm and socio-economic characteristics of smallholder milk producers and their influence on technology adoption in Central Mexico. *Tropical Animal Health and Production*, 44, pp.1199-1211.
- Gebremedhin, B., Ahmed, M.M. and Ehui, S.K., 2003. Determinants of adoption of improved forage technologies in crop-livestock mixed systems: Evidence from the highlands of Ethiopia. *Tropical grasslands*, 7(4), pp.262-273.
- Getachew, E., 2022. *The effect of buyer seller relationship on sales effectiveness: the case of Noah Realestate Ethiopia* (Doctoral dissertation, St Mary's University, London).
- Getnet, A., Tassie, K. and Ayele, Z.B., 2022. Estimating Smallholder Farmers' Willingness to Pay for Sustainable Irrigation Water Use in North Western Ethiopia: A Contingent Valuation Method Study in Gumara Irrigation Project. *Advances in Agriculture*, pp.1-2.
- Gininda, P.S., Antwi, M.A. and Oladele, O.I., 2014. Smallholder sugarcane farmers' perception of the effect of micro agricultural finance institution of South Africa on livelihood outcomes in Nkomazi local municipality, Mpumalanga Province. *Mediterranean Journal of Social Sciences*, 5(27), pp.1032-1040.
- Gomera, P.M. and Mafini, C., 2020. Supply chain management enablers, barriers and disruptions in the animal feed industry in the Western Cape Province of South Africa. *Journal of Transport and Supply Chain Management*, 14(1), pp.1-12.

- Gonfa, L., 2015. *Farmers' willingness to pay for improved forage seed in LIVES Districts of west Shewa Zone, Ethiopia* (Doctoral dissertation, Haramaya University, Ethiopia).
- Guèye, E.F., 2000. The role of family poultry in poverty alleviation, food security and the promotion of gender equality in rural Africa. *Outlook on agriculture*, 29(2), pp.129-136.
- Gujarati, D. and Porter, D.C., 2010. Functional forms of regression models. *Essentials of econometrics*, 6, pp.132-177.
- Gumber, G. and Rana, J., 2017. Factors influencing willingness to pay price premium for organic food in India. *International Journal of Emerging Research in Management & Technology*, 6(2), pp.1-15.
- Haab, T., Lewis, L., Whitehead, J., 2020. State of the Art of Contingent Valuation. *Oxford Research Encyclopedia of Environmental Science*. Available at: <https://doi.org/10.1093/acrefore/9780199389414.013.450>. [Accessed 7 July 2023].
- Hakeem, S., Abd, and Dipak, D., 2013. Knowledge of tomato growers using poly plastic in Thi-Qar province of Iraq. *Indian Research Journal of Extension Education*, 13(3), pp.55-58.
- Hall, A., Sulaiman, R. and Bezkorowajnyj, P., 2007. Reframing technical change: livestock fodder scarcity revisited as innovation capacity scarcity. *United Nations University, Maastricht Economic and Social Research and Training Centre on Innovation and Technology, Maastricht, The Netherlands*, 19(6211), pp.2-22.
- Hall, R. and Kepe, T., 2017. Elite capture and state neglect: new evidence on South Africa's land reform. *Review of African Political Economy*, 44(151), pp.122-130.
- Hanyani-Mlambo, B., 2017. *Effectiveness of innovation platforms in enhancing technology adoption, productivity and viability: the case of smallholder dairying in Rusitu and Gokwe, Zimbabwe* (Doctoral dissertation, University of KwaZulu-Natal, South Africa).

- Herd-Hoare, S.C. and Shackleton, C.M., 2020. Integrating ecosystem services and disservices in valuing smallholder livestock and poultry production in three villages in South Africa. *Land*, 9(9), pp.294.
- Hlatshwayo, P.P.K. and Worth, S.H., 2016. Stakeholders' perceptions about visibility and accountability of the state agricultural extension in Nquthu Area, KwaZulu Natal Province, South Africa. *South African Journal of Agricultural Extension*, 44(2), pp.174-185.
- Hlatshwayo, S.I., Modi, A.T., Hlahla, S., Ngidi, M. and Mabhaudhi, T., 2021. Usefulness of seed systems for reviving smallholder agriculture: A South African perspective. *African Journal of Food, Agriculture, Nutrition and Development*, 21(2), pp.17581-17603.
- Hlomendlini, P.H., 2015. *Key factors influencing smallholder market participation in the former homelands of South Africa: Case study of the Eastern Cape* (Doctoral dissertation, Stellenbosch: Stellenbosch University, South Africa).
- Hossain, M.S., Islam, A.K.M.S., Kabir, M.J., Sarkar, M.A.R., Mamun, M.A.A., Rahman, M.C., Salam, M.U. and Kabir, M.S., 2021. Role of training in transferring rice production technologies to farm level. *Bangladesh Rice Journal*, 25(1), pp.111-120.
- Howieson, J., Conradie, P., Ballard, N. and Jordaan, G., 2014. Project Pasture development for community livestock production in the Eastern Cape province of South Africa.[online] Available at: <https://www.aciar.gov.au/sites/default/files/2022-05/Final-Report-for-LPS-2004-022.pdf>. [Accessed 4 May 2023].
- Hulme, M., 2018. "Gaps" in climate change knowledge: Do they exist? Can they be filled?. *Environmental Humanities*, 10(1), pp.330-337.
- Hygrotech Forum. 2018. The Forum. [online] Available at: <https://hygrotech.co.za/wp-content/uploads/2023/03/Volume-2-2018.pdf>
- Ingutia, R. and Sumelius, J., 2022. Determinants of food security status with reference to women farmers in rural Kenya. *Scientific African*, 15, pp. 2-14.

- Islam, M.S. and Islam, M.M., 2020. Evaluation of knowledge, attitude and practice (KAP) of farmers regarding organic farming. *Fundamental and Applied Agriculture*, 5(3), pp.393-403.
- Jaleta, M., Yirga, C., Kassie, M., De Groote, H. and Shiferaw, B., 2013. Knowledge, adoption and use intensity of improved maize technologies in Ethiopia.
- Jia, B., St-Hilaire, S., Singh, K. and Gardner, I.A., 2017. Biosecurity knowledge, attitudes and practices of farmers culturing yellow catfish (*Pelteobagrus fulvidraco*) in Guangdong and Zhejiang provinces, China. *Aquaculture*, 471, pp.146-156.
- Johnson, B., Martinez-Berman, L. & Curley, C., 2022. Formation of attitudes: How people (wittingly or unwittingly) develop their viewpoints. *Oxford Research Encyclopedia of Psychology*. Available at: <https://oxfordre.com/psychology/view/10.1093/acrefore/9780190236557.001.0001/acrefore-9780190236557-e-812>. [Accessed 5 April 2023].
- Jumbe, C.B.L. and Nyambose, W.H., 2016. Does conservation agriculture enhance household food security? Evidence from smallholder farmers in Nkhosha in Malawi. *Sustainable Agriculture Research*, 5(1), pp.118-127.
- Kamanzi, M. and Mapiye, C., 2012. Feed inventory and smallholder farmers' perceived causes of feed shortage for dairy cattle in Gisagara District, Rwanda. *Tropical Animal Health and Production*, 44, pp.1459-1468.
- Kamrath, C., Wesana, J., Bröring, S. and De Steur, H., 2019. What do we know about chain actors' evaluation of new food technologies? A systematic review of consumer and farmer studies. *Comprehensive Reviews in Food Science and Food Safety*, 18(3), pp.798-816.
- Kaur, P., Stoltzfus, J. and Yellapu, V., 2018. Descriptive statistics. *International Journal of Academic Medicine*, 4(1), pp.60-63.
- Kawula, N., 2019. *Farmers' perceptions and attitudes to technology adoption in the Ugu District of KwaZulu-Natal, South Africa* (Doctoral dissertation, University of Kwazulu-Natal, South Africa).

