Adaptive Strategies to Mitigate Water Scarcity Among Smallholder Cattle Farmers in Vulnerable Areas of the Greater Tzaneen Local Municipality

By

Dollen Mahlo (18021489)

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Institute for Rural Development

Faculty of Science, Engineering and Agriculture

SOUTH AFRICA

Supervisor **Prof M. Manjoro**

Co-Supervisors **Ms G.B. Oloo**

Dr M.V. Mkwanazi

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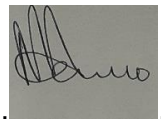
DECLARATION

I, Dollen Mahlo, hereby declare that this dissertation for Masters of Rural Development (AGMARD) degree submitted to the Institute for Rural Development at the University of Venda has not been submitted previously for any degree at this or another University. It is original in design and in execution, and all reference material contained therein has been duly acknowledged. The dissertation was approved by the Higher Degrees Committee of the Faculty of Science Engineering and Agriculture at the University of Venda and all suggestions have been addressed to the satisfaction of the Supervisors.

Signature ……  …… **Date**…12 August 2024……

Dollen Mahlo

ABSTRACT

The rapid increase in demand for livestock and livestock products, driven by factors such as population growth, urbanization, and rising incomes, is projected to escalate significantly by 2050. The estimates indicate the utilization of over 60 billion livestock for meat, egg, and dairy production. This surge in demand poses substantial challenges, particularly in the context of climate change impacts on water resources. Smallholder livestock farmers, who are integral to meeting this demand, are disproportionately affected by climate change-induced water scarcity. Despite their significant contribution to the agricultural Gross Domestic Product (GDP), these farmers face daily depletion of water reserves, indicating severe water scarcity. Climate variability further exacerbates this situation, with animal water consumption expected to triple. This study aimed to examine the adaptive strategies employed by smallholder livestock farmers in vulnerable areas of the Greater Tzaneen Local Municipality to mitigate water scarcity. A convergent parallel mixed methods design was utilized, wherein both quantitative and qualitative data were collected and analyzed concurrently. Purposive sampling was used to select participants, primarily through face-to-face interviews. Secondary data was obtained from literature, journal manuscripts, policy documents, and municipal reports. Quantitative data were analyzed using the Statistical Package for Social Sciences (SPSS) version 27, while thematic content analysis was performed using Atlas.ti version 8. The findings revealed several adaptive strategies employed by farmers to address water scarcity, including changes in water sources and collaborations with government agencies such as the Department of Water and Sanitation. Challenges such as cattle mortality due to water scarcity were also identified, highlighting the need for additional adaptive measures to ensure sustainable cattle farming. The study underscores the necessity of enhancing adaptive strategies to mitigate the adverse effects of water scarcity on smallholder livestock farming in the context of increasing climate variability.

Keywords: Livestock production, smallholder farmers, Tzaneen Local municipality, water security

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To my Husband Hlayiseko Nukeri, I always thank God for blessing me with you. Thank you for understanding when I spent long hours on this study and for not giving you attention.

DEDICATION

This work is dedicated to my mother Mapula Ines Mahlo, who values education more than anything else on earth. She desires to see all her children achieving the highest level of

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Thank you, mother!

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ABBREVIATIONS AND ACRONYMS

DAFF : Department of Agriculture Forestry and Fisheries

DALRRD: Department of Land Reform ad Rural Development

GDP : Gross Domestic Product

IDP : Integrated Development Plan

IKS : Indigenous Knowledge Systems

IPCC : Intergovernmental Panel of Climate Change

GHG : Greenhouses Gases

MLD : Megalitres per Day

SA : South Africa

SPSS: Statistical Package for Social Sciences

SSA : Sub-Saharan African

CHAPTER 1: INTRODUCTION

1.1 **Background**

Globally, there has been a significant increase of over 60% in demand of livestock and livestock products, largely attributed to factors such as human population growth, urbanization, and rising incomes (Yitbarek, 2019). Projections indicate that the global population is expected to reach 9.2 billion by 2050, accompanied by a notable increase in urbanization rates, which are projected to reach 70% (Yitbarek, 2019). Moreover, income levels are anticipated to rise by 1.1-3.1% by 2050 (Yitbarek, 2019). Currently, the utilization of livestock for meat, egg, and dairy production involves over 60 billion land animals globally (Yitbarek, 2019). This figure is expected to escalate further, with projections indicating that the global livestock population could surpass 100 billion by 2050, marking a remarkable increase of 180% in both beef meat and milk production (Yitbarek, 2019). However, alongside this surge in demand, livestock production faces significant challenges, particularly due to the adverse impacts of climate change.

Climate change poses a considerable threat to livestock production, primarily due to its impact on water availability (Rojas-Downing *et al.,* 2017). Water is an indispensable factor in livestock production, essential for various processes within the industry (Rojas-Downing *et al.,* 2017). The depletion of water sources poses a significant concern for the sustainability of livestock production systems (Jellason *et al.,* 2022). Thus, addressing the challenges posed by climate change and water scarcity is imperative for long-term viability of livestock industry. Water scarcity problems are expected to worsen due to increasing rainfall variability, decreasing rainfall amounts and the depletion of groundwater resources (Jellason *et al.,* 2022).

Cattle are vital to communal farming in Africa. Communal farmers depend on cattle for draught power, and it is estimated that over 90% of the cultivated area is ploughed using animal-drawn implements (Rampokanyo, 2012). Cattle are a source of wealth, status, and security, and an important form of savings in cattle-rearing societies. Cattle are a hardy form of capital that does not suffer from the desertion which afflicts other forms of investment (Banda & Tanganyika, 2021). Despite declines in cattle numbers due to disease and sales, few households do not own at least one animal, even if it is only the family milker tethered under the tree (Shackleton & Ntshudu, 2023). Wealthier households who can afford to stall feed their animals in winter months often purchase additional cattle specifically for ploughing from poorer households, offering income-earning opportunities. Moreover, since draught power requirements are at least 1.5-2 animals per household, a cattle-less household can often

obtain draft labour from better-off neighbours through various exchange or hire agreements (Taruvinga *et al.,* 2022).

The escalating water scarcity in drylands hampers essential land functions such as nutrient cycling and primary production, potentially leading to desertification (Jellason *et al.,* 2022). Consequently, there is a growing recognition of the importance of adaptation strategies across various knowledge and policy domains over the past four decades (Jellason *et al.,* 2022). This underscores the urgent need to prioritize adaptation efforts to address complex challenges faced by dryland ecosystems and communities dependent on them. Water scarcity is adversely affecting cattle production in Africa (Bahta, 2020).

The semi-arid climate of South Africa can be traced to high elevation, a sub-tropical latitude, and the inflow of dry air from the South Atlantic which is prominent during winter and in the Pacific El Niño phase. Moisture is locally dissipated via evaporative fluxes compounded by anthropogenic stress (Jury, 2021). The Western Cape (WC) Province for example was one of the provinces mostly affected by the 2015–2018 droughts, which was declared the most severe on record since the 1926–1933 droughts (Botai *et al.,* 2017; Zwane, 2019). According to Pii & Ncube (2022), there were heavy economic losses of approximately 5.9 billion ZAR in the agricultural sector, including livestock farming, of approximately 30 000 jobs loss and export reduction of between 13 and 20%. Pii & Ncube (2022) further alluded that about 17 000 livestock died of starvation. Smallholder livestock farmers were the most affected by the 2015–2018 drought because they lacked the resources to deal with the impacts of drought in the Overberg and West Coast Districts, Western Cape, South Africa (Pii & Ncube, 2022).

According to Kom *et al.* (2020), rural famers in Limpopo province are grappling with climate change impacts on cattle farming and as a result, they have adopted adaptation measures like adjusting production and using climate-adaptive breeds. Smallholder cattle farmers are particularly vulnerable due to limited adaptive capacity, few options, and financial constraints. It's crucial to explore opportunities for effective coping and adaptation strategies to mitigate adverse climate effects. The choice of adapting within individual farmer is normally determined by seasonal climatic variation as well as other socio-economic drivers (Wood *et al.,* 2014). Hence, adaptation is the ability of a system to respond or adjust to risks or potential effects of climate variability and change conditions (IPCC, 2014). Shikwambana & Malaza (2022) reported that, smallholder cattle farmers in South Africa use a variety of strategies like breed improvement, the use of science and technology, management systems and capacity building to manage and adapt to negative impacts of climate change. Therefore, adaptation remains one of the strategies for addressing climate challenges that prevail in the livestock sector (Idrissou *et al.,* 2020).

Farmers with low adaptive capacity are more vulnerable to climate change impacts (Feleke *et al.,* 2016). Understanding their adaptive behaviour is crucial for designing effective resilience-building programs. Most relevant strategies put in place by cattle farmers to cope to climate change are indigenous adaptive strategies like creation of paddocks/camps to conserve grazing lands, rainwater harvesting from mountain slopes, construction of stock dams for water storage, transhumance, and reduction in herd size (Ncube & Lagardien, 2015). Some farmers use conventional adaptive strategies like the use of concentrated feed, and livestock diversification (Idrissou *et al.,* 2021). In this study, insights on adaptive strategies to mitigate water scarcity among smallholder cattle farmers in vulnerable areas of the Greater Tzaneen Local Municipality were examined.

1.2 Statement of the research problem

Cattle production is an important agricultural commodity for food security. Livestock provides 17 % kilocalories and 33 % protein consumption contributing to the livelihoods of 1.0 billion people internationally (Bogale & Erena, 2022). In South Africa alone for example, the cattle industry contributes to approximately 60% of agricultural output and employs approximately 500 000 people nationwide (Department of Agriculture, Forestry and Fisheries (DAFF) 2016; Matlou & Bahta, 2019). Cattle play an important role in poverty alleviation, income enhancement and risk reduction for poor rural households. The impact of water scarcity on cattle production especially for smallholder cattle farmers is becoming a significant physical stressor in temperate and humid regions. Water scarcity due to drought impacts cattle production (Bahta & Myeki, 2022).

Literature suggests that scientific studies have generally focused on effects of water scarcity for smallholder cattle farmers (Sikhweni & Hassan 2014; Bahta, 2020; Matlou *et al.,* 2021). Rarely have researchers included adaptive strategies to water scarcity by smallholder livestock farmers in vulnerable areas especially those focusing on cattle. Coping and adaptation choices are limited by insufficient knowledge and low levels of resources. Furthermore, the extent to which farmers' level of vulnerability influences their choice of coping or adaptation strategies remains uncertain (Muthelo, 2018; Zhou *et al.,* 2022). As such, understanding adaptive strategies to water scarcity by smallholder cattle farmers in vulnerable areas becomes critical and urgent. The study determined adaptive strategies to water scarcity by smallholder cattle farmers in vulnerable areas in Greater Tzaneen Local municipality.

1.3 Justification/Rationale of the Study

The Mogapeng and Shiluvane are characterised by absolute poverty and water- scarcity, mainly due to frequent droughts (Stats SA, 2011). The smallholder cattle farmers in the two villages practicing subsistence farming are faced with water scarcity. The information from

the study will be crucial to enable the government at the local level, provincial and national level to make informed decisions on policies and strategies to support smallholder cattle farmers, especially in vulnerable areas. It will also assist responsible authorities with bases of support cattle to farmers. The results of the study will be used by the extension officers and cattle farmers to address the effects of water insecurity for cattle productivity. In addition, the knowledge will generated empower smallholder cattle farmers with information that might help them to improve on cattle productivity. The study results will also benefit smallholder cattle farmers in a bid to strengthen their adaptive mechanisms while improving their contribution towards economic development and poverty reduction. Moreover, the results of the study will add to the body of knowledge in academic literature especially in rural development.

1.4 Main Objective

The main objective of the study was to explore adaptive strategies used by smallholder farmers vulnerable to water security for improved cattle production. To achieve this, the following specific objectives were used.

1.4.1 Specific Objectives

1. To identify adaptive strategies in response to water insecurity by smallholder cattle farmers in vulnerable areas;
2. To determine factors that influence selection of adaptive strategies in response to water insecurity by smallholder cattle farmers in vulnerable areas and
3. To recommend relevant adaptive strategies to water insecurity for sustainable smallholder cattle farming.

1.4.2 Research questions

1. What are the adaptive strategies in response to water insecurity by smallholder cattle farmers in vulnerable areas?
2. Which factors influence selection of adaptive strategies in response to water insecurity by smallholder cattle farmers?
3. Which adaptive strategies to water insecurity are relevant for sustainable smallholder cattle farming?

1.5 Operational definitions of key terms and concepts

Adaptation

Alterations/changes in physiological, behavioural, and structural characters of an individual in response to their environment (Jain *et al.,* 2019).

Adaptation strategy

Resistance-based focused on maintaining the current state of a system in the face of climate change or climate-driven changes in the environment. In agriculture adaptive strategies are implemented to alleviate the potential negative effects of climate change. Key synergies need to be identified, as mitigation practices may compete with modifications to local agricultural practices aimed at maintaining production and income (Grigorieva *et al.,* 2023).