- Kebede, G., Assefa, G., Feyissa, F. and Mengistu, A., 2016. Forage legumes in crop-livestock mixed farming systems: A review. *International Journal of Livestock Research*, 6(4), pp.1-18.
- Khan, M.A., Chander, M. and Bardhan, D., 2013. Willingness to pay for cattle and buffalo insurance: an analysis of dairy farmers in central India. *Tropical animal health and production*, 45, pp.461-468.
- Khan, N., Ray, R.L., Sargani, G.R., Ihtisham, M., Khayyam, M. and Ismail, S., 2021. Current progress and future prospects of agriculture technology: Gateway to sustainable agriculture. *Sustainability*, 13(9), pp.1-31.
- Khapayi, M. and Celliers, P.R., 2016. Factors limiting and preventing emerging farmers to progress to commercial agricultural farming in the King William's Town area of the Eastern Cape Province, South Africa. *South African Journal of Agricultural Extension*, 44(1), pp.25-41.
- Kidane, T.T., Wei, S. and Sibhatu, K.T., 2019. Smallholder farmers' willingness to pay for irrigation water: Insights from Eritrea. *Agricultural Water Management*, 222, pp.30-37.
- Kind, P., Jones, K. and Barnby, P., 2007. Developing attitudes towards science measures. *International journal of science education*, 29(7), pp.871-893.
- King Sabata Dalindyebo Local Municipality. 2022. Available at: <https://ksd.gov.za/wp-content/uploads/2022/06/KSD-Municipality-IDP-2022-2027.pdf> [Accessed 22 September 2024].
- King Sabata Dalindyebo Local Municipality. 2023. Available at: <https://ksd.gov.za/wp-content/uploads/2023/11/23-11-2023-Draft-MTAS-2023-2026-1.pdf>.
- Komba, C. and Muchapondwa, E., 2018. Adaptation to climate change by smallholder farmers in Tanzania. In *Agricultural adaptation to climate change in Africa*. [online] Available at: <https://econrsa.org/wp-content/uploads/2022/06/wp299.pdf>
- Komba, C. and Muchapondwa, E., 2018. Adaptation to climate change by smallholder farmers in Tanzania. In *Agricultural adaptation to climate change in Africa*, Routledge, pp. 129-168.

- Koshe, A., 2022. *Determinants of supplementary feeding use among commercially oriented smallholder farmers in the Eastern Cape Province of South Africa* (Master's Dissertation, University of Pretoria, South Africa).
- Kuehne, G., Llewellyn, R., Pannell, D.J., Wilkinson, R., Dolling, P., Ouzman, J. and Ewing, M., 2017. Predicting farmer uptake of new agricultural practices: A tool for research, extension, and policy. *Agricultural Systems*, 156, pp.115-125.
- Kumwenda, M. and Ngwira, A., 2003. Forage demand and constraints to adoption of forage technologies by livestock keepers in Malawi. *Tropical Grasslands*, 37(4), pp.274–278.
- Kwaza, A., Beyene, S.T., Mlambo, V. and Mopipi, K., 2016. Mineral concentration and standing crop yield dynamics of forages in semi-arid communal grazing lands of South Africa: effect of landscape and season. *Animal Nutrition and Feed Technology*, 16(2), pp.209-226.
- Lacrosseseed. (2019). Available at: https://lacrosseseed.com/Admin/Public/Download.aspx?file=Files%2FFiles%2F_La+Crosse+Seed%2FTECH-SHEET-FF__Enhancer.pdf.
- Lamega, S.A., Klinck, L., Komainda, M., Odhiambo, J.J.O., Ayisi, K.K. and Isselstein, J., 2024. Feed Gaps Among Cattle Keepers in Semiarid and Arid Southern African Regions: A Case Study in the Limpopo Province, South Africa. In *Sustainability of Southern African Ecosystems under Global Change: Science for Management and Policy Interventions* (pp. 527-550).
- Loevinsohn, M., Sumberg, J., Diagne, A. and Whitfield, S. 2013. *Under what circumstances and conditions does adoption of technology result in increased agricultural productivity? A Systematic Review Prepared for the Department for International Development*. [online] Available at: https://assets.publishing.service.gov.uk/media/57a08a13ed915d3cfd000594/Prod_uactivity_systematic_review_report_Loevinsohn.pdf. [Accessed 12 June 2023].
- Loki, O., 2022. Farmers' perceptions towards privatisation of extension services in Eastern Cape and kwazulu-natal provinces of South Africa. *Journal of International Agricultural and Extension Education*, 29(4), pp.27-53.

- Louw, A. and Jordaan, D., 2016. Supply chain risks and smallholder fresh produce farmers in the Gauteng province of South Africa. *Southern African Business Review*, 20(1), pp.286-312.
- Lugusa, K.O., Wasonga, O.V., Elhadi, Y.A. and Crane, T.A., 2016. Value chain analysis of grass seeds in the drylands of Baringo County, Kenya: A producers' perspective. *Pastoralism*, 6, pp.1-15.
- Lukuyu, B., Ahumuza, R. and Maina, K. 2021. *Criteria that farmers use to select forage varieties to plant in Uganda*. [online] Available at: <https://cgspace.cgiar.org/server/api/core/bitstreams/657e1d79-d96e-47e6-8b05-f1805d0b288f/content>. [Accessed 25 June 2024].
- Lukuyu, B.A., Kitalyi, A., Franzel, S., Duncan, A.J. and Baltenweck, I., 2009. Constraints and options to enhancing production of high-quality feeds in dairy production in Kenya, Uganda and Rwanda. *World Agroforestry Centre*, 95(1), pp.6-16.
- Lukuyu, B.A., Maina, K., Marwa, M.E., Haule, A. and Bekunda, M.A. 2020. Integrating livestock into agricultural systems for increased livestock productivity: Evidence from smallholder dairy farmers in Babati District, Tanzania. *cgspace.cgiar.org*. [online] Available at: <https://cgspace.cgiar.org/items/fe99afdc-9a3d-4b53-a6a5-8eb6b62a5ec8>. [Accessed 1 March 2024].
- Lukuyu, B.A., Ravichandran, T., Maass, B.L., Laswai, G.H., Bwire, J. and Duncan, A.J., 2015. Enhancing livestock productivity through feed and feeding interventions in India and Tanzania. *ILRI Project Report*.
- Lukuyu, J.M., Blanchard, R.E. and Rowley, P.N., 2019. A risk-adjusted techno-economic analysis for renewable-based milk cooling in remote dairy farming communities in East Africa. *Renewable energy*, 130, pp.700-713.
- Lusk, J.L., 2003. Effects of cheap talk on Consumer willingness-to-pay for Golden Rice. *American Journal of Agricultural Economics*, 85(4), pp.840-856.
- Magawana, M., Dugmore, T., de Villier, J. and Gcumisa, S., 2021. Effect of lambing season, year, sex and birth status on weaning and post-weaning growth performance of Merino lambs. *Applied Animal Husbandry & Rural Development*, 14, pp.61-68.

- Mahlombe, C., 2018. *The role of agricultural development projects in poverty reduction in the OR Tambo District Municipality of the Eastern Cape Province, South Africa.* (Masters dissertation, University of Pretoria, South Africa).
- Maity, A. and Pramanik, P., 2013. Climate change and seed quality: an alarming issue in crop husbandry. *Current Science*, 105(10), pp.1336-1338.
- Majaha, J., 2023. *The impact of drought in the South African agricultural sector and the skills implications.* Available at: <https://scholar.sun.ac.za/server/api/core/bitstreams/21c4a11a-ddc0-44bc-a394-c48d615ad58e/content>. [Accessed 1 December 2023].
- Makkar, H.P., 2016. Smart livestock feeding strategies for harvesting triple gain—the desired outcomes in planet, people and profit dimensions: a developing country perspective. *Animal Production Science*, 56(3), pp.519-534.
- Manyeki, J.K., Kubasu, D., Kirwa, E.C. and Mnene, W.N., 2013. Assessment of socio-economic factors influencing adoption of natural pastures improvement technologies in arid and semi-arid lands of Kenya. *Livestock Research for Rural Development*, 25(11), pp.141-144.
- Mapiye, C., Foti, R., Chikumba, N., Poshiwa, X., Mwale, M., Chivuraise, C. and Mupangwa, J.F., 2006. Constraints to adoption of forage and browse legumes by smallholder dairy farmers in Zimbabwe. *Livestock Research for Rural Development*, 18(12), pp.1-12.
- Mapiye, C., Foti, R., Chikumba, N., Poshiwa, X., Mwale, M., Chivuraise, C. and Mupangwa, J.F., 2006. Constraints to adoption of forage and browse legumes by smallholder dairy farmers in Zimbabwe. *Livestock Research for Rural Development*, 18(12), pp.84-86.
- Mapiye, O., 2017. *Towards a management database to improve the sustainability of cattle production and its contribution to food security: A case of emerging beef farmers in Limpopo Province, South Africa* (Doctoral dissertation, Stellenbosch: Stellenbosch University, South Africa).

- Mapiye, O., Makombe, G., Molotsi, A., Dzama, K. and Mapiye, C., 2021. Towards a revolutionized agricultural extension system for the sustainability of smallholder livestock production in developing countries: The potential role of ICTs. *Sustainability*, 13(11), pp. 2-18.
- Martínez-García, C.G., Dorward, P. and Rehman, T., 2013. Factors influencing adoption of improved grassland management by small-scale dairy farmers in central Mexico and the implications for future research on smallholder adoption in developing countries. *Livestock Science*, 152(2-3), pp.228-238.
- Martínez-García, C.G., Dorward, P. and Rehman, T., 2013. Factors influencing adoption of improved grassland management by small-scale dairy farmers in central Mexico and the implications for future research on smallholder adoption in developing countries. *Livestock Science*, 152(2-3), pp.228-238.
- Marwa, M.E., Mburu, J., Oburu, R.E.J., Mwai, O. and Kahumbu, S., 2020. Impact of ICT based extension services on dairy production and household welfare: the case of iCow service in Kenya. *Journal of Agricultural Science*, 12(3), pp.1-12.
- Mashamaite, K.A., 2014. *The contributions of smallholder subsistence agriculture towards rural household food security in Maroteng Village, Limpopo Province* (Doctoral dissertation, University of Limpopo (Turfloop Campus), South Africa).
- Mastenbroek, A., Sirutyte, I. and Sparrow, R., 2021. Information barriers to adoption of agricultural technologies: willingness to pay for certified seed of an open pollinated maize variety in Northern Uganda. *Journal of Agricultural Economics*, 72(1), pp.180-201.
- Mathebula, J., Molokomme, M., Jonas, S. and Nhemachena, C., 2017. Estimation of household income diversification in South Africa: A case study of three provinces. *South African Journal of Science*, 113(1-2), pp.1-9.
- Matshawule, S. & Beyene, S.T., 2022. Farmers' perceptions of livestock husbandry and rangeland management practices in two communal coastal areas of the Eastern Cape Province, South Africa. *International Journal of Food Science and Agriculture*, 6(3), pp.309-319.

- Mattee, A.Z. and Gebreyes, M.G., 2013. Nature and Cost of Participation in Farmer Field Schools. Case Study of North Wollo Administration Zone, Ethiopia. *Article in the Journal of Continuing Education and Extension*, 4(1), pp.116-117.
- Maziya, M., Tirivanhu, P., Kajombo, R.J. and Gumede, N.A., 2020. Gender disparities in poverty among smallholder livestock farmers in South Africa. *South African Journal of Agricultural Extension*, 48(2), pp.21-35.
- Mbatha, M.W., 2024. The Provision of Agricultural Extension Services to Rural Farmers as a Strategy to Improve Agricultural Practices in South Africa. *South African Journal of Agricultural Extension*, 52(1), pp.1-19.
- McDermott, J.J., Staal, S.J., Freeman, H.A., Herrero, M. and Van de Steeg, J.A., 2010. Sustaining intensification of smallholder livestock systems in the tropics. *Livestock science*, 130(1-3), pp.95-109.
- Mdiya, L., Taruvinga, A., Mushunje, A., Mopipi, K. and Ngarava, S., 2021. Rural community use and perception of rangeland products in Eastern Cape Province, South Africa. *African Journal of Science, Technology, Innovation and Development*, 13(6), pp.757-768.
- Mdoda, L. and Obi, A., 2019. Analysis of profitability of smallholder irrigated food plots in the Eastern Cape province of South Africa. *Journal of Agribusiness and Rural Development*, 53(3), pp.225-232.
- Mdoda, L., Tshotsho, A. and Nontu, Y., 2022. Adoption of mass media for agricultural purposes by smallholder farmers in the Eastern Cape Province of South Africa. *South African Journal of Agricultural Extension*, 50(2), pp.117-136.
- Meeske, R., Botha, P.R., Van der Merwe, G.D., Greyling, J.F., Hopkins, C. and Marais, J.P., 2009. Milk production potential of two ryegrass cultivars with different total non-structural carbohydrate contents. *South African Journal of Animal Science*, 39(1), pp.15-19.
- Meijer, S.S., Catacutan, D., Ajayi, O.C., Sileshi, G.W. and Nieuwenhuis, M., 2015. The role of knowledge, attitudes and perceptions in the uptake of agricultural and

- agroforestry innovations among smallholder farmers in sub-Saharan Africa. *International journal of agricultural sustainability*, 13(1), pp.40-54.
- Meissner, H.H., Blignaut, J.N., Smith, H.J. and Du Toit, C.J.L., 2023. The broad-based economic impact of beef and dairy production: A global review. *South African Journal of Animal Science*, 53(2), pp.250-275.
- Meissner, H.H., Scholtz, M.M. and Palmer, A.R., 2013. Sustainability of the South African livestock sector towards 2050 Part 1: Worth and impact of the sector. *South African Journal of Animal Science*, 43(3), pp.282-297.
- Meyers-Mashamba, G.J., 2021. *Livelihood strategies of unemployed youth: The case of Cradock, Eastern Cape* (Doctoral dissertation, University of the Free State, South Africa).
- Miller, M.A., 2022. Market-based commons: Social agroforestry, fire mitigation strategies, and green supply chains in Indonesia's peatlands. *Transactions of the Institute of British Geographers*, 47(1), pp.77-91.
- Mohajan, H., 2017. The impact of knowledge management models for the development of organizations. *Journal of Environmental Treatment Techniques*, 5(1), pp.12-33.
- Molla, Y., 2006. *Integrating the formal and informal wheat seed supply systems to improve farmers' access to modern cultivars in the north Shewa zone of the Amhara regio* (Masters dissertation, Alemaya University of Agriculture, Ethiopia).
- Mossie, H., Adem, M. and Aynalem, M., 2019. Farmers' Willingness to Pay for Rice Post-Harvest Handling Technology in Ethiopia: Review Study. *J Rice Res*, 7(2), pp.2-8.
- Motshekga, L.M., 2022. *Productivity and physiological responses of winter annual forage legumes to planting date and short-term rotation with forage sorghum for sheep production under no-till system in Limpopo Province* (Doctoral dissertation, University of Limpopo, South Africa).
- Moyo, B. and Ravhuhali, K.E., 2023. Dry season feeding strategies and winter forage production by communal area sheep farmers of the Eastern Cape province in South Africa. *Cogent Food & Agriculture*, 9(1), pp.216-775.

- Mpandeli, S. and Maponya, P., 2014. Constraints and challenges facing the small scale farmers in Limpopo Province, South Africa. *Journal of agricultural Science*, 6(4), pp.135-141.
- Mpanza, T.D.E., Hassen, A. and Akanmu, A.M., 2020. Evaluation of *Stylosanthes scabra* accessions as forage source for ruminants: growth performance, nutritive value and in vitro ruminal fermentation. *Animals*, 10(11), pp.19-39.
- Mthi, S., Nyangiwe, N., Thubela, T., Nyalambisa, N., Madyibi, Z. and Yawa, M., 2020. Cattle production and breeding practice in communal farming system in the Eastern Cape province, South Africa. *Applied Animal Husbandry & Rural Development*, 16(1), pp.42-54
- Muchangi, C.T., 2016. *Influence of farmer's characteristics, agricultural extension and technology-specific factors on adoption of organic farming technologies in Embu west sub-county, Embu, Kenya* (Doctoral dissertation, University of Nairobi, Kenya).
- Mudau, H.S., Msiza, N.H., Sipango, N., Ravuhali, K.E., Mokoboki, H.K. and Moyo, B., 2022. Veld restoration strategies in South African semi-arid rangelands. Are there any successes?—A review. *Frontiers in Environmental Science*, 10, pp.2-12.
- Muinga, R.W., Saha, H.M., Lewa, K.K., Munga, G.S., Mambo, L.C., Bimbuji, S. and Mburu, L., 2015. Cassava-based Napier grass silage for increased milk yield during the dry season in coastal Kenya. *Eastern Africa Agricultural Productivity Project*.
- Mulatu, T., 2016. *Farmers' willingness to pay for improved forage seed: the case of Sidama Zone, Southern Nations nationalities and people regional STATE, ETHIOPIA* (Doctoral dissertation, Haramaya University, Ethiopia).
- Müller, F.L., Igshaan Samuels, M., Cupido, C.F., Swarts, M.B., Amary, N.M., Hattas, D., Morris, C., Cyster, L.F. and Stephen Boatwright, J., 2019. The impacts of season and livestock management strategy on the quality of diets selected by goats and sheep in the semi-arid rangelands of Namaqualand, South Africa. *African Journal of Range & Forage Science*, 36(2), pp.105-114.