Agriculture

All forms of farming, including soil preparation and tillage, harvesting, growing, and producing any agricultural or horticultural commodities, raising cattle, dairy cattle, or chickens, and any other activities carried out on a farm as a byproduct or in conjunction with farming operations. However, it excludes the production or processing of sugar, coconuts, abaca, tobacco, pineapples, or other farm products. (Harris & Fuller, 2014).

Climate change

The Intergovernmental Panel on Climate Change (IPCC) describes the alteration of socioecological systems in reaction to actual or perceived climatic spurs or effects in order to mitigate the effects of climate change.
(Sibiya, 2023).

Drought

A prolonged decrease in precipitation is referred to as a drought. This leads to a scarcity of water, which harms the environment, cattle, and agriculture. Since droughts adversely affect the agricultural industry, those that depend on the commodities from industries suffer as well (Amadeo, 2022). Food becomes scarce, and demand exceeds supply. Prices go up, and the commodities markets waiver (Amadeo, 2022).

Cattle

Domesticated bovine farm animals that are raised for their meat, milk, hides or for draft purposes (Lotha, 2021).

Smallholder

Those that cultivate one or two cash crops and subsistence crops on small-scale parcels of land (less than two hectares), nearly entirely using family labor.Smallholder only refers to their limited resource endowment relative to other farmers in the sector. Farmers owning small-based plots of land (of less than 2 hectares) in which they grow subsistence crops and one or two cash crops relying almost exclusively on family labour (Sabo *et al.,* 2017).

Vulnerable

Characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a natural hazard (Wang *et al.,* 2022)

1.6 Outline of the Dissertation

Chapter 1 presents the introduction where the research focus is unpacked. This is followed by the statement of the problem, justification, research objectives, and research questions that guide the study. An important aspect of this chapter is that it consists of operational definitions of key terms and concepts that are used in this research.

Chapter 2 provides a comprehensive literature review on adaptive strategies by smallholder livestock farmers in vulnerable areas. It also provides a conceptual framework for water scarcity, and effects of water security on smallholder cattle farmers.

Chapter 3 presents the design of the research, the target population that was sampled and sampling techniques that were employed. It also, provides the methods for data collection and methods of analysis, validity and reliability in addressing the objectives of the study. Ethical considerations essential for the proposed study are explained.

In chapters 4, 5 and 6 the research findings are presented discussed. Each objective forms a chapter and follows a paper structure with title, abstract, introduction, results, discussions and conclusions.

Chapter 7 is a synthesis of key study findings, presenting of the general discussion, conclusion and recommendations. In addition, a list of references and appendices forms part of this dissertation.

CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

This chapter presents literature reviewed based on two research objectives namely, adaptation strategies in response to water insecurity by smallholder cattle farmers in vulnerable areas and factors that influence selection of adaptive strategies in response to water insecurity by smallholder farmers in vulnerable areas. A literature review is a survey of academic sections, manuscripts and additional credible resources applicable to a specific concern, section of study, or concept, and in doing so, offering an explanation, synopsis, and critical assessment of these mechanisms (Mudavanhu, 2017).

Reviews of the literature are intended to give readers an overview of the sources you have looked at when researching a certain subject and to show them how your work fits into the greater body of knowledge. (Ramdhani *et al.,* 2014). Literature review gives an overview of what has been said, who are the key writers, what are the prevailing theories and hypotheses, which questions are being asked, and which methods and methodologies are appropriate and useful. As such, it is not in itself primary research, but rather it reports on other scholars' findings (Ramdhani *et al.,* 2014). Although various scientific studies have been undertaken on the effects of water scarcity on smallholder cattle farming, there are still gaps. These gaps are highlighted under the following sub-headings.

2.2. Causes of water scarcity

Water scarcity is one of the greatest challenges of the twenty-first century (Chakkaravarthy & Balakrishnan, 2019). Overpopulation, agriculture, pollution of water and improper government policies are the important reasons behind water scarcity (Chakkaravarthy & Balakrishnan, 2019). FAO, (2013) reported agriculture, encompassing crops, livestock, fisheries, aquaculture, and forestry, is both a cause and a victim of water scarcity (FAO , 2013). It accounts for an estimated 70 percent of global water withdrawals, while increasing competition with other sectors for water.

2.2.1. Agriculture use

Yang *et al.* (2019) stated that 90% water resources is used in agriculture. Eighty percent of groundwater goes to irrigation and agricultural purposes. Some innovative solutions have been developed to improve water use efficiency and maintain or even increase yields. In the future, the demand for food is highly expected, directly impacting the amount of water used in agriculture. In addition, as a result of amplified water shortage and famine due to temperature alteration (Nhemachena *et al.,* 2020). It is anticipated that the extensive use of water for irrigation would rise as rivalry between agriculture and other economic sectors intensifies.

2.2.2. Population growth

Chakkaravarthy & Balakrishnan (2019) posits that the world's population is growing at a rate of 80 million people each year. This means that each year we need to find a way to add about 64 billion cubic meters of water to the global water supply. India is the second-most populous country in the world, with more than 1 billion citizens. Roughly half of India's population, a staggering 569 million, practice open defecation. In the year 2030, India will be number one in population (Manasi & Latha, 2020). O'Neill, (2024) reports that the annual population growth in South Africa increased by 0.03 percentage points (+3.57 percent) in 2023. In total, the population growth amounted to 0.87 percent in 2023. This increase was preceded by a declining population growth. Smedley, (2017) emphasized that there are millions of people all over the world who do not have access to water, or, if they have access, that water is not usable. About 70% of the Earth's surface is covered with water and 3% of it is actually freshwater that is fit for human consumption (Smedley, 2017). Some 1.1 billion people worldwide lack access to water, and a total of 2.7 billion find water scarce for at least one month of the year (Chakkaravarthy & Balakrishnan, 2019).

2.2.3. Pollution of water

Chakkaravarthy & Balakrishnan (2019) further stated that water contamination is a serious issue, particularly in places where there may not be an effective sewage system. Anything from oil to carcasses to chemicals to feces can cause pollution. Pollution can be anything from oil, to carcasses, to chemicals, and to faecal matter. Water pollution affects the entire biosphere plants and organisms living in these bodies of water. Department of Water and Sanitation, (2023) reports that in South Africa based on water quality tests carried out by South African municipalities themselves during the 2021/2022 municipal financial year, 54% of water supply systems achieved excellent or good microbiological water quality compliance, and 46% achieved poor or bad microbiological water quality compliance.

2.3. Effects of water scarcity on cattle production

The value of services and products provided through cattle production are vast and include economic and social benefits. Cattles provide opportunities for the production and marketing of animal-based foods and products. Animal based foods such as butter, milk and meat provide nutrition in rural areas. It is also a common practise in rural areas for animal-based foods to be sold in order to gain a financial income for other household needs. Additionally, the use of cattle for transportation, animal labour in agricultural production and, provision of manure for crop production are all common practises in many rural areas of the developing world (Tona, 2021).

Some cattle farmers, especially the poorest ones, lost a significant portion of their cattle investment during the drought period. Cattle farmers were forced to sell their cattle at a loss to commercial cattle farmers, while some of the cattle died due to famine (Ndlovu & Mjimba, 2021). Farmers who can afford to maintain cattle investment during drought period complained about the total costs of maintaining cattle during droughts (Tabane, 2017). For example, in 2016 the cost of drought relief cattle feed (Lucerne) is more or less R40 per 50kg, and the cost of cattle salt is more or less R45 per 50kg this was reported by Tabane (2017). A cattle farmer who was able to maintain his cattle during drought period estimates that the total expenditure of maintaining his cattle during this period was more or less R70 000 for approximately 40 cows (Tabane, 2017). For poor cattle owners, such costs were unbearable. As a result, commercial farmers saw an opportunity to buy cattle at a price less than what the cattle would usually sell for under different circumstances, whereby rural cattle owners are not pressed to sell due to disadvantageous environmental conditions (Tabane, 2017)

2.4. Adaptation strategies

The IPCC (2016) defines adaptation as 'adjustment in natural or human systems to a new or changing environment. Adaptation to climate change refers to adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Various types of adaptation mechanism can be distinguished, including anticipatory and reactive adaptation, private and public adaptation, and autonomous and planned adaptation'. Farmers who face water scarcity require innovative and sustainable adaptation strategies in order to maintain the productive capacity of the resource base. Adaptation may occur at different levels ranging from local to national and global. Most of cattle farmers resort to both conventional and indigenous adaptive strategies (Altieri *et al.,* 2015).

Kihila (2018) argues that in response to water scarcity, smallholder cattle farmers from their indigenous knowledge have overtime developed their own coping and adaptation strategies to counteract the changes. The strategies have helped communities in adjusting and ensuring that life is sustained. This suggests that the contribution of indigenous knowledge in development of local coping and adaptation strategies that can complement the global knowledge system has proved to have a role in management of climate change through its contribution. Indigenous knowledge can provide relationships by which the people connect to natural environment hence it becomes useful in enhancing the management of natural resources and in developing effective coping and adaptation strategies. Bauer (2022) further stated that indigenous knowledge in this respect refers to the knowledge that is attributed to a particular community while coping and adaptation strategies refer to reactive and proactive adjustments or adaptations in response to climate change. Some of these indigenous adaptive

strategies are closure of grazing areas as one of the mechanisms for restoring degraded soils. Apart from supply of pasture the strategy offers additional benefit in terms of provision of soil cover for soil erosion prevention (Silva *et al.,* 2024). This strategy helps to restore degraded soils and promotes vegetation growth, which has been pointed out to reduce soil erosion and enhance soil productivity.

Most of the adaptation strategies are sustainable as the smallholder farmers seem to favour them since they are less costly and are Indigenous Knowledge System (IKS) based (Mushore *et al.* 2021). Below is the explanation of some adaptive strategies considered by smallholder farmers.

2.4.1. Breeding strategies

Numerous indigenous breeds have naturally evolved to thrive in challenging environmental conditions. Nevertheless, in developing nations, there is often insufficient technological advancements in livestock breeding and agricultural programs (Mapiye *et al.,* 2019). Such technological deficiencies hinder the acceleration of adaptation processes that could otherwise enhance resilience and productivity in livestock farming. Adaptation strategies address not only the tolerance of livestock to heat, but also their ability to survive, grow and reproduce in conditions of poor nutrition, parasites and diseases (Chawala *et al.,* 2021). Such measures could include: identifying and bolstering regional breeds that have adjusted to the feed supply and climate in the area, and if climate change is faster than normal choice, the risk to existence plus adjustment of new breed is greater (Chawala *et al.,* 2021). The study assessed adaptation to water scarcity.

2.4.2. Livestock management systems

Efficient and affordable adaptation practices need to be developed for the rural poor who are unable to afford expensive adaptation technologies. These could include (i) provision of shade and water to reduce heat stress from increased temperature. Given current high energy prices, providing natural (low cost) shade instead of high cost air conditioning is more suitable for rural resource-constrained producers; (ii) reduction of livestock numbers – a lower number of more productive animals leads to more efficient production and lower GHG emissions from livestock production (Georgieva *et al.,* 2022); (iii) changes in livestock/herd composition (iv); accompanied by infrastructure to harvest and store rainwater, such as tanks connected to the roofs of houses and small surface and underground dams. In this study, smallholder cattle farmers` usage of efficient and adaptive strategies that are not expensive were be determined.

2.4.3. Capacity building for cattle keepers

Godde *et al.* (2021) explain that there is a need to improve the capacity of cattle producers and herders to understand and deal with climate change, increasing their awareness of global

changes. In addition, training in agro-ecological technologies and practices for the production and conservation of fodder improves the supply of animal feed and reduces malnutrition and mortality in herds. The study examined how smallholder cattle farming can be improved and strengthened.

2.5 Conceptual Framework

The conceptual framework of the study presented in Figure 2. 1 shows the linkages of water scarcity effects on smallholder cattle farmers' food security and nutrition status as well as their wellbeing (Aguilar *et al.,* 2022). Water scarcity effect causes a decline on cattle production due to extreme weather conditions experienced. The decline in cattle production results in limited food availability for smallholder cattle farmers. This leads to substitution with undesirable commodities, negatively affecting nutrition security of smallholder cattle farmers, as well as minimizing their livelihood options (Islam & Karim, 2019). Therefore, to avoid smallholder cattle farmers' vulnerability due to water scarcity, climate change and variability, interventions and support systems should be available, accessible and useful to the smallholder cattle farmers. Cattle production would significantly contribute towards an improved food security and nutrition status and maximised livelihood options for improved wellbeing of smallholder cattle farmers (Sekaran *et al.,* 2021).