- Municipal Turnaround Strategy (MTAS). 2023. Available at: <https://ksd.gov.za/wp-content/uploads/2023/11/23-11-2023-Draft-MTAS-2023-2026-1.pdf> [Accessed 15 February 2024].
- Mutavi, S.K., 2017. *Determinants of adoption of forage technologies among peri-urban dairy farmers in the semi-arid region of South Eastern Kenya* (Doctoral dissertation, Southern Kenya University, Kenya).
- Muzari, W., Gatsi, W. and Muvhunzi, S., 2012. The impacts of technology adoption on smallholder agricultural productivity in sub-Saharan Africa: A review. *Journal of Sustainable Development*, 5(8), pp.69.
- Muzerengwa, C., 2017. *Personality and Self-esteem as Predictors of Employability Among Final Year Students at a Previously Disadvantaged South African University* (Doctoral dissertation, University of Fort Hare, South Africa).
- Mwangi, D.M. and Wambugu, C., 2003. Adoption of forage legumes: the case of *Desmodium intortum* and *Calliandra calothyrsus* in central Kenya. *Tropical Grasslands*, 37(4), pp.227-238.
- Mwangi, M. and Kariuki, S., 2015. Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. *Journal of Economics and Sustainable Development*, 6(5), pp. 208-213.
- Mweshi, G.K. and Sakyi, K., 2020. Application of sampling methods for the research design. *Archives of Business Review–Vol*, 8(11), pp.180-193.
- Mzuyanda, C., Luvhengo, U., Jiba, P., Khobai, H. and Letsoalo, S.S., 2022. Analyzing the delivery of public agricultural extension services to rural households during Covid-19: A case study of Idutywa, Eastern Cape, South Africa. *South African Journal of Agricultural Extension*, 50(1), pp.60-75.
- Nash, D. and Ammann, S., 2015. Together we have made KwaZulu-Natal a better province to live in forage cereals for dryland pasture production. Available at: [https://www.kzndard.gov.za/images/Documents/RESOURCE_CENTRE/GUIDE_LINE_DOCUMENTS/Research_and_Technology_Bulletin/2015.15%20Forage%](https://www.kzndard.gov.za/images/Documents/RESOURCE_CENTRE/GUIDE_LINE_DOCUMENTS/Research_and_Technology_Bulletin/2015.15%20Forage%20)

20Cereals%20for%20dryland%20pasture%20production.pdf [Accessed 25 September 2023].

- Nazu, S.B., Saha, S.M., Hossain, M.E., Haque, S. and Khan, M.A., 2022. Willingness to pay for adopting conservation tillage technologies in wheat cultivation: policy options for small-scale farmers. *Environmental Science and Pollution Research*, 29(42), pp.63458-63471.
- Ndah T, Schuler J, Nkwain VN., Nzogela, B., Mangesho, W.E., Mollel, R., Loina, R. and Paul, B.K., 2017. *Factors Affecting the Adoption of Forage Technologies in Smallholder Dairy Production Systems in Lushoto, Tanzania*. CIAT Working Paper. CIAT Working Paper. Cali, Colombia: International Center for Tropical Agriculture (CIAT). Available at: <https://cgspace.cgiar.org/handle/10568/89807>. [Accessed 05 May 2023].
- Ndah, H.T., Schuler, J., Nkwain, V.N., Nzogela, B., Mangesho, W., Mollel, R., Loina, R., Zander, P. and Paul, B.K., 2022. Determinants for smallholder farmers' adoption of improved forages in dairy production systems: The case of Tanga region, Tanzania. *Agronomy*, 12(2), pp.1-13.
- Ndambiri, H.K., Ritho, C.N. and Mbogoh, S.G., 2013. An evaluation of farmers' perceptions of and adaptation to the effects of climate change in Kenya. *International Journal of Food and Agricultural Economics*, 1(1), pp.75-96.
- Ndandani, A., 2016. *Range condition assessment to document the extent of degradation on selected semi-arid rangelands of the Eastern Cape, South Africa* (Doctoral dissertation, University of Fort Hare, South Africa).
- Ndaru, P.H., Huda, A.N., Prasetyo, R.D., Shofiatun, U., Nuningtyas, Y.F. and Ndaru, R.K., 2020, April. Providing high-quality forages with hydroponic fodder system. In *IOP Conference Series: Earth and Environmental Science*, 478(1), pp.1-5.
- Negawo, A.T., Teshome, A., Kumar, A., Hanson, J. and Jones, C.S., 2017. Opportunities for Napier grass (*Pennisetum purpureum*) improvement using molecular genetics. *Agronomy*, 7(2), pp.28.

- Nenngwekhulu, N., 2019. *Financial analysis of the Recapitalisation and Development Programme in South Africa* (Doctoral dissertation, University of Pretoria, South Africa).
- Ngumbela, X.G., Khalema, E.N. and Nzimakwe, T.I., 2020. Local worlds: Vulnerability and food insecurity in the Eastern Cape province of South Africa. *Jàmbá: Journal of Disaster Risk Studies*, 12(1), pp.1-10.
- Ningi, T., Taruvinga, A. and Zhou, L., 2020. Determinants of energy security for rural households: The case of Melani and Hamburg communities, Eastern Cape, South Africa. *African Security Review*, 29(4), pp.299-315.
- Njima, P.M., 2016. *An assessment of factors influencing production of hydroponics fodder among smallholder dairy farmers in Kiambu sub county, Kenya* (Doctoral dissertation, University of Nairobi, Kenya).
- Nkamisa, M., Ndhleve, S., Nakin, M.D., Mngeni, A. and Kabiti, H.M., 2022. Analysis of trends, recurrences, severity and frequency of droughts using standardised precipitation index: Case of OR Tambo District Municipality, Eastern Cape, South Africa. *Jàmbá-Journal of Disaster Risk Studies*, 14(1), pp.11-47.
- Nkonki-Mandleni, B., Ogunkoya, E.T. and Omotayo, A.O., 2019. Socioeconomic factors influencing livestock production among smallholder farmers in the Free State province of South Africa. *International Journal of Entrepreneurship*, 23(1), pp.1-17.
- Nkosi, C.N., Piketh, J.S., Burger, P.R. and Harrold, A.J., 2017, April. Variability of domestic burning habits in the South African Highveld: A case study in the KwaDela Township (April 2017). In *2017 International Conference on the Domestic Use of Energy (DUE)* (pp. 23-29). IEEE. doi: 10.23919/DUE.2017.7931820.
- Ntawuruhunga, D., Affognon, H.D., Fiaboe, K.K., Abukutsa-Onyango, M.O., Turoop, L. and Muriithi, B.W., 2020. Farmers' knowledge, attitudes and practices (KAP) on production of African indigenous vegetables in Kenya. *International Journal of Tropical Insect Science*, 40, pp.337-349.

- Ntshangase, N.L., Muroyiwa, B. and Sibanda, M., 2018. Farmers' perceptions and factors influencing the adoption of no-till conservation agriculture by small-scale farmers in Zashuke, KwaZulu-Natal Province. *Sustainability*, 10(2), pp.1-16.
- Ntsiapane, A.D., Swanepoel, J.W., Nesamvuni, A.E. and Ojo, T.O., 2023. Assessing the efficiency of smallholder wool farmers in the changing paradigms of the Free State province of South Africa. *South African Journal of Animal Science*, 53(1), pp.125-132.
- Nxumalo, K.K.S., Oduniyi, O.S., Antwi, M.A. and Tekana, S.S., 2019. Determinants of market channel choice utilised by maize and sunflower farmers in the North West province, South Africa. *Cogent Social Sciences*, 5(1), pp.16-18.
- Nyam, Y.S., Ojo, T.O., Belle, J.A., Ogundeji, A.A. and Adetoro, A.A., 2022. Determinants of profit efficiency among smallholder sheep farmers in South Africa. *African Journal of Science, Technology, Innovation and Development*, 14(3), pp.620-629.
- Nyambali, A., Tjelele, J.T., Mndela, M., Mapiye, C., Strydom, P., Raffrenato, E., Dzama, K., Muchenje, V. and Mkhize, N., 2023. Participatory inventory and nutritional evaluation of local forage resources for smallholder free-range beef production in semi-arid areas of South Africa. *African Journal of Range & Forage Science*, 40(1), pp.62-70.
- Nyamushamba, G.B., Mapiye, C., Tada, O., Halimani, T.E. and Muchenje, V., 2017. Conservation of indigenous cattle genetic resources in Southern Africa's smallholder areas: turning threats into opportunities—A review. *Asian-Australasian journal of animal sciences*, 30(5), pp.603.
- Nyangiwe, N., Goni, S., Khethani, T., Thubela, T., Jansen, M., Mthi, S., Yawa, M., Tokozwayo, S., Gulwa, U., Mapholi, N.O. and Jaja, I.F., 2021. Ticks, demographics, vegetation cover, and farmer's age influence red meat production in resource-poor regions of Eastern Cape Province of South Africa. *Open Journal of Animal Sciences*, 11, pp. 682-696.
- Nyongesa, J.M., Bett, H.K., Lagat, J.K. and Ayuya, O.I., 2016. Estimating farmers' stated willingness to accept pay for ecosystem services: Case of Lake Naivasha watershed

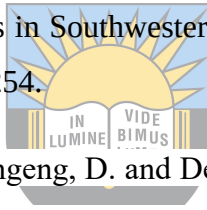
Payment for Ecosystem Services scheme-Kenya. *Ecological Processes*, 5(15), pp.1-15.