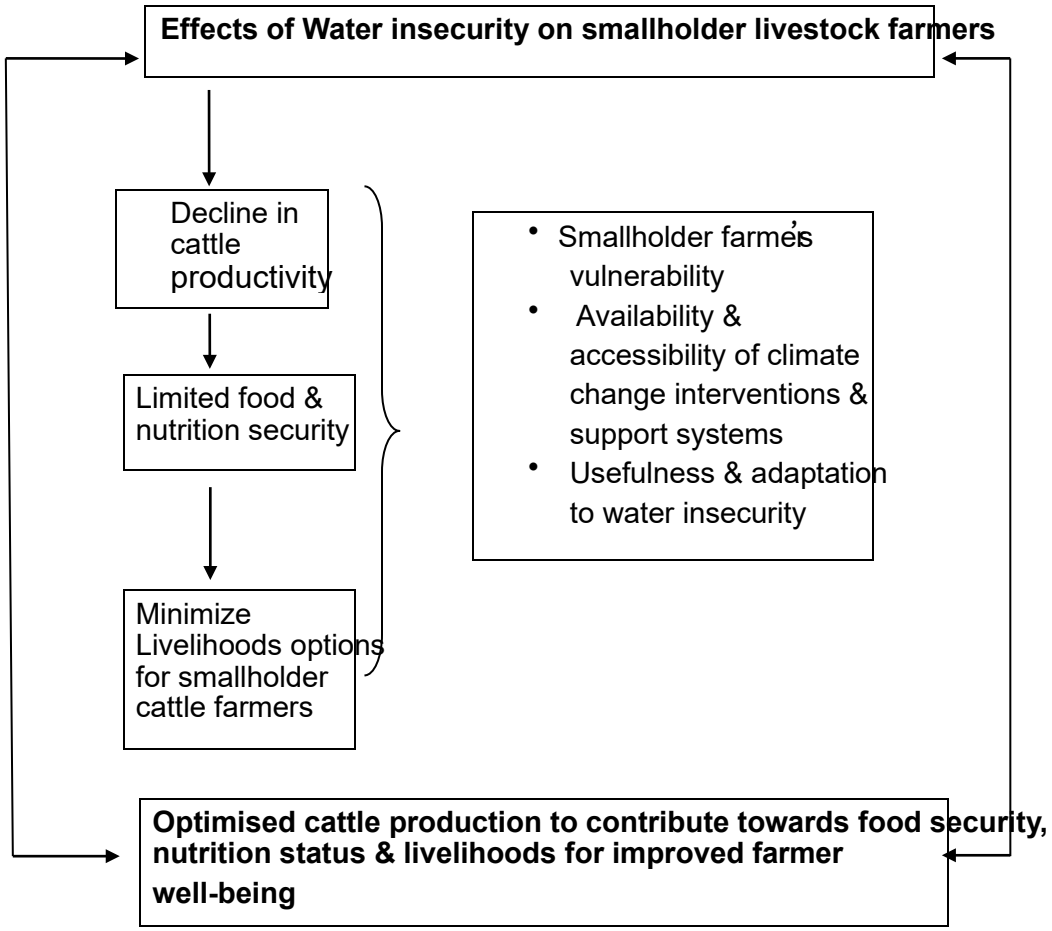


Figure 2.1 Water scarcity effects on smallholder cattle farmers' food security and nutrition status as well as their wellbeing

Source: El Bilali et al. (2020)

2.6. Summary of Literature Review

According to the above reviewed literature, water is a precious resource that must be conserved globally by all sectors of the economy, including agriculture and thus cattle farmers. The researcher reviewed scientific literature on the effects of water scarcity on cattle farming. Although the debate on cattle products and water scarcity remains open, the interaction between cattle and water resources should be considered with the objective of establishing sustainable farming systems especially for smallholder cattle farmers. This study, therefore examined adaptive strategies by smallholder cattle farmers in vulnerable areas for cattle water security in Greater Tzaneen Local Municipality. The methodology to achieve the mentioned study objective is presented in the chapter that follows.

CHAPTER 3: RESEARCH METHODOLOGY

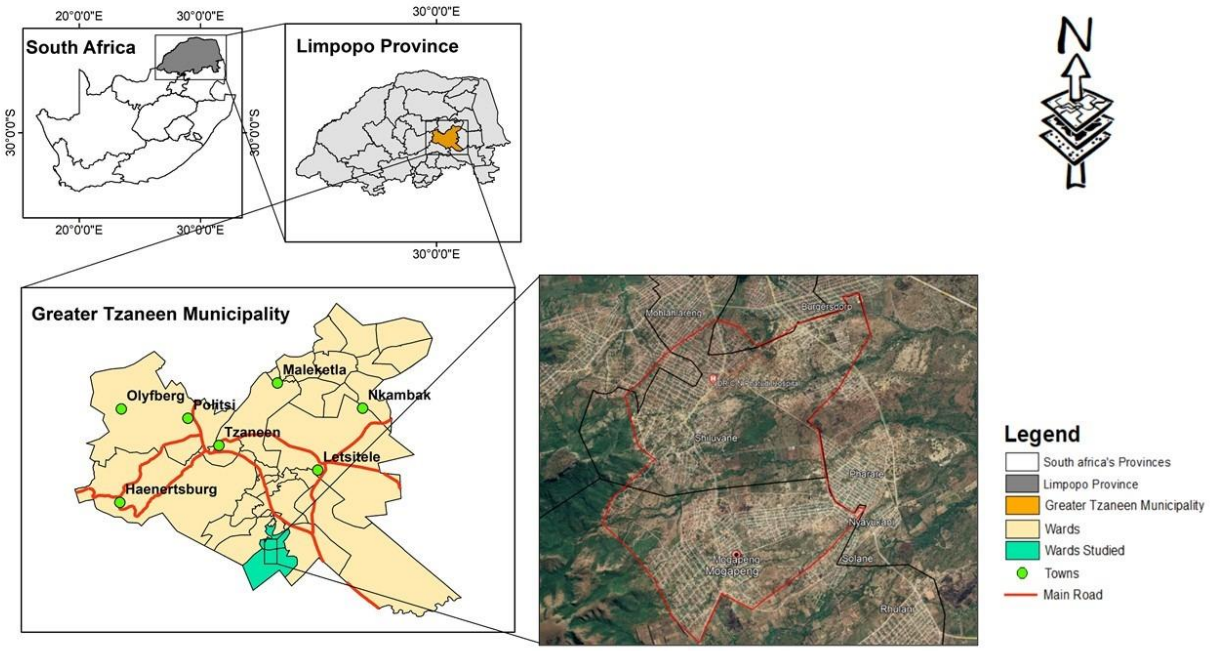
3.1. Introduction

The chapter presented the methodology that was adopted for the study. It outlined the design and techniques that were used to ensure the attainment of the stated objectives rigorously and scientifically. Specifically, the chapter provided a detailed description of the study area, research design, study population, and data collection methods, techniques and tools that were used to obtain data. Data analysis techniques used were also discussed. Finally, the ethical considerations for the study were presented.

3.2. Description of the Study Area

This study was conducted in the Greater Tzaneen Municipality in Limpopo Province, South Africa (Census, 2011). The rural villages of Mogapeng, and Shiluvane were the main focus for this study, selected due to the availability of devoted smallholder cattle farmers who practice both subsistence and sale surplus. Mogapeng village consists of a land area of approximately 2,80 km². The village has a population of 2 702 which consists of 686 households (Census, 2011). Mogapeng village with a GPS point of 24. 0679°S 30 2789° E is situated 37km Southeast from Tzaneen town. This village has a lot of cattle farmers of whom are practicing communal livestock farming. (Census, 2011). Shiluvane village consists of a land area of approximately 4,63 km². The village has a population of 2,049 which consists of 519

households (Census, 2011). Shiluvane village with a GPS point of 24. 0413°S 30. 2767°E is situated 36km, Southeast from Tzaneen town. This village has a tract of land with associated building devoted to agriculture especially cattle farming.



Source: Google Earth, 2022

Figure 3.1: Map of Mogapeng and Shiluvane village

3.3. Research Design

Convergent parallel mixed methods design was used in the study. It entailed that the researcher concurrently conducts the quantitative and qualitative elements in the same phase of the research process, weighs the methods equally, analyses the two components independently, and interprets the results at once (Demir & Pismek, 2018). Thus, with this design in this study, two data sets were analyzed independently, and results were combined during interpretation. The approach is considered appropriate as both the data sets provide an equal value in understanding the research problem (Creswell, 2014).

Sileyew (2019) further stated that research design is intended to provide an appropriate framework for a study. A significant decision in research design process is the choice to be made regarding research approach since it determines how relevant information for a study will be obtained; however, the research design process involves many interrelated decisions. Dannels (2018) further stated that regardless of the sophistication of the statistical analysis, the researcher's conclusions may be worthless if an inappropriate research design has been used. In this study, hence, a parallel mixed method design was used to ensure that the research problem is adequately and logically explained. The design ensured the triangulation of data collection on the adaptive strategies used by smallholder cattle farmers as a result of water scarcity.

The study entailed exploring perceived adaptive strategies in response to water insecurity by smallholder cattle farmers in vulnerable areas. Thus, a combination of both explorative and descriptive data provided a conclusive picture from both narrative stories and descriptive statistics to establish definitive conclusions about the research focus. The qualitative explorative approach was applied to map and identify the adaptive strategies for both male and female smallholder cattle farmers. Specifically, the approach was used to respond to objectives 1, 2 and 3. On the other hand, the quantitative study was descriptive in nature to describe ways to strengthen the adaptive strategies in response to water insecurity.

3.4. Population and sampling procedures

3.4.1. Population

The target population of the study were all the men and women who are involved in cattle farming in the Greater Tzaneen Local Municipality. Shukla (2020) argues that population consists of all the units on which the findings of research can be applied. In other words, population is a set of all the units which possess variable characteristics under study and for which findings of research can be generalised.

3.4.2. Sampling procedures and sample size

The stratified purposive technique was desirable for all women and men (smallholder farmers) involved in cattle farming in Greater Tzaneen Local municipality. Palinkas *et al.* (2015) stated that purposive sampling is a technique widely used in qualitative and quantitative research for the identification and selection of information-rich cases for the most effective use of limited resources. In addition, this involves identifying and selecting individuals or groups of individuals that are especially knowledgeable about or experienced with a phenomenon of interest. The targeted sample size for the study was a total of 60 respondents, 25 from Mogapeng village, 25 from Shiluvane village who are involved in cattle farming and 2 community leaders from Mogapeng village, 2 community leaders and 6 Indigenous Knowledge Systems (IKS) holders from Shiluvane village.

3.5. Data collection

Face-to-face interviews were used as the primary data collection method and literature material, policy documents, municipal reports were used to gather secondary data. Face-to-face interviews in this study were used to deeply understand and solicit for information about the adaptive strategies by smallholder cattle farmers in response to water scarcity. Moreover, interviews built an understanding on how best the adaptive strategies could be strengthened. Specifically, qualitative data was collected using semi-structured interviews. DeJonckheere & Vaughn, (2019) argued that qualitative research interviews unfold as an interviewer asks questions to the interviewee to gather subjective information about a particular topic of experience. Questionnaires were distributed to respondents to collect quantitative data. In this study, questionnaires were used to collect demographics information of the respondents. Roopa & Rani (2012) defines questionnaires as the main means of collecting quantitative primary data. With the use of this tool, quantitative data may be gathered in a regulated manner that ensures internal consistency and coherence for analysis.

3.6. Validity and reliability

To validate and ensure that the data collected is reliable, data collection was conducted with a group of men and women who share the same characteristics as those who are part of the study. The total number of men is 36 and women is 24. ‘Data were collected through personal interviews using a pre-tested structured questionnaire. Pretesting helped in determining if respondents understood the questions as well as having the information that the questions required.

3.6.1. Reliability

Reliability refers to the consistency of a measurement where the results can be reproduced under the same conditions (Seale, 2012). This study therefore, undertook this exercise to ensure that the questionnaire and interview guide provide the same findings when administered to the same respondents repeatedly.

3.6.2. Validity

Validity refers to the accuracy of a measurement where the results really do represent what they are supposed to measure. (Babbie & Mounton, 2002).

3.7. Data management and analysis

Data collected was stored for future reference and verification in case more papers are generated from the dissertation. Data management is a term that describes the organization, storage, preservation, and sharing of data collected and used in a research project. It involves the everyday management of research data during the lifetime of a research project (for example, using consistent file naming conventions). Qualitative data was analysed thematically. Atlas. ti 8 was used to build and group emerging themes from the empirical evidence in conjunction with the literature information. The software allowed for a systematic analysis and review of qualitative data with more clarity enabling the building of themes (Vaughn & Turner, 2016). Moreover, the software allowed the visual inspection of the themes and sub-themes using network diagrams (Vaughn & Turner, 2016). Specifically, open coding was used. Open coding is the grouping of discreet variables that broadly explain a phenomenon (Smit, 2002), hence, in this study the adaptive strategies perceived were categorized into themes using the software. Atlas ti version 8 is recommended in the analysis of large pieces of information such as texts, audio and photographic material (Smit, 2002). As such, the software was deemed relevant for this study as data was collected using interviews. Open coding was used to assess issues discussed and code them into key themes. Through the process of coding, and re-coding key themes that describe critical issues in identifying the adaptivestrategies that were used by smallholder cattle farmers and factors that influenced their choice of strategies were isolated. Quantitative data was examined using IBM Statistical Package for Social Sciences (SPSS) version 27. Descriptive data were computed. The demographics of the study were analysed using the SPSS.

Calzon (2021) states that data analysis is collecting, modelling, and analysing data to extract insights that support decision-making. There are several methods and techniques to perform analysis depending on the data, the aim of the analysis and study aim.

3.8. Ethical considerations

In research, ethical consideration are the most important points that deserve attention. This is mainly because of the necessity to strictly respect the consent of the respondents whether they are willing to participate in the research or not. The study should explain the aims, purpose of the study, the implications, and possible risks for involvement in the study to the respondents (Bhandari, 2019).

In this study, respondents were guaranteed their anonymity, respondents' personal information was not shared, privacy meaning protecting the respondents' right to control access to their participation in the study was guaranteed, and confidentiality meaning that the condition in which the identity of the respondents were known, and the study took steps to protect the identity of the respondents so that it cannot be discovered by other people. The principle of honesty was highly adhered to, throughout the study. Respect for respondents was observed. The ethical clearance was issued by the University of Venda research ethics committee to ensure that research respondents were protected and would only participate only by their consent. The respondents were informed how the data provided was used and informed of their right to withdraw from participating at any time during the interviews and questionnaires, without any prejudice. The right of respondents to withdraw at any stage of the research was made known to them prior to starting any interview (University of Venda, 2022).

It was emphasized to the respondents that the data and results were to be used for academic purposes only. Data was treated with strict confidence and professionalism. Collected data was safely kept in electronic devices and remain accessible only to the researcher and the supervisors for a period of 5 years to allow data verification, feedback and paper writing.

CHAPTER 4: IDENTIFYING ADAPTIVE STRATEGIES IN RESPONSE TO WATER INSECURITY BY SMALLHOLDER CATTLE FARMERS IN VULNERABLE AREAS

ABSTRACT

The livestock (cattle) sub-sector holds significant importance within the agricultural landscape, particularly in South Africa, where it plays a pivotal role in enhancing the livelihoods of rural communities. Livestock production exemplified by cattle farming, serves as a cornerstone by providing essential resources such as food, draught power, organic fertilizer, and fuel, thereby strengthening household economies. This multifaceted role of livestock proves instrumental in meeting the diverse objectives of resource-poor farmers, underscoring its socio-economic significance. South Africa stands as a notable contributor to meat production, accounting for 21.4% of the total meat output in Africa and 1% globally. Amidst this backdrop, this study examined adaptive strategies adopted by smallholder cattle farmers in response to water insecurity, particularly in vulnerable regions. Employing a quantitative explorative approach, the research aims to identify adaptive strategies utilized by both male and female smallholder cattle farmers. The findings of the study revealed pertinent demographic characteristics among respondents, predominantly consisting of male household heads (60%) aged over 48 years. A notable proportion (26.7%) have attained tertiary education. Furthermore, a significant proportion of respondents, primarily male pensioners, reported unemployment (26.7%). In terms of livestock management practices, respondents (93.3%) indicated a preference for organic cattle due to their suitability for mountain grazing, contrasting with conventional systems reliant on technological interventions for productivity enhancement. An alarming trend emerges from the findings, indicating a prevalence of cattle mortality attributed to water scarcity within the past 12 months. In response to this challenge, all respondents (100%) reported employing various adaptive strategies. Notably, rotational grazing emerged as a prevalent practice with respondents (31.7%) opting to change grazing areas weekly, fortnightly, or monthly to allow for pasture recovery and mitigate soil erosion resulting from overgrazing. In conclusion, the study underscores a critical role of adaptive strategies in mitigating the impacts of water scarcity on smallholder cattle farming in vulnerable regions. The findings shed light on the nuanced socio-economic dynamics and resource management practices within the livestock sub-sector, highlighting the resilience and adaptability of rural communities in confronting environmental challenges.

Key words: Adaptive strategy, cattle, smallholder farming,

4.1. Introduction

In arid and semi-arid regions worldwide, smallholder farmers face pronounced vulnerability to the pervasive challenge of water scarcity (Ariom *et al.,* 2022). This vulnerability stems from a variety of factors, including the prevalence of multiple environmental stressors, limited adaptive capacity within communities, inadequate governance structures, and minimal investments in water resource management (Halimani *et al.,* 2021). Smallholder livestock farmers are generally resource-limited, own small pieces of land and manage their livestockon communal, leased, or private land for food security and income (Gwiriri *et al.,* 2019). The livestock sub-sector is an important agricultural stronghold that contributes immensely to improving the livelihoods of the rural poor in South Africa. The reason is that the livestock production, for example, cattle play a vital role through food provision by strengthening the household-economy through the provision of draught power, organic fertilizer, and fuel (Cheteni & Mokhele, 2019).

Cheteni & Mokhele, (2019) further stated that livestock plays multiple roles in the lives of the poor and meets the multiple objectives that are desired by the resource-poor farmers. Furthermore, it is important to mention that South Africa produces 21.4% of the total meat produced on the continent of Africa and 1% of global meat production. Thus, the livestock sector contributes approximately 49% of agricultural output and provides 36% of the population's protein needs; hence it is considered the largest national agricultural sector (Department of Agriculture, Forestry and Fisheries (DAFF), 2012). Myeki & Bahta (2021) argued that smallholder livestock farming contributes to improving the livelihoods of the rural poor in South Africa. It plays a vital role by providing food and has the potential to strengthen households' economy. Livestock production plays multiple roles in the lives of the poor and meets the various objectives desired by resource-poor farmers. Furthermore, smallholder agriculture, including the livestock sector in South Africa, has been identified as a notable vehicle to foster poverty reduction, solve household food insecurity, and enhance resilient livelihoods (Myeki & Bahta, 2021).

Poor quality water can have negative effects on the growth, reproduction, and general productivity of the cattle. In some cases, death could occur within days or hours due to water deprivation or after drinking contaminated water. Therefore, continuous monitoring of water quality and quantity is important to maintain a productive livestock program (Salverson, 2021). Water needs are influenced by environmental temperature, class of livestock, weight, and stage of production. The warmer it gets; the more water cows need. Cows with nursing calves need more water than dry cows. As cattle gain weight, they need more water. Despite the mentioned observation, the significance of water for beef cattle is frequently disregarded, yet

water intake profoundly influences cattle performance. Therefore, it is imperative to promulgate water scarcity adaptation and coping strategies among smallholder livestock farmers (Walz & Berger, 2023). Carra *et al.* (2023) further stated that measuring water consumption in the livestock sector, improving water productivity, and assessing its impact on livestock is cruacial in in responding to water insecurity by smallholder cattle

farmers in vulnerable areas.

4.2. Methodology

The study used questionnaires and face-to-face interviews to identify adaptive strategies in response to water scarcity by smallholder cattle farmers in vulnerable areas. The detailed description of the methods and techniques used is fully outlined in Chapter 3. The results are presented below.

4.3. Results

The results section consists of the findings from 60 respondents who participated in the study. The respondents were divided into two, 30 respondents are from Mogapeng village, and 30 respondents are from Shiluvane village.

Demographic distribution of the research respondents

4.3.1. Gender of the respondents

Table 4.1 indicated that more than half 60% of the research respondents were male. This is justified because men are mainly responsible for herding cattle. This also indicated that most households are headed by men. Brown, (2022) emphasised that traditionally, young men and boys are responsible for protecting cattle from predators and herding them to water sources and pastureland. The cattle herds roam to new areas with the changing of the seasons, a practice that allows the grasslands to regenerate, and men are responsible.

4.3.2. Age of the research respondents

As shown in Table 4.1 few respondents 8.5% were between the ages of 19 and 28 years, 11.7% respondents were between the ages of 29 and 38 years and over half of the respondents 51.7% were above the age of 48. This is supported by Goni *et al.* (2018) that the prevalence older male livestock farmers have been reported in different studies on communal livestock production in South Africa.

4.3.3. Employment status of the respondents

As shown in Table 4.1 few respondents 13.3% were formally employed, while more than a quarter of unemployed respondents, 30.0% were informally employed and more than half 56.7% were unemployed.

4.3.4. Education level of the respondents

It shows that in Table 4.1 18.3% respondents had no formal education. About a quarter 25.0% only went to primary, some 15.0% respondents were able to reach secondary school while others 26.7% made it to tertiary education.

4.3.5. Smallholder cattle owner

All the respondents from both Mogapeng and Shiluvane village indicated that they are cattle farmers and owners . In support of the findings Mugumaarhahama, (2021) depicted that farming remains the most predominant livelihood activity and source of income of sub-Saharan African (SSA) rural households. Furthermore, livestock is valuable in sustainable agriculture by providing manure and labour for increased productivity and therefore enhancing the well-being and increase income of farmers in SSA. Livestock production, especially of cattle, remains one of the few available opportunities for income generation at the household level (Mugumaarhahama, 2021.

Table 4.1. Demographic information of the respondents

Variable	Frequency	Percentage (%)
Gender		
Female	24	40
Male	36	60
Total	**60**	**100**
Age		
19-28 years	5	8.3
29-38 years	7	11.7
39-48 years	17	28.3
Over 48 years	31	51.7
Total	**60**	**100**
Marital Status		
Single	10	16.7
Widowed	10	16.7
Living together	14	23.3
Married	26	43.3
Total	**60**	**100**
Employment status		
Employed (formal)	8	13.3
Employed (informal)	18	30.0
Unemployed	34	56.7
Total	**60**	**100**
Education level		
No formal schooling	9	15.0
Matric	9	15.0
No formal schooling	11	18.3
Primary school	15	25.0
Tertiary	16	26.7
Total	**60**	**100**

4.3.6. Type of cattle for production by smallholder farmers

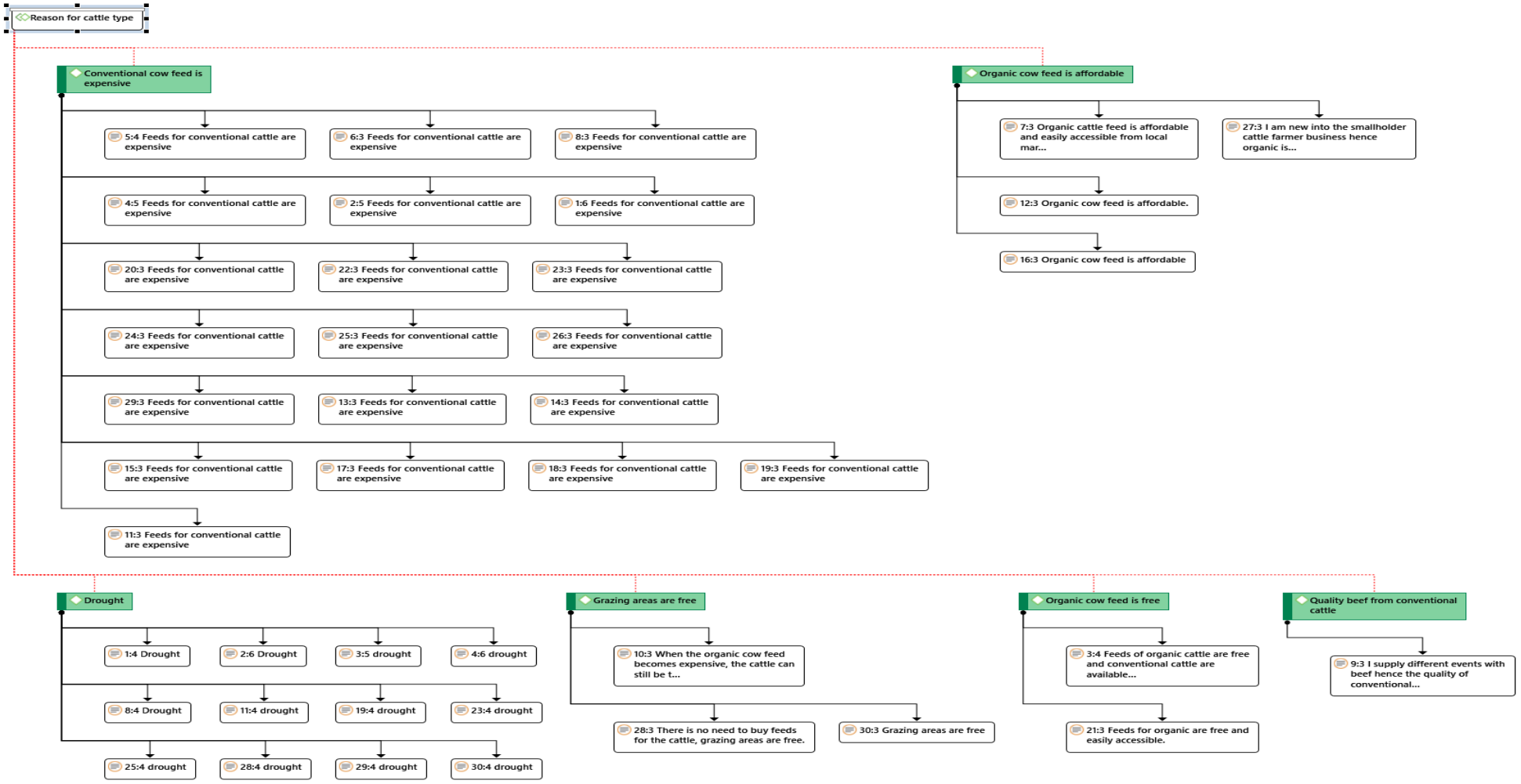
Table 4.2 showed that almost all the respondents 93.3% have organic cattle, only one respondent 1.7% has conventional cattle and 5.0% have both organic and conventional type of cattle. Rocha (2021) posits that organic production, whether for plant agriculture or livestock agriculture, emphasizes mechanical and biological methods of farming. The smallholder farmers cannot use artificial fertilizer or synthetic pesticides to produce feeds, and unapproved antibiotics to treat these cattle. Examples include using ladybugs as a biological pesticide against aphids produced without genetic engineering (i.e. they cannot feed genetically modified types of feed, like corn or soy). Traditionally, these cattle are raised exclusively on pasture. Conventionally raised cattle also start life on pasture. Calves are born and stay on range typically 6-8 months until they are sent to a feedlot, where they are fed over 4-6 months to market weight of 544-590 KGs (Rocha, 2021). Another difference between these two systems is that conventional systems rely on technologies to improve productivity. Technologies may include the use of antibiotics that allow for quick or preventative medical treatment when necessary. It is not to say that organic farmers do not treat their animals. Instead, they tend towards more homeopathic treatments, such as using *Aloe vera* to treat rashes (Butcher *et al.,* 2021).