Nzogela, B., Mwendia, S.W., Mwilawa, A.J., Kizima, J., Bwire, J. and Notenbaert, A.O., 2021. Farmers' perceptions on different forage types in southern highlands of Tanzania. *IGC Proceedings (1997-2023)*, 25(5), pp. 1-4.

Obi, A. and Pote, P., 2012. Technical constraints to market access for crop and livestock farmers in Nkonkobe Municipality, Eastern Cape province. *Unlocking markets to smallholders: Lessons from South Africa*, pp.91-112.

Oduniyi, O.S., Rubhara, T.T. and Antwi, M.A., 2020. Sustainability of livestock farming in South Africa. Outlook on production constraints, climate-related events, and upshot on adaptive capacity. *Sustainability*, 12(7), pp.2-16.

Oladele, O.I., 2005. A Tobit analysis of propensity to discontinue adoption of agricultural technology among farmers in Southwestern Nigeria. *Journal of central european agriculture*, 6(3), pp.249-254.



Olum, S., Gellynck, X., Juvinal, J., Ongeng, D. and De Steur, H., 2020. Farmers' adoption of agricultural innovations: A systematic review on willingness to pay studies. *Outlook on Agriculture*, 49(3), pp.187-203. 

Together in Excellence

Onsomu, C.B., 2019. *Knowledge, Attitude, Practice and Ex-Ante Adoption of Integrated Pest and Pollination Management (Ippm) Innovation Among Avocado Growers in Kenya* (Doctoral dissertation, University of Nairobi, Kenya).

Onunka, N.A., Okoroafor, U.E. and Amadi, C.O., 2018. The role of seed technology in the development of root and tuber crops sector and poverty alleviation. *Nigeria Agricultural Journal*, 49(1), pp.71-75.

OR Tambo District Municipality. 2020. OR Tambo District Municipality EC: Profile and analysis, District Development Model. Pretoria: <https://www.cogta.gov.za/ddm/wp-content/uploads/2020/11/ORTamnco-September-2020.pdf>.

OR Tambo District Municipality. 2022. *FINAL IDP 2022-27 – OR Tambo*. [online] Available at: https://ortambodm.gov.za/wpfd_file/final-idp-2022-27/ [Accessed 22 September 2024].

- Orlowski, J. and Wicker, P., 2019. Monetary valuation of non-market goods and services: a review of conceptual approaches and empirical applications in sports. *European Sport Management Quarterly*, 19(4), pp.456-480.
- Ouédraogo, A., Zampaligré, N., Mulubrhan, B. and Adesogan, A.T., 2022. Assessment of peri-urban livestock producers' willingness to pay for improved forages as cash crops. *Agronomy Journal*, 114(1), pp.63-74.
- Ouédraogo, A., Zampaligré, N., Mulubrhan, B. and Adesogan, A.T., 2022. Assessment of peri-urban livestock producers' willingness to pay for improved forages as cash crops. *Agronomy Journal*, 114(1), pp.63-74.
- Owusu, M.A., 2009. *The assessment of market potential and marketing prospects of organic fruits and vegetables in Kumasi Metropolis of Ghana* (Doctoral dissertation, Kwame Nkrumah University of Science and Technology, Ghana).
- Oyetunde-Usman, Z., 2022. Heterogenous factors of adoption of agricultural technologies in West and East Africa countries: A review. *Frontiers in Sustainable Food Systems*, 6, pp.1-12.
- Palmer, A.R. and Ainslie, A.M., 2005. Grasslands of South Africa. *Grasslands of the World*, 34, pp.77.
- Palmer, T. and Ainslie, A., 2006. Country pasture/forage resource profiles. *Food and Agriculture Organization, South Africa*. Available at: https://ees.kuleuven.be/eng/klimos/toolkit/documents/658_SouthAfrica_English.pdf. [Accessed 4 March 2024].
- Paul, B.K., Koge, J., Maass, B.L., Notenbaert, A., Peters, M., Groot, J.C. and Tittonell, P., 2020. Tropical forage technologies can deliver multiple benefits in Sub-Saharan Africa. A meta-analysis. *Agronomy for Sustainable Development*, 40(4), p.22.
- Petronella, M.N., 2015. *Application of the Lewis Labour Surplus Model in the Smallholder Agricultural Sector of the Eastern Cape Province*. (Doctoral dissertation, University of Fort Hare South Africa, South Africa).
- Philp, J.N., Vance, W., Bell, R.W., Chhay, T., Boyd, D., Phimpachanhvongsod, V. and Denton, M.D., 2019. Forage options to sustainably intensify smallholder farming

systems on tropical sandy soils. A review. *Agronomy for Sustainable Development*, 39 (30), pp.1-19.

Pienaar, P.L., 2013. *Typology of smallholder farming in South Africa's former homelands: Towards an appropriate classification system* (Doctoral dissertation, Stellenbosch University, South Africa).

Pilarova, T., Bavorova, M. and Kandakov, A., 2018. Do farmer, household and farm characteristics influence the adoption of sustainable practices? The evidence from the Republic of Moldova. *International Journal of Agricultural Sustainability*, 16(4-5), pp.367-384.

Quddus, M.A., 2012. Adoption of dairy farming technologies by small farm holders: practices and constraints. *Bangladesh Journal of Animal Science*, 41(2), pp.124-135.

Rakau, P. 2021. *New fodder radish varieties can boost dairy production*. [online] Food For Mzansi. Available at: <https://www.foodformzansi.co.za/the-potential-of-new-fodder-radish-varieties-as-feed-for-mzansi-cattle/>.

Rasanjali, W.M.C., Wimalachandra, R.D.M.K.K., Sivashankar, P. and Malkanthi, S.H.P., 2021. Impact of agricultural training on farmers' technological knowledge and crop production in Bandarawela agricultural zone. *Applied Economics & Business*, 5(1), pp.37-50.

Rehman, T., McKemey, K., Yates, C.M., Cooke, R.J., Garforth, C.J., Tranter, R.B., Park, J.R. and Dorward, P.T., 2007. Identifying and understanding factors influencing the uptake of new technologies on dairy farms in SW England using the theory of reasoned action. *Agricultural systems*, 94(2), pp.281-293.

Robert, T., Sarah, N.A. and Samuel, O., 2020. Drivers and restrictions of range pasture improvement by agro-pastoralists in Kiruhura District, Uganda. *African Journal of Agricultural Research*, 16(11), pp.15-30.

Rogers, E.M., 1995. Lessons for guidelines from the diffusion of innovations. *The Joint Commission journal on quality improvement*, 21(7), pp.324-328.

- Salome, E.N. and Rotimi, O., 2013. Implications of training and development programmes on accountants' productivity in selected business organizations in Onitsha, Anambra State, Nigeria. *International journal of Asian social science*, 3(1), pp.266-281.
- Samuels, I., Cupido, C., Swarts, M.B., Palmer, A.R. and Paulse, J.W., 2016. Feeding ecology of four livestock species under different management in a semi-arid pastoral system in South Africa. *African Journal of Range & Forage Science*, 33(1), pp.1-9.
- Schroeder, A., 2019. *Investigating the diet selection and genetic variation of small ruminants in a dryland pastoral system in South Africa*. (Master's dissertation, University of Western Cape, South Africa).
- Schroeder, A., Samuels, M.I., Swarts, M., Morris, C., Cupido, C.F. and Engelbrecht, A., 2019. Diet selection and preference of small ruminants during drought conditions in a dryland pastoral system in South Africa. *Small Ruminant Research*, 176, pp.17-23.
- Schulze, J., Frank, K. and Müller, B., 2016. Governmental response to climate risk: Model-based assessment of livestock supplementation in drylands. *Land Use Policy*, 54, pp.47-57.
- Sebeho, M.A., 2016. *Perceptions and attitude of farmers and extensionists towards extension service delivery in the Free State Province, South Africa* (Masters dissertation, University of Pretoria, South Africa).
- Sennuga, S.O., Baines, R.N., Conway, J.S. and Angba, C.W., 2020. Awareness and adoption of good agricultural practices among smallholder farmers in relation to the adopted villages programme: The case study of Northern Nigeria. *Journal of Biology, Agriculture and Healthcare*, 10(6), pp.34-49.
- Sennuga, S.O., Fadiji, T.O. and Thaddeus, H., 2020. Factors influencing adoption of improved agricultural technologies (IATs) among smallholder farmers in Kaduna State, Nigeria. *International Journal of Agricultural Education and Extension*, 6(2), pp.382-391.
- Senyolo, M.P., Long, T.B., Blok, V., Omta, O. and van der Velde, G., 2021. Smallholder adoption of technology: Evidence from the context of climate-smart agriculture in

South Africa. *Journal of Development and Agricultural Economics*, 13(2), pp.156-173.