Table 4.2. Type of cattle owned by smallholder farmers

Type of cattle	Yes	No
1. Conventional	1 (1.7%)	59 (98.3%)
2. Both	3 (5.0%)	57 (95.0%)
3. Organic	56 (93.3%)	4 (6.7%)

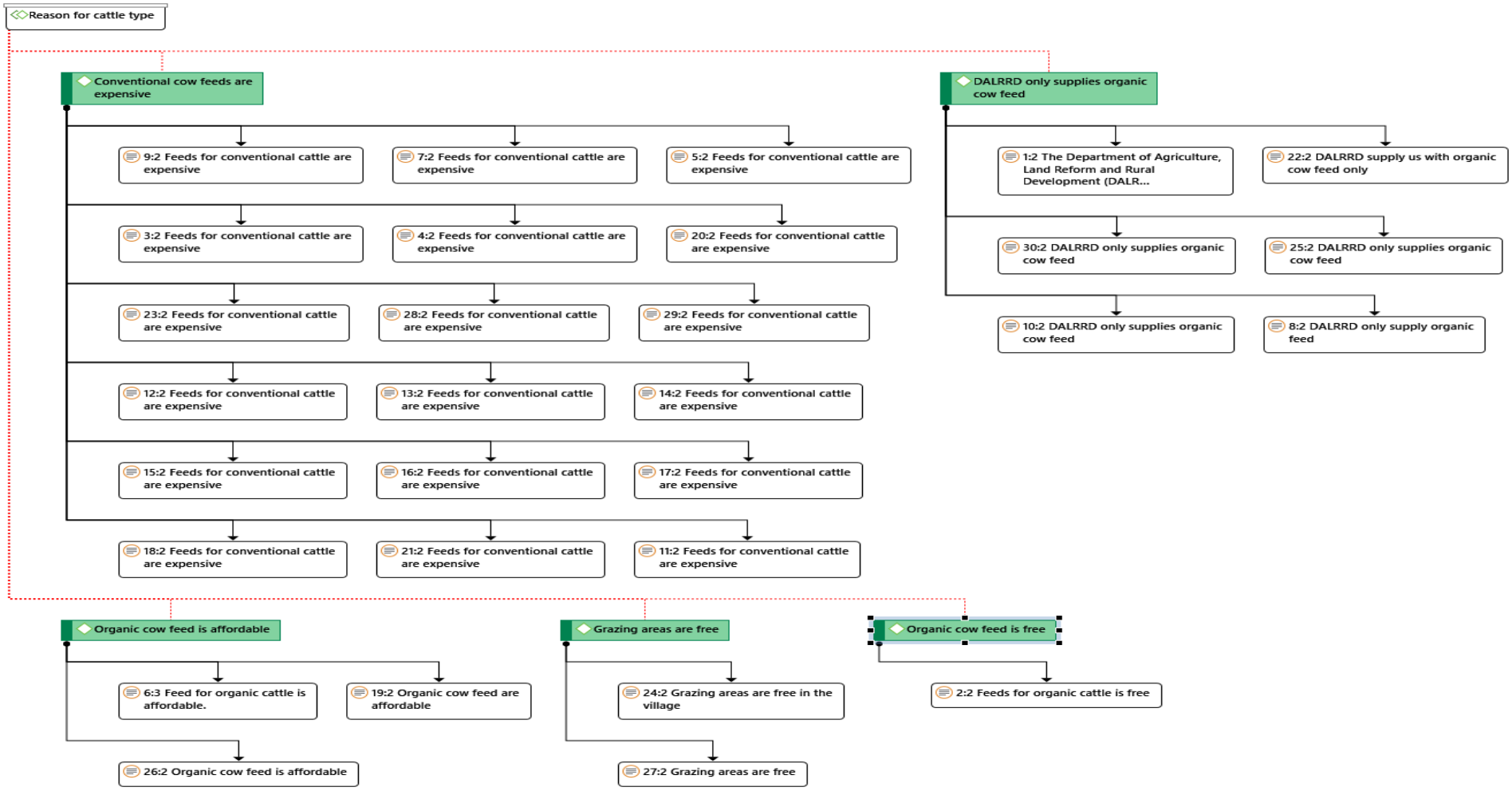
4.3.7. Main reason for choosing cattle type for production

Majority of respondents amounting to 63.3% indicated that conventional feed is expensive compared to organic cow feed (Figures 4.1 and 4.2). This is because respondents were either self-employed or unemployed. Respondents 11.7% chose organic cattle because organic cow feed is affordable and easily accessible. Some respondents 10% resorted to organic cattle because the Department of Agriculture Land Reform and Rural Development (DALRRD) only supplies organic cow feed. Others 8.3% indicated that they own organic cattle because the grazing areas are free. At least 3.3% of the respondents said organic cow feed is free. In Support to the findings, only few 3.3% of respondents indicated that they had the conventional type of cattle because the conventional cattle provide quality beef, the respondents further said that they provide beef at different events like funerals, parties, and weddings hence the choice of the type of cattle.



- *The green shaded headings represent the reasons for choosing cattle type*

Figure 4.1. Reasons for choosing cattle type for production in Mogapeng village

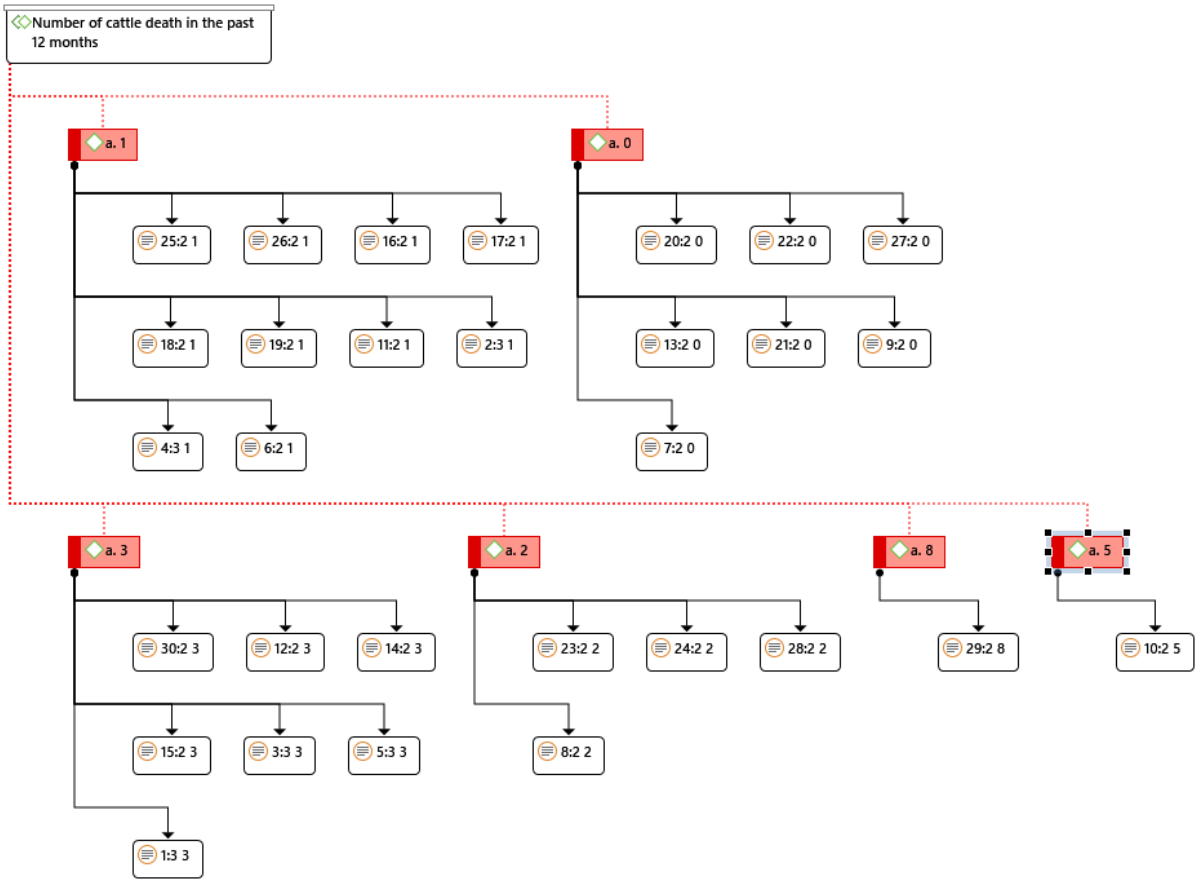


- *The green shaded headings represent the reasons for choosing cattle type*

Figure 4.2: Reasons for choosing cattle type for production in Shiluvane village

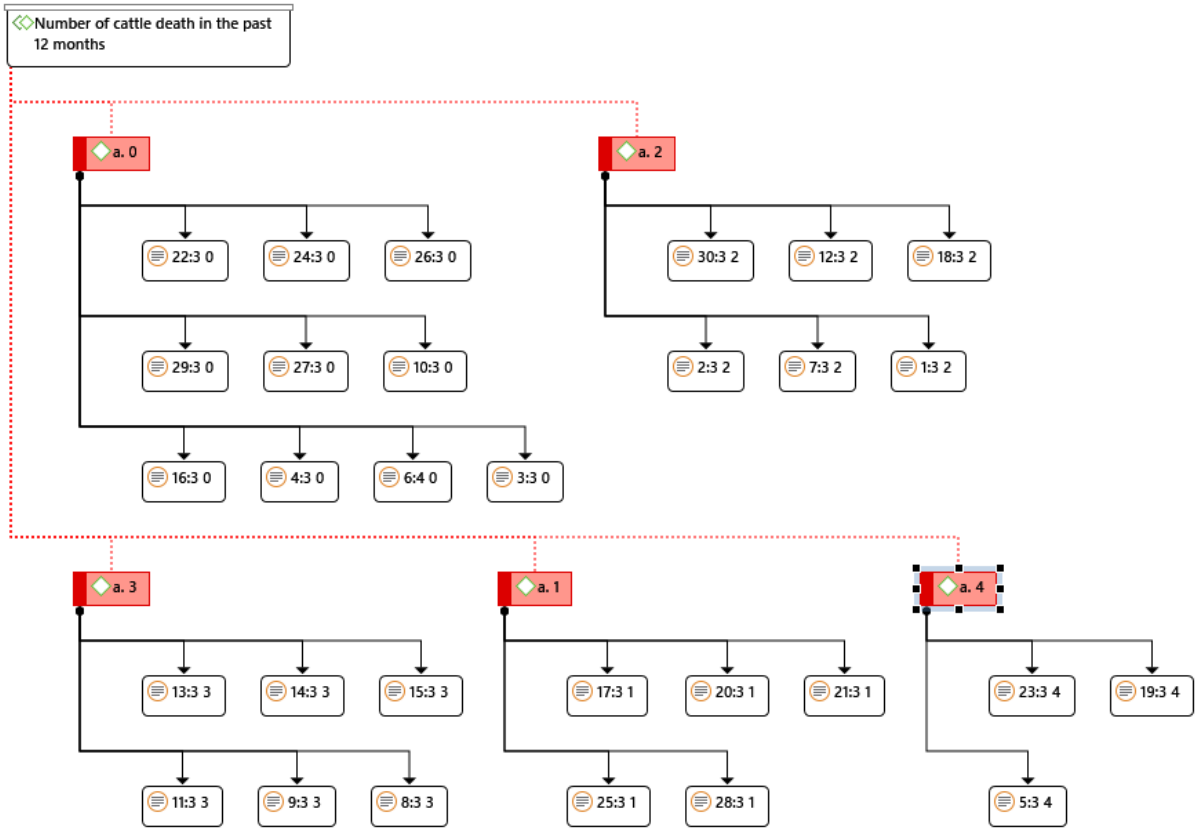
4.3.8. Cattle mortality due to water scarcity in the past 12 months

Figures 4.3 and 4.4 showed that about a quarter (25%) of respondents lost 1 cattle due to water scarcity in the area. About 21,7% lost 3 cattle and 16.7% had lost about 2 cattle. At least (1.7%) respondent had lost f 8 cattle. 1.7% had lost 5 cattle. Only 28.3% respondents did not experience any cattle deaths.



- *The red shaded headings represent the number of cattle that died in the past 12 months.*

Figure 4.3. The number of cattle that died due to water scarcity in the past 12 months in Mogapeng Village

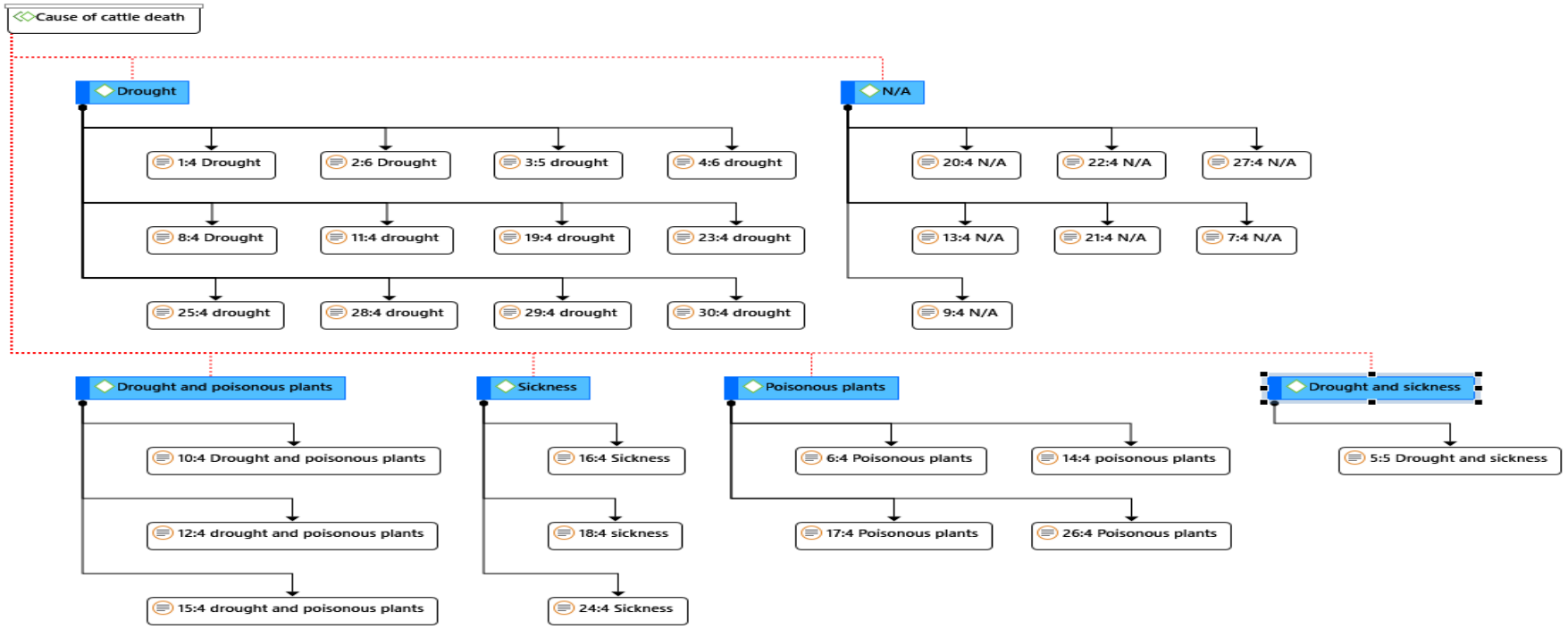


- *The red shaded headings represent the number of cattle that died in the past 12 months.*

Figure 4.4. The number of cattle that died due to water scarcity in the past 12 months in Shiluvane village

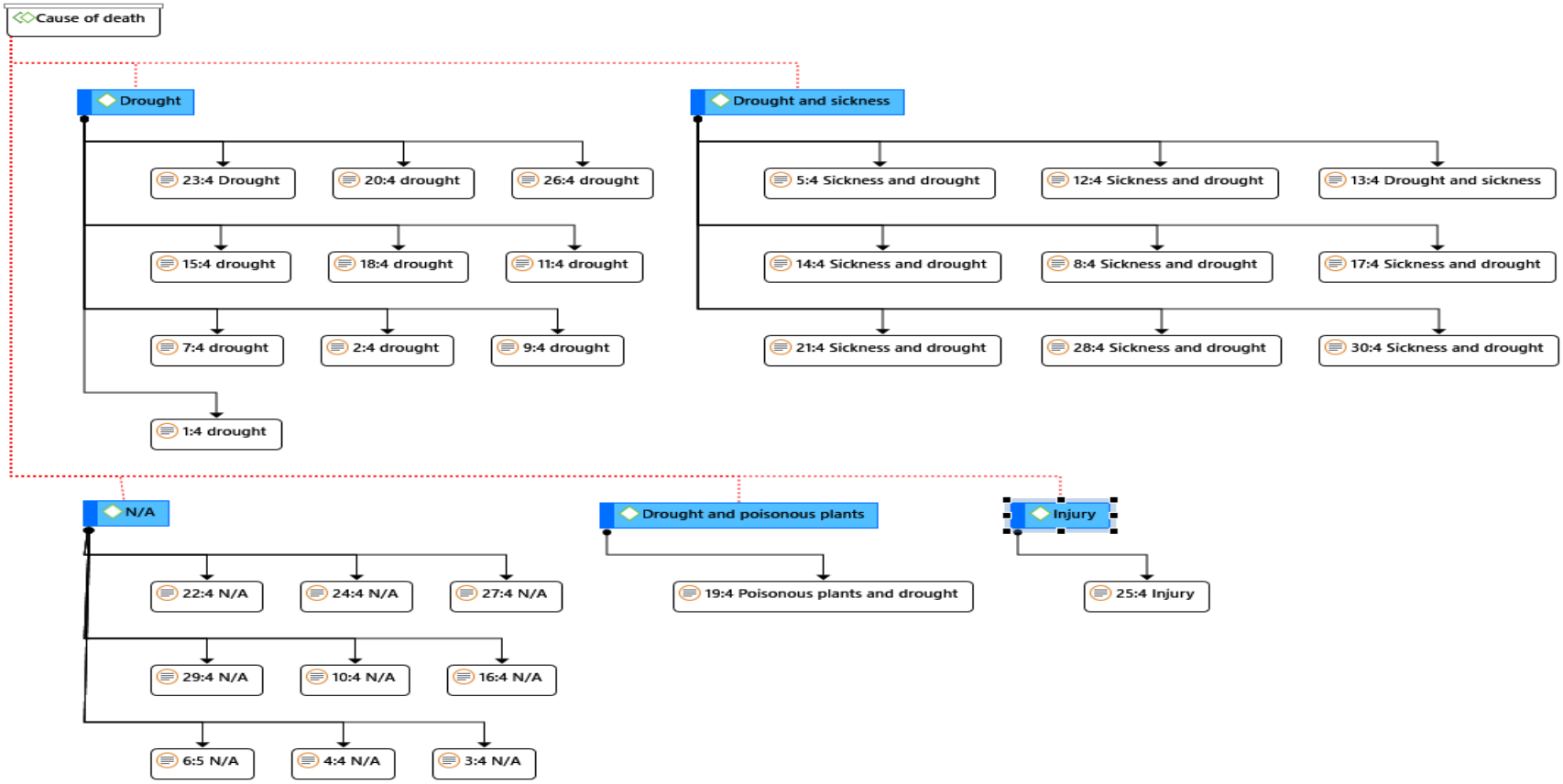
4.3.9. Causes of mortality in the past 12 Months

Figures 4.4 and 4.5 showed that more than half 36.7% of respondents experienced cattle death due to drought as a result of water scarcity, 16.7% due to both drought and sickness, and about 6.7% experienced cattle death due to both drought and consumption of poisonous plants around the villages. Some 5% respondents experienced cattle death due to sickness and at least 1.7% experienced cattle death due to injury. Only 28.3% did not experience any cattle death. The findings revealed that 23 farmers from Mogapeng village and 20 farmers from Shiluvane village experienced cattle mortality while 7 farmers from Mogapeng village and 10 farmers from Shiluvane village did not experience any cattle mortality.