Shange, N.S.Q., 2015. *Socio-Economic Factors Influencing the Adoption of in-Field Rainwater Harvesting Technology for Enhancing Household Food Security by Smallholder Farmers in the Nkonkobe Municipality, Eastern Cape Province* (Doctoral dissertation, University of Fort Hare, South Africa).

Shee, A., Azzarri, C. and Haile, B., 2019. Farmers' willingness to pay for improved agricultural technologies: Evidence from a field experiment in Tanzania. *Sustainability*, 12(1), pp.2-13.

Sikundla, T., Mushunje, A. and Akinyemi, B.E., 2018. Socioeconomic drivers of mobile phone adoption for marketing among smallholder irrigation farmers in South Africa. *Cogent Social Sciences*, 4(1), pp.9-12.

Sikwela, M.M., 2013. *The impact of farmer support programmes on market access of smallholder farmers in the Eastern Cape and KwaZulu-Natal provinces, South Africa* (Doctoral dissertation, University of Fort Hare, South Africa).

Singh, A.S. and Masuku, M.B., 2014. Sampling techniques & determination of sample size in applied statistics research: An overview. *International Journal of economics, commerce and management*, 2(11), pp.1-22.

Slayi, M., Zhou, L. and Jaja, I.F., 2023. Exploring farmers' perceptions and willingness to tackle drought-related issues in small-holder cattle production systems: a case of rural communities in the Eastern Cape, South Africa. *Applied Sciences*, 13(13), pp.5-24.

Sollenberger, L.E., Vendramini, J.M., Pedreira, C.G. and Rios, E.F., 2020. Warm-season grasses for humid areas. *Forages: The science of grassland agriculture*, 2, pp.331-345.

Statistics South Africa. 2016. *Community Survey 2016* | *Statistics South Africa*. [online] Available at: https://www.statssa.gov.za/?page_id=6283.

Sun, X., Lyu, J. and Ge, C., 2022. Knowledge and farmers' adoption of green production technologies: an empirical study on IPM adoption intention in major Indica-Rice-

- Producing areas in the Anhui province of China. *International Journal of Environmental Research and Public Health*, 19(21), pp.9-12.
- Taruvinga, A., Kambanje, A., Mushunje, A. and Mukarumbwa, P., 2022. Determinants of livestock species ownership at household level: Evidence from rural OR Tambo District Municipality, South Africa. *Pastoralism*, 12(1), pp.1-11.
- Temesgen, D. and Tola, T., 2015. Determinates of small holder farmers willingness to pay for agricultural extension services: A case study from Eastern Ethiopia. *African Journal of Agricultural Research*, 10(20), pp.2152-2158.
- Temesgen, D. and Tola, T., 2015. Determinates of smallholder farmers willingness to pay for agricultural extension services: A case study from Eastern Ethiopia. *African Journal of Agricultural Research*, 10(20), pp.52-58.
- Terblanche, S.E., 2013. An overview of agricultural extension in South Africa. *South African Journal of Agricultural Extension*, 41(1), pp.107-117.
- Teshome, B., Negash, R. and Shewa, A., 2019. Determinants of adoption of improved Jalenea potato variety: The case of Chencha Woreda, Southern Ethiopia. *Journal of Development and Agricultural Economics*, 11(7), pp.170-185.
- Thornton, P.K., Boone, R.B. and Ramirez-Villegas, J., 2015. *Climate change impacts on livestock*. CCAFS Working Paper no. 120. CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS). Copenhagen, Denmark. Available at: <www.ccafs.cgiar.org> [Accessed 14 August 2024].
- Tiongco, M., Narrod, C., Scott, R., Kobayashi, M. and Omiti, J., 2012. Understanding knowledge, attitude, perceptions, and practices for HPAI risks and management options among Kenyan poultry producers. *Health and animal agriculture in developing countries*, pp.281-304.
- Tjelele, J., Muller, F., Pule, G., Letsoalo, M., Mbona, A., Tlou, M. and Ngoepe, K., 2020. *Veld Management and Planted Pastures*. [online] Available at: <https://www.arc.agric.za/arc-iscw/CSA-Toolbox/Pages/assets/modules/13.pdf>.
- Tokozwayo, S., Thubela, T., Mthi, S., Nyangiwe, N., Khetani, T.L., Gulwa, U., Goni, S., Jansen, M., Qokweni, L. and Guza, B., 2021. Evaluation of communal rangeland

condition under the east griqualand veld type of Eastern Cape Province, South Africa. *Applied Animal Husbandry & Rural Development*, 14, pp.1-8.

Tshoni, S., 2015. *Analysis of Smallholders' farm diversity and risk attitudes in the Stellenbosch local municipal area* (Master's Dissertation, Stellenbosch University, South Africa).

Tshuma, M.C., 2014. Understanding the small-scale agricultural sector as a precondition for promoting rural development in South Africa. *African Journal of Agricultural Research*, 9(31), pp.2409-2418.

Ulimwengu, J. and Sanyal, P., 2011. Joint estimation of farmers' stated willingness to pay for agricultural services. *International Food Policy Research Institute Discussion Paper*, 1070, pp.5.

Ullah, A., Khan, D., Zheng, S. and Ali, U., 2018. Factors influencing the adoption of improved cultivars: a case of peach farmers in Pakistan. *Ciência Rural*, 48(11), pp.2-9.

United Nations Development Programme., 2015. *Sustainable Development Goals*. [online] Sustainable Development Goals. Available at: <https://www.undp.org/sustainable-development-goals>.

Utami, C. W., Indrianto, A. T. L., and Pratama, I., 2019. Agricultural Technology Adoption in Indonesia: The Role of the Agriculture Extension Service, the Rural Financing and the Institutional Context of the Lender. *International Journal of Innovation, Creativity and Change*, 7(7), pp.258-276.

Van de Pol, R. and Jordaan, J.J., 2008. The fodder bank system: its current place in veld management. *Grassroots: Newsletter of the Grassland Society of Southern Africa*, 8(1), pp.36-44.

Van Rooyen, P., 2016. Forage crops for cooler months. *Stockfarm*, 6(10), pp.32-35.

Wegedie, K.T., Eyasu, A.M., Yizengaw, Y.S. and Shiferaw, G.A., 2020. Analysis of households' willingness to pay for improved solid waste management Services in Gondar city, Ethiopia: evidence from a double-bounded dichotomous contingent valuation method. [online] doi:<https://doi.org/10.21203/rs.3.rs-117252/v1>.

- Welu, G., 2015. Challenges and opportunities of seed multiplication in Eastern Tigray Ethiopia. *Journal of Biology, Agriculture and Healthcare*, 5(3), pp.42-54.
- Wilk, J., Andersson, L. and Warburton, M., 2013. Adaptation to climate change and other stressors among commercial and small-scale South African farmers. *Regional environmental change*, 13, pp.273-286.
- Worku, H.A., 2023. Livestock Production System Dynamics, Trends and Drivers of Change in Highlands Areas of Ethiopia: A Review. *Journal of Fisheries & Livestock Production*, 11, pp.394.
- Wye Group. 2011. *Statistics on rural development and agricultural household income* (2nd ed.). United Nations Publications.
- Wynn, E., 2020. Taking practice seriously. In *Design at work*. CRC Press, pp. 45-64.
- Yigezu, Y.A., Mugeru, A., El-Shater, T., Aw-Hassan, A., Piggin, C., Haddad, A., Khalil, Y. and Loss, S., 2018. Enhancing adoption of agricultural technologies requiring high initial investment among smallholders. *Technological Forecasting and Social Change*, 134, pp.199-206.
- Yu, Y., Wang, E. and Wang, Z., 2023. Valuing Nonuse Value of a National Forest Park with Consideration of the Local Residents' Environmental Attitudes. *Forests*, 14(7), pp.14-18.

Appendixes



University of Fort Hare
Together in Excellence



ARC • LNR
Excellence in Research and Development

The University of Fort Hare, Department of Agricultural Economics and Extension, Faculty of Science and Agriculture in collaboration with the Agricultural Research Council are investigating **“Small-scale livestock farmers’ knowledge, attitudes, practices and willingness to pay for fodder seed technology in OR Tambo district municipality in the Eastern Cape province of South Africa”**

Student’s name : Ayabonga Toko
Email : 201820990@ufh.ac.za / TokoA@arc.agric.za
Contact number : 063 623 1411
Supervisor : Dr. A. Mayekiso
Email : amayekiso@ufh.ac.za
Co-supervisor : Dr M. Mamabolo
Email : RanchoM@arc.agric.za

Aim of the study: To analyse small-scale livestock farmers’ knowledge, attitudes, practices, and willingness to pay for fodder seed technology in OR Tambo district municipality in the Eastern Cape province of South Africa.

Ethics: The study will abide by ethical standards stipulated by the University of Fort Hare. The respondents will be informed about the research and its purpose, thus informed consent form will be obtained from the respondents. The respondents will be assured that any information that is confidential in the research will be kept confidential. The researcher will fully explain that participation in the research is voluntary, and respondents can discontinue at any time they wish. Respondents will be assured that their participation in this research study will not result in any penalties, prejudice, or comebacks. The interview might take approximately 45 minutes.

Name of enumerator: _____

Municipality: _____

Date of interview: _____

Name of the village: _____

SECTION A: SOCIO-ECONOMIC CHARACTERISTICS

A1. Please state your age as of today

1. Age	
--------	--

A2. Gender

Female	1
Male	2

A3. Race

African	1
White	2
Coloured	3
Indian	4
Other, specify	5

A4. Marital Status

Single	1
Married	2
Divorced	3
Widow	4
Other, specify	5



University of Fort Hare
Together in Excellence

A5. Educational level

No formal education	1
Primary education	2
Secondary education	3
Tertiary education	4

A6. Employment status

Unemployed	1
Employed	2
Self employed	3
Other, specify	4

.....

A6. Source of income (select all that are applicable)

Old age pension	1
Child grant	2
Sale of farm produce	3
Off farm wages/salaries	4
Other, please specify	

.....

A7. What is your estimated monthly income from the sources above?

.....

A8. Are you a full-time farmer?

Yes	1
No	2



A9. Household size

SECTION B: Farm information

University of Fort Hare
Together in Excellence

B1. Please indicate the number of livestock you have for the following species

Species	Number
Cattle	
Sheep	
Goat	

B2.What are the major feed resources for your livestock?

Communal grazing land	1
Crop residues	2
Commercial feed	3
Cut grass and browses	4
Other(specify)	5

.....

B3. How much arable land (ha) do you have?

1. Less than 0.5 hectares	1
2. 0.5-1hectares	2
3. 1-2 hectares	3
4. >2 hectares	4

B4. Do you utilize the land for farming?

1. Yes	1
2. No	2

B4b. If No why?

.....

B4c. If yes, how much land is utilized?

1. Less than 0.5 hectares	1
2. 0.5-1hectares	2
3. 1-2 hectares	3
4. >2 hectares	4



B5. How did you acquire land?

Bought	1
Commonage	2
Rent	3
Inherited	4
Other (specify)	5

University of Fort Hare
Together in Excellence

.....

EXTENSION SERVICES

B6. Where do you get agricultural information and advice?

From an extension officer	1
From neighbouring farmers	2
From research stations	3
From social media	4
Other, please specify	5

.....

B7. Do you interact with an extension officer?

Yes	1
-----	---

No	2
----	---

B8. How often do you interact with your extension officer?

Once a week	1
Once in two weeks	2
Once in a month	3
Never	4
Other, please specify	5

.....

B9. Are you currently engaged in any project with the extension officer?

Yes	1
No	2

B10. If yes, please state the name of the project.

.....

B11. Do extension officers tell you anything about fodder varieties?

Yes	1
No	2



University of Fort Hare
Teaching for Transformation

B12. Do you have any problem in acquiring fodder seeds?

Yes	1
No	2

B13. If yes, what is the problem?

.....

B14. How do you access fodder seeds?

Purchase	1
Gift from friends/relatives	2
Given free by the Department of Agriculture	3
Other, please specify	4

.....

B15. If purchase, where do you buy the seeds?

Seed companies	1
----------------	---

Other farmers	2
NGO	3
Other, please specify	4

.....



University of Fort Hare
Together in Excellence

SECTION C: Small-scale farmers' knowledge, attitudes and practices

C1. Farmer's knowledge

Please indicate the extent to which you are knowledgeable about the following statements about fodder seed technology. **Codes: Know=1; Not sure/ Neutral=2; and Don't Know=3**

Knowledge about fodder seed technology		Code
C1.1	Do you know that seed technology is a way for improving the genetic and physical features of fodder seed?	
C1.2	Do you know that fodder seed technology provides fodder resilient varieties that are suitable for livestock feed?	
C1.3	Do you know that you can use fodder seeds to plant fodder when there is shortage of feed?	
C1.4	Do you know that the purpose of fodder seed technology is to increase agricultural production by spreading high-yielding fodder seeds of excellent quality?	
C1.5	Do you know that there are fodder cultivars that can thrive in the mist of changing climate?	
C1.6	Did you know that fodder is an essential input for animal feed, made up of sprouted grains such as barley, wheat, maize?	

C2. Farmer's attitudes

This section seeks to reveal your attitudes towards fodder seed technology. Please indicate your level of agreement with the statements below. **Codes: 5=strongly agree, 4 =agree, 3= neutral, 2 = disagree, and 1=strongly disagree.**

In order to arrive at the composite attitude score, the scores obtained by each respondents for every item will be summed up and on the basis of their attitude scores, the respondents will be classified into three categories namely; Positive (Strongly agree and agree), Neutral, negative (disagree and strongly disagree)

Attitudes towards fodder seed technology		Code
C2.1	Fodder seeds are always available	
C2.2	Fodder seeds are not expensive	
C2.3	Using fodder can increase livestock productivity	
C2.4	The government should always give out these fodder seeds	
C2.5	Natural grazing is enough for livestock	
C2.6	There is extra land to plant fodder	

C3. Farmer's practices

C3.1 Do you plant fodder seed?

Yes	1
No	2

C3.2	Seedlings and planting
	Which company seed cultivar/s do you use? <i>(if applicable select more than one)</i> Codes: 1= Agricol , 2= Capstone seeds, 3= Hydrotech , 5= Sansor, 6= McDonalds Seeds, 7= Pannar, 8=Afgri, 9=Clovelly Seeds, 10=Klein Karoo, 11= Tsitsikama seeds, 12=Oakhurst farm
C3.3	Fertigation
	Which of the following water sources do you use? <i>(if applicable select more than one)</i>
	1 = Borehole/ Irrigation 2 = Municipal 3= Rain-fed 4 = Other <i>(specify)</i>
	Which of the following nutrient solutions do you use? <i>(if applicable select more than one)</i>
	1 = Calcium 2 = Potassium 3= NPK 4 = Other <i>(specify)</i>
	C3.3.4 Which irrigation method do you use? <i>(if applicable select more than one)</i>
	1= Surface 2=Sprinkler 3= Drip/trickle 4= Subsurface 5= Other <i>(specify)</i>

C4. Which seed companies do you know from the list below? (You can choose more than one)

Agricol	1
PANNAR	2
Capstone	3
Sansor	4
Afgri	5
Clovelly seeds	6
Klein Karoo	7
McDonalds Seeds	8
Tsitsikama	9
Oakhurst	10
Biggs	11
Hydrotech	12

C5. Please choose fodder varieties you know from the list below

Codes: 1. Enhancer 2=LS 35 3=Endurance 4=Sukari 5=Agriboost 6=Hutton 7=Kamma 8=Sophia 9=Springfield 10= Moneymaker 11=PAN263 12=NCD Grazer 13=Daitry delight 14=Trojan 15=Blue Chip 16=Jenna

C6. Which fodder variety do you prefer? From the list of those that you know?

.....

Codes: 1. Enhancer 2=LS 35 3=Endurance 4=Sukari 5=Agriboost 6=Hutton 7=Kamma 8=Sophia 9=Springfield 10= Moneymaker 11=PAN263 12=NCD Grazer 13=Dairy delight 14=Trojan 15=Blue Chip 16=Jenna

C7. Please state why you prefer that variety

.....

SECTION D: Farmer's willingness to pay

Please note that the information to be collected here is for research purposes only, this means that you will not be sold any seeds here and you are not going to pay anything.

D1. Agriboost (Q)

Characteristics of Agriboost (*Lolium multiflorum*)

- ❖ This is a very high sugar grass with excellent feed quality,
- ❖ Agriboost is very densely tilled and competitive cultivar that is able to cover the ground and has high grazing tolerance,
- ❖ Agriboost can be utilised as a new sowing option or as a tool to plant into exiting pastures.

1. Would you be willing to pay money for Agriboost seed?

Yes	1
No	2
If No go to D2	

a. If Yes to 1, how much are you willing to pay per kg of Agriboost seed?

.....

b. Would you be willing to pay R.....per kg of Agriboost seed?

1-Yes	If Yes go to c
2- No	If No go to d

Increase price from a. by 25%

c. Would you be willing to pay R..... per kg of Agriboost seed?