- *The blue-shaded headings represent the causes of cattle mortality*

Figure 4.5: Reasons for cattle mortality in Mogapeng village

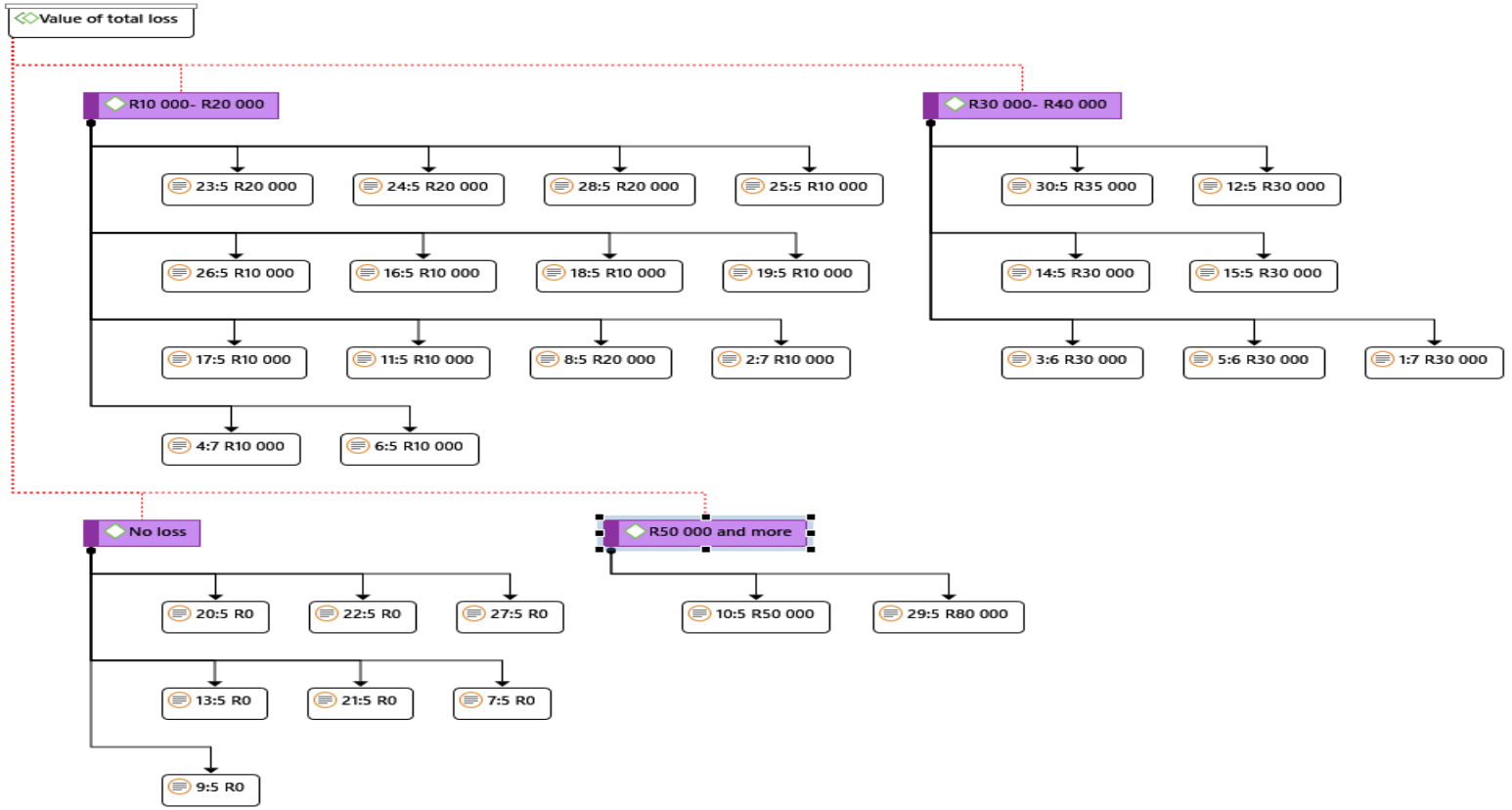


- *The blue-shaded headings represent the causes of cattle mortality*

Figure 4.6: Reasons for cattle mortality in Shiluvane village

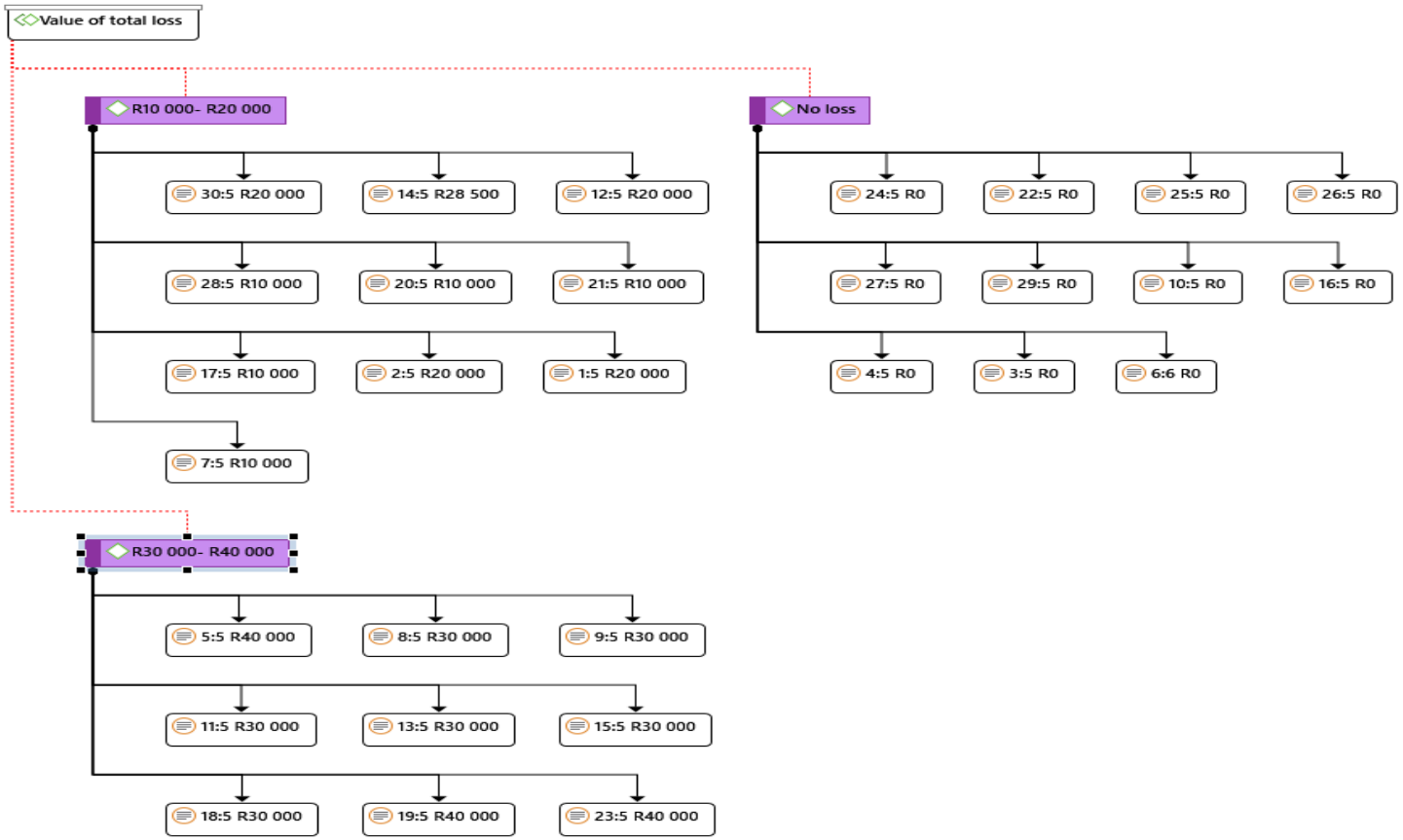
4.3.10. Value of total loss from the cattle death due to water scarcity in the past 12 months

From the findings, the respondents stated that each cow cost R10 000 and a calf cost around R5 000 hence Figure 4.7 and 4.8 showed that almost half 40% of respondents had a total loss value of between R10 000 and R20 000 while 26.7% of respondents had a value of total loss of between R30 000 and R40 000. At least 3.3% of the respondents had a value of total loss of R50 000 and more. More than a quarter 28.3% of the respondents had no loss because they had strategies that prevented cattle mortality.



- *The purple-shaded headings represent the total loss of cattle that died due to mortality*

Figure 4.7: The value of total loss in Mogapeng Village



- *The purple-shaded headings represent the total loss of cattle that died due to mortality*

Figure 4.8: The value of total loss in Shiluvane village

Table 4.3 Strategies used to avoid cattle death as a result to water scarcity in Mogapeng and Shiluvane village

Mogapeng Village	Shiluvane village
Cattle migration	Cattle migration
Changing grazing areas weekly/ fortnight/ monthly	Changing grazing areas weekly/ fortnight/ monthly
Buying cow feed	Buying cow feed
Buying cow feed and making use of borehole water for cattle consumption	
Providing better nutrition	
Construction better kraal for cattle	

4.3.11. Adaptive strategies used by smallholder cattle farmers in response to water scarcity

Respondents mentioned varied strategies used to avoid cattle death amongst their livestock in response to water scarcity. The effects of water scarcity caused cattle mortality amongst the farmers, hence the need to have adaptive strategies. Washaya *et al.* (2022) emphasized that the details of adaptive strategies vary with different situations. Table 4.3 shows that a quarter of 31.7% respondents changed grazing areas weekly/fortnight/ monthly as a strategy to avoid cattle death, this strategy allow the grazing areas to produce grass during the period when the cattle are taken to a different grazing area. Some 31.7% respondents used cattle migration as a form of strategy to avoid cattle death. About 28.3% of respondents resorted to buying cow feed because the grazing areas were no longer sufficient for the whole villagers. Respondents 3.3% who experienced cattle death due to sickness resorted to buying their own cattle preventive and treatment medicine. At least 1.7% of respondents bought cow feed and used borehole water for cattle drinking to avoid cattle death.

4.4. Discussion

The findings revealed that most of the respondents were males who headed their family structure, Ryan & Chiappardi (2009) established that boys are responsible for the herding of livestock, at a young age; they take charge of the goats, sheep, and calves, which are generally herded together close to the settlement. As the boys grow older, they graduate to herding cattle. This is how male acquire more knowledge of cattle in the villages, as we know that back in the old days, only males were allowed to herd cattle and females remained at home. More than half of the respondents were over the age of 48 years. The findings also revealed that majority of the respondents went up to tertiary level. Most of these respondents were unemployed males as most of them are pensioners. In support of the findings, Bollig & Vehrs, (2020) emphasized that cattle ownership has a gendered dimension, privileging male household heads over female household heads, elderly men over younger men and salary earners over unemployed people.

The findings revealed that respondents" indicated that they had organic cattle, it was mentioned that organic cattle were more convenient as they could easily be taken to the mountain to graze. Conventional cattle rely on technologies to improve productivity. The findings concur with the findings of Australian organic, (2022) that organic farming is an ecological management system that maintains and enhances soil fertility, promotes ecological balance, animal health, and conserves biodiversity. The land and pasture on which organic livestock are raised must be certified organic and meet all organic crop production standards, with an exception for trace minerals and vitamins sometimes required to meet the animal's nutritional requirements. Organic livestock feed must not contain hormonal growth promotants (HGPs), antibiotics, preservatives, or synthetic chemicals.

The findings of this study revealed that most of the respondents experienced cattle mortality due to water scarcity in the past 12 months. These findings concur with Middleton, (2022) that deaths of cows and calves are inevitable; however, many deaths can be preventable if proper steps are taken. Determining trends in causes of death was a critical step to this prevention. The findings show that most cattle deaths were caused by drought which was the result of water scarcity in the villages, some by sickness, consuming poisonous plants, and injury. With hot temperatures, blue-green algae can overgrow in livestock water sources. The algal toxins cause rapid death by damaging the liver; dead cattle are often found near the scummy water source. Furthermore, poisoning is another way several animals could suddenly die. Any number of toxins are deadly to cattle, ranging from human-made chemicals to toxic plants

(Rothenburger, 2018). Middleton (2022) added that one common reason for cows to die is injury. The cause of death due to water scarcity resulted in a value of the total loss.

Adaptive strategies in response to water insecurity by smallholder cattle farmers were identified. The findings show that all respondents have identified different adaptive strategies that they use in response to water scarcity. Some of the respondents change grazing areas weekly, fortnight, or monthly, this strategy allows the grazing area to recover and avoid soil erosion as a result of overgrazing, in support of the findings Ryan & Chiappardi, (2009) explained that a homestead can have many families grouped together within a fenced enclosure. Each settlement has access to an individual grazing area and a more distant communal area for rotational grazing. Some respondents use cattle migration as a strategy, as it allows the cattle to graze in the mountains where there is more grazing and fewer animals than around the community. Some respondents resorted to buying cow feed as there were no sufficient grazing areas around the villages.

4.5. Conclusion

The results revealed that more than half of the respondents were males. The results also showed that respondents were smallholder cattle farmers. They further revealed that the majority of the respondents had organic type of cattle as it was more convenient than conventional type of cattle. The respondents had different reasons why they chose organic cattle than conventional. They stated that organic cattle allow room for the cattle to be grazed in the mountains and in cases where there is insufficient grazing areas, the farmers can buy cow feed and feed the cattle at home. Most of the respondents experienced cattle death which resulted in varied total losses. Thus, the effects of the water scarcity caused cattle mortality that primarily resulted in the value loss of finances. Most cattle deaths were caused by drought as a result of water scarcity in the villages. Changing grazing areas, cattle migration, buying cow feed, and installing boreholes for cattle consumption were also identified as the adaptive strategies in response to water scarcity.

CHAPTER 5: FACTORS THAT INFLUENCED THE SELECTION OF THE ADAPTIVESTRATEGIES IN RESPONSE TO WATER SCARCITY BY SMALLHOLDER CATTLE FARMERS IN VULNERABLE AREAS

ABSTRACT

This study determined factors that influenced the choice of adaptive strategies by cattle farmers in Greater Tzaneen Municipality in Limpopo, South Africa. Face-to-face interviews were conducted in Mogapeng and Shiluvane village in Limpopo South Africa. The data was collected through interviews with semi-structured and structured questions to understand and determine factors that influenced the choice of adaptive strategies. Correlation analysis was used to determine the relationship between factors that influenced the choice of adaptive strategies and adaptive strategies and demographics. The findings show that the majority of the respondents (48.3%) were influenced by the insufficient grazing areas hence all the cattle farmers could not graze their cattle in one place. The findings further show that some of the respondents (15%) were influenced by the inconsistent medicine and cow feed supply from the DALRRD. The DALRRD supplied farming medicine to the farmers. However, because of the number of cattle farmers have, the DALRRD was inconsistent with the medicine and cow feed supply. The findings revealed that respondents (3.3%) were influenced by the distance traveled as it further revealed that some of the respondents (18.3%) traveled a distance between 16km- 30km to graze the cattle. Respondents (8.3%) from both villages were influenced by cattle theft and grazing areas. The cattle theft was a result of cattle migration as cattle farmers took the cattle to the mountain.

***Keywords**:* adaptive strategies, cattle, farming, graze, adoption criteria

5.1. Introduction

In South Africa, the production of livestock has great potential to alleviate food insecurity and poverty (Nkonki-Mandleni *et al.,* 2019). The livestock industry contributes to approximately 48% of South Africa's agricultural output and employs approximately 500 000 people nationwide. Livestock is by far the largest sub-sector in the South African agricultural sector, contributing to an estimated 25–30% of the total agricultural output per year (Bahta, 2021). Cattle, sheep and goat farming occupy approximately 53% of all agricultural land in South Africa (Matlou & Bahta, 2019). However, as with the rest of the African region, the agricultural sector in South Africa is vulnerable to drought which results from water scarcity (FAO 2013). Prolonged droughts are regular and recurrent features that affect smallholder and emerging farmers and are one of the most important disasters in economic, social and environmental terms in Southern Africa, including South Africa (Ruwanza *et al.,* 2022). Recurrent drought is a challenge for smallholder farmers because of unavailability of resources.