1-Yes	If Yes go to d
2- No	If No go to d

Increase price from a. by 50%

d. What is the maximum amount you are willing pay per kg of Agriboost?

.....

e. Why is your maximum willingness to pay the amount stated in (d) above?

The variety is worth that amount (Value attaching to variety)	1
Because I can afford it	2
I want to access good fodder seeds	3
Because I have no more information about it	4
The government should pay the rest	5
Other reasons (please specify)	6

D2. Enhancer

Characteristics of Enhancer (*Lolium multiflorum*)

- ❖ It will produce quality forage throughout spring and summer.
- ❖ It functions well as a cover crop.
- ❖ As a cool-season bunch grass, it is best adapted to cool, moist conditions.
- ❖ It does not grow as well in hot, dry summer weather.
- ❖ High fibre digestibility, high relative forage quality, palatability.

2. Would you be willing to pay money for Enhancer seed?

Yes	1
No	2
If No go to D3	

University of Fort Hare
Together in Excellence

a. If Yes to 2, how much are you willing to pay per kg for Enhancer seed?

.....

b. Would you be willing to pay R.....per kg of Enhancer seed?

1-Yes	If Yes go to c
2- No	If No go to d

Increase price from a. by 25%

c. Would you be willing to pay R..... per kg of Enhancer seed?

1-Yes	If Yes go to d
2- No	If No go to d

Increase price from a. by 50%

d. What is the maximum money you are willing pay per kg of Enhancer?

.....

e. Why is your maximum willingness to pay the amount stated in (d) above?

The variety is worth that amount (Value attaching to variety)	1
Because I can afford it	2
I want to access good fodder seeds	3
Because I have no more information about it	4
The government should pay the rest	5
Other reasons (please specify)	6

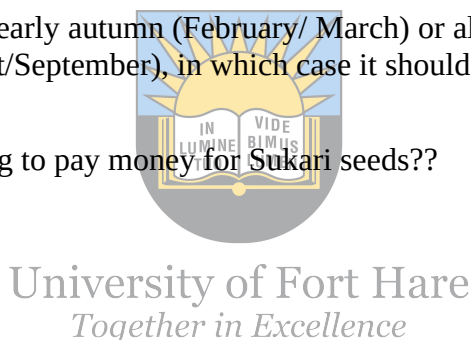
D3. Sukari

Characteristics of Sukari

- ❖ It is an Italian ryegrass that lasts exceptionally long through the summer and in some cases, even until autumn.
- ❖ High dry matter and sugar content.
- ❖ Outstanding high midwinter production.
- ❖ It is well adapted to handle heat stress and acidic soil.
- ❖ It can be established in early autumn (February/ March) or alternatively early spring after the major frosts (August/September), in which case it should provide pasture for about 15 months.

3. Would you be willing to pay money for Sukari seeds??

Yes	1
No	2
If No go to D4	



a. If Yes to 1, how much are you willing to pay per kg for Sukari seed?

.....

b. Would you be willing to pay R.....per kg of Sukari seed?

1-Yes	If Yes go to c
2- No	If No go to d

Increase price from a. by 25%

c. Would you be willing to pay R..... per kg of Sukari seed?

1-Yes	If Yes go to d
2- No	If No go to d

Increase price from a. by 50%

d. What is the maximum amount you are willing pay per kg of Sukari?

.....

e. Why is your maximum willingness to pay the amount stated in (d) above?

The variety is worth that amount (Value attaching to variety)	1
Because I can afford it	2
I want to access good fodder seeds	3
Because I have no more information about it	4
The government should pay the rest	5
Other reasons (please specify)	6

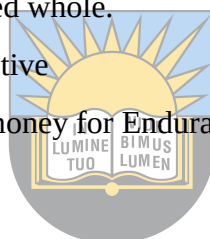
D4. Endurance

Characteristics of Endurance

- ❖ Improves milk production during the dry winter and spring.
- ❖ It usually produces good quality root and leaf material right through to the end of August, in some areas, production can extend into September.
- ❖ It is highly palatable, drought and heat tolerant.
- ❖ Dry matter is highly digestible. It constitutes good forage for sheep and cattle. For cattle, best pulled or ploughed out and fed whole.
- ❖ It is usually not cold or frost sensitive

4. Would you be willing to pay money for Endurance seed?

Yes	1
No	2
If No go to D5	



University of Fort Hare
Together in Excellence

a. If Yes to 1, how much are you willing to pay per kg for Endurance seed?

.....

b. Would you be willing to pay R.....per kg of Endurance seed?

1-Yes	If Yes go to c
2- No	If No go to d

Increase price from a. by 25%

c. Would you be willing to pay R..... per kg of Endurance seed?

1-Yes	If Yes go to d
2- No	If No go to d

Increase price from a. by 50%

d. What is the maximum amount you are willing pay per kg of Endurance?

.....

e. Why is your maximum willingness to pay the amount stated in (d) above?

The variety is worth that amount (Value attaching to variety)	1
Because I can afford it	2
I want to access good fodder seeds	3
Because I have no more information about it	4
The government should pay the rest	5
Other reasons (please specify)	6

D5. LS 35

Characteristics of LS 35 (*Secale cereale*)

- ❖ It has the ability to produce feed very quickly
- ❖ It is an ideal variety to mix with rye grass pastures to stand as a nurse crop or in periods where feed or land is limited and a quick fodder crop is needed
- ❖ LS 35 is a spring type with short duration, meaning it will go to seed if not managed closely
- ❖ It does not require a cold spell with change in light hours to initiate seeding.

5. Would you be willing to pay money for LS 35 seed?

Yes	1
No	2
If No go to D6	

a. If Yes to 1, how much are you willing to pay per kg of LS 35 seed?

1-Yes	If Yes go to b
2- No	If No go to d

University of Fort Hare
Together in Excellence

b. Would you be willing to pay R.....per kg of LS35 seed?

1-Yes	If Yes go to c
2- No	If No go to d

Increase price from a. by 25%

c. Would you be willing to pay R..... per kg of LS35 seed?

1-Yes	If Yes go to d
2- No	If No go to d

Increase price from a. by 50%

d. What is the maximum amount you are willing pay per kg of LS35?

.....

e. Why is your maximum willingness to pay the amount stated in (d) above?

The variety is worth that amount (Value attaching to variety)	1
Because I can afford it	2
I want to access good fodder seeds	3
Because I have no more information about it	4
The government should pay the rest	5
Other reasons (please specify)	6

D6. In a case where the farmer did not have knowledge about the fodder seed technology, now that they have some information, is the farmer willing to accept the technology?

.....

D7. In a case where the farmer did not have knowledge about the fodder seed technology, now that they have some information, is the farmer willing to pay to use the technology?

.....

The end..... Thank you for participating

Enkosi!!



University of Fort Hare
Together in Excellence



University of Fort Hare
Together in Excellence

ETHICS CLEARANCE
REC-270710-028-RA Level 01

Project Number:	MAY031STOK01
Project title:	Small-scale livestock farmers' knowledge, attitudes, practices and willingness to pay for fodder seed technology in 3 district municipalities of the Eastern Cape province of South Africa.
Qualification:	Master of Science in Agriculture: Agricultural Economics
Student name:	Ayabonga Toko
Registration number	201820990
Supervisor:	Dr A Mayekiso
Department:	Agricultural Economics
Co-supervisor:	N/A

On behalf of the University of Fort Hare's Research Ethics Committee (UREC) I hereby grant ethics approval for MAY031STOK01. This approval is valid for 12 months from the date of approval. Renewal of approval must be applied for BEFORE termination of this approval period. Renewal is subject to receipt of a satisfactory progress report. The approval covers the undertakings contained in the above-mentioned project and research instrument(s). The research may commence as from the 26/09/23, using the reference number indicated above.

Note that should any other instruments be required or amendments become necessary, these require separate authorisation.

Please note that UREC must be informed immediately of

- Any material changes in the conditions or undertakings mentioned in the document;
- Any material breaches of ethical undertakings or events that impact upon the ethical conduct of the research.

The student must report to the UREC in the prescribed format, where applicable, annually, and at the end of the project, in respect of ethical compliance.

UREC retains the right to

- Withdraw or amend this approval if
 - Any unethical principal or practices are revealed or suspected;
 - Relevant information has been withheld or misrepresented;
 - Regulatory changes of whatsoever nature so require;
 - The conditions contained in the Certificate have not been adhered to.
- Request access to any information or data at any time during the course or after completion of the project.

Your compliance with Department of Health 2015 guidelines and any other applicable regulatory instruments and with UREC ethics requirements as contained in UREC policies and standard operating procedures, is implied.

UREC wishes you well in your research.

Yours sincerely,



Dr A Nyika

Chairperson: Inter-Faculty Research Ethics Committee

29 September 2023