Smallholder farmers in South Africa are faced with constraints that have undermined their potential to produce adequate output (Shikwambana & Malaza, 2022). Some of the notable constraints include higher demand for agricultural land, lack of capital, rising prices of farm inputs, low prices of farm output which, together with other challenges such as lack of assets, information, access to services, poor physical and institutional infrastructure, have resulted in a cost-price squeeze for farmers (Matlou & Bahta, 2019). Farmers adopt various strategies to remain in production amidst water scarcity challenges. However, determinants of selecting an adaptive strategy are not well known.

The main objective of this study was to determine factors that influence the selection of the adaptivestrategies in response to water scarcity by smallholder cattle farmers. The findings will help policymakers to formulate appropriate policy interventions to sustain smallholder cattle farmers against exposures of drought that would have resulted from water scarcity. The latter is a threat to livelihood, food security, survival and achieving the sustainable development goal (SDG) of ending hunger and poverty by 2030. It is therefore the objective of this study to determine factors that influence selection of adaptive strategies in response to water insecurity by smallholder cattle farmers in vulnerable areas.

5.2. Methodology

The study used face-to-face interviews to determine factors that influenced the selection of the adaptive strategies in response to water scarcity by smallholder cattle farmers in vulnerable areas. A detailed description of methods and techniques used is fully outlined in Chapter 3. The results are presented below.

5.3. Results

The results in this chapter include correlation analysis between factors that influenced the choice of adaptive strategies in response to water scarcity by smallholder cattle farmers, and adaptive strategies and demographics. The distance travelled by respondents to access water source is also included.

The demographic profiles of the respondents were presented in chapter 4 in table 4.1.

5.1 Correlational Analysis

Pearson correlational analysis was performed to estimate the relationship between demographics, adaptive strategies, and factors that influenced the choice of adaptive strategies. Table 5.1 shows that there is a positive significant relationship between adaptive strategies by smallholder farmers and factors that influenced the choice of adaptive strategies (r= .163; p = .214). These are expected results because the factors were influenced by the adaptive strategies chosen by farmers. Furthermore, there is a significant positive relationship between factors that influenced the choice of adaptive strategies and gender (r= .162; p=.217) this is expected that mostly male respondents resorted to migration, and it further shows a negative relationship between factors that influenced the choice of adaptive strategies and age (r= -.073; p =. 503) this indicates that the factors that influenced the choice of adaptive strategies were not determined by age difference. There was no significant relationship between factors that influenced the choice of adaptive strategies and education level (r= .055; p = .678) these results mean that the factors that influenced the choice of adaptive strategies were influenced by education level. To the contrary, the relationship between factors that influenced the choice of adaptive strategies and marital status is positively significant (r= .088; p = .503).

Table 5.1 Correlation analysis for demographics, adaptive strategies, and factors that influenced the choice of adaptive strategies

		Gender	Age	Marital Status	Education level	Adaptive strategies used by smallholder cattle farmers	Factors that influenced choice of adaptive strategies
Gender	Pearson Correlation	1					
	Sig. (2-tailed)						
Age	Pearson Correlation	.128	1				
	Sig. (2-tailed)	.329					
Marital Status	Pearson Correlation	-.045	.307*	1			
	Sig. (2-tailed)	.730	.017				
Education level	Pearson Correlation	-.092	-.589**	-.353**	1		
	Sig. (2-tailed)	.487	.000	.006			
Adaptive strategies used by smallholder cattle farmers	Pearson Correlation	-.145	-.203	-.076	.130	1	
	Sig. (2-tailed)	.269	.120	.562	.323		
Factors that influenced choice of adaptive strategies	Pearson Correlation	.162	-.073	.088	-.055	.163	1
	Sig. (2-tailed)	.217	.579	.503	.678	.214	

*. Correlation is significant at the 0.05 level (2-tailed). **. Correlation is significant at the 0.01 level (2-tailed).

5.3.2. Distance travelled by respondents to access water source

More than half of the respondents travel a distance between 1 and 15km, 18.3% respondents travels 16km-30km to access water for cattle drinking. Close to a fifth 18.3% respondents do not travel any distance as they have installed boreholes to assist with water for cattle production.

5.4. Discussions

The adaptive strategies were identified in chapter 4. In this chapter, the focus is on correlational analysis between demographics, adaptive strategies and factors that influenced the choice of adaptive strategies chosen. The results showed that there is a positive significant relationship between factors that influenced the choice of adaptive strategies and adaptive strategies, gender, and marital status. Furthermore, there no relationship between factors that influenced the choice of adaptive strategies and age and education level. In detail, the findings show that majority of the respondents were influenced by the insufficiency of the grazing areas hence all the cattle farmers could not graze their cattle in one place. Some of the cattle farmers resorted to cattle migration that enabled the cattle to have new grazing areas as some of the grazing areas were poisonous.

In support of the findings, Zenda & Malan, (2021) posits that in most communal lands in South Africa, there is extensive grazing of livestock, the most of which are cattle, sheep and goats. The carrying capacity of livestock is high, but changes in response to rainfall, are causing fluctuations with populations declining under drought conditions due to water scarcity or increasingly high rainfall conditions (Zenda & Malan, 2021). The rangelands are heavily overgrazed, and some dwarf Karoo bushes have been replaced by less palatable grass and bush, resulting in overgrazed and degraded land. The reason behind this is that, within grazing areas of communal spaces, there is minimal management of natural resources, which subjects them to continuous grazing (Zenda & Malan, 2021).

The findings further show that some of the respondents were influenced by inconsistent medicine supply and cow feed supply from the DALRRD. The DALRRD supplied farming medicine to the farmers, however, because of the number of cattle farmers have, the DALRRD was inconsistent with the medicine and cow feed supply. The findings concur with the study of Monkwe *et al.* (2023) which posits that one of the key problems for smallholder cattle farmers is the effectiveness of support services, particularly those related to animal health, nutrition, and the marketing of cattle and small stock. As a result, government assistance for

health issues is less effective because veterinarians and animal health professionals who assist communal farmers lack communication skills.

Respondents from both villages were influenced by cattle theft and grazing areas. The cattle theft was a result of cattle migration as cattle farmers took the cattle to the mountain. In support of the findings, Monkwe *et al.* (2023) stated that cattle production in the subtropics is hampered by climatic stress, nutritional stress, and diseases, as well as insufficient access to land and water, a lack of market channels, poor rangeland management, and a lack of feed resources andas a result, vulnerability to these stressors has a significant impact on fertility, growth rate, and mortalities, all of which have a detrimental impact on cattle production.

The findings revealed that respondents were influenced by the distance traveled as it further reveals that some of the respondents traveled a distance between 16 and 30km to graze the cattle. In support of the results, Ekwem *et al.* (2023), emphasized that in Africa, cattle production, and livelihoods often depend on the ability to move livestock to communal areas to access resources critical for their survival, such as pasture and water. Such movements tend to be local, but they cover variable distances depending on the season, as seasonality influences resource availability.

The findings revealed that respondents were influenced by the poor nutritious cow feed supplied by the DALRRD, and some respondents were influenced by the nutritious cow feed from the local markets. Since DALRRD supplied few of the respondents with cow feed, these cattle farmers resorted to buying cow feed. In support of the findings, Kırkpınar & Açıkgöz, (2018) emphasized that poor-quality feeds provide livestock with fibre, but are low in energy, protein, minerals and vitamins. Inadequate amounts of nutrients may lower conception rates, and disease and parasite resistance. It may result in weak calves and lambs, and sometimes in still-born offspring. When low-quality forages are fed, you must provide mineral and vitamin supplements. Ensure that you feed a balanced diet to provide adequate energy and protein. Pay particular attention to supplying adequate vitamin A and minerals, either through free-choice or force-feeding (Kırkpınar & Açıkgöz, 2018).

5.5. Conclusion

All of the smallholder cattle farmers identified different adaptive strategies as a result of water scarcity; hence the factors that influenced the choice of the adaptive strategies were determined. Most smallholder farmers were influenced by the insufficient grazing areas in the village, so they resorted to cattle migration, etc. Another factor that influenced the cattle farmers was the inconsistent cow feed and medicine supply from the DALRRD. This implies that the DALRRD did supply only to specific cattle farmers and also there were days that the medicine and cow feed were not supplied.

CHAPTER 6: TO RECOMMEND RELEVANT ADAPTIVE STRATEGIES TO WATER SCARCITY FOR SUSTAINABLE SMALLHOLDER CATTLE FARMING

ABSTRACT

This study recommends adaptive strategies for sustainable farming in Greater Tzaneen Municipality in Limpopo, South Africa. Face-to-face interviews were conducted in Mogapeng and Shiluvane village in Limpopo South Africa. The data was collected through interviews with semi-structured and structured questions to understand and determine factors that influenced the choice of adaptive strategies. Data was analysed descriptively and thematically using Atlas ti version 8.1 to build themes. The results revealed that more than half 58.3% of the respondents indicated that they received support from the DALRRD. It was revealed that respondents who received support from the DALRRD received plunge dip chemicals as a form of support. It further revealed that the required support by respondents (15%) from the DALRRD was cattle vaccine and cattle medicine as both cattle vaccine and cattle medicine were not distributed to every smallholder cattle farmer. Some respondents (11.7%) required cow feeds as the cow feed was given only to those with more than 10 cattle. It was revealed that respondents (25%) recommended that DALRRD should support every smallholder cattle farmer with farming products, construct a plunge dip, and supply plunge dip chemicals sufficient for all livestock. It was recommended that cow feeds should be supplied to all the cattle farmers who cannot afford to purchase at the local markets. Respondents (5%) recommended that DALRRD should host workshops about livestock farming and respondents recommended that the findings should be reported to the DALRRD office.

Key words: Cattle vaccine, chemicals, Department of Agriculture, Land Reform and Rural Development Cow feeds, plunge dip

6.1. Introduction

Agriculture is a major social and economic sector in the Southern African Development Community (SADC) region, contributing between 4 and 27% of the region's gross domestic product (GDP) (Langwenya, 2019). The majority of the population in the region depend largely on agriculture for their primary source of livelihood, employment, and income. Smallholder farming is the most widely used method of agricultural farming in sub-Saharan Africa, with the majority of the rural poor depending on it for survival (Muthelo *et al.,* 2019)

Smart, (2017) stated that drought is a recurrent phenomenon, occurring at different intensities in South Africa, which leads to water scarcity. The year 2015 was officially declared the driest year in South Africa since 1904. Resource-poor livestock farmers, whose productivity is highly threatened by frequent water scarcity, are affected the most. These droughts (water scarcity) are due to the high inconsistency in inter-annual and intra-seasonal rainfall over most parts of South Africa (Muthelo, 2018). In semi-arid regions such as the Free State province of South Africa, water scarcity is the climate hazard that has the most harmful effects on livestock farmers. The risks posed by water scarcity are dependent on the interaction of water scarcity with the vulnerability of both human and natural systems, as well as their ability to adapt (Du Preez & Van Huyssteen, 2020)

An important part of the solution to the water scarcity problem is to put people who are vulnerable at the center of communication for adaptation. This requires treating the end users of information not merely as a target audience, but as partners in co-learning through processes and products that reflect their own contributions (Muthelo *et al.,* 2019). There are several success stories about adaptation among the most vulnerable, but they are mostly from developed countries and have been developed into projects. It has become imperative to accelerate the process of replication and dissemination of best practices. Water scarcity adaptation and coping strategies need to be promulgated among vulnerable livestock farmers, and this requires innovative approaches towards knowledge sharing.

During the periods of water scarcity and beyond, smallholder cattle farmers often lose their livelihood and investment in cattle farming. During water scarcity periods, smallholder cattle farmers cannot manage or cope without external assistance in terms of relief packages from governmental and non-governmental agencies (Duguma & Janssens, 2021). Mudombi, (2011) posits that water scarcity can lead to food shortages, insufficient grazing area, social unrest and can stall land redistribution. In many areas, water scarcity has forced cattle farmers to sell off some of their cattle to buy fodder for the remaining cattle. Ahmad *et al.* (2022) emphasized that insufficient knowledge and the low levels of resources or livelihood assets available to cattle farmers during vulnerable situations such as water scarcity and other climate hazards

limit coping and adaptation choices. In addition, reducing vulnerability is a key feature of improving smallholder farmers' adaptive capacity and resilience to water scarcity. The extent to which cattle farmers' levels of vulnerability influence their choice of coping or adaptation strategies remains uncertain. Studies focus on the socio-economic aspects of global climatic variability, almost exclusively restricting their analyses to the impact of the environment on agricultural production (Muthelo *et al.,* 2019). It is therefore the objective of this study to recommend relevant adaptive strategies to water scarcity for a sustainable cattle farming.

6.2. Methodology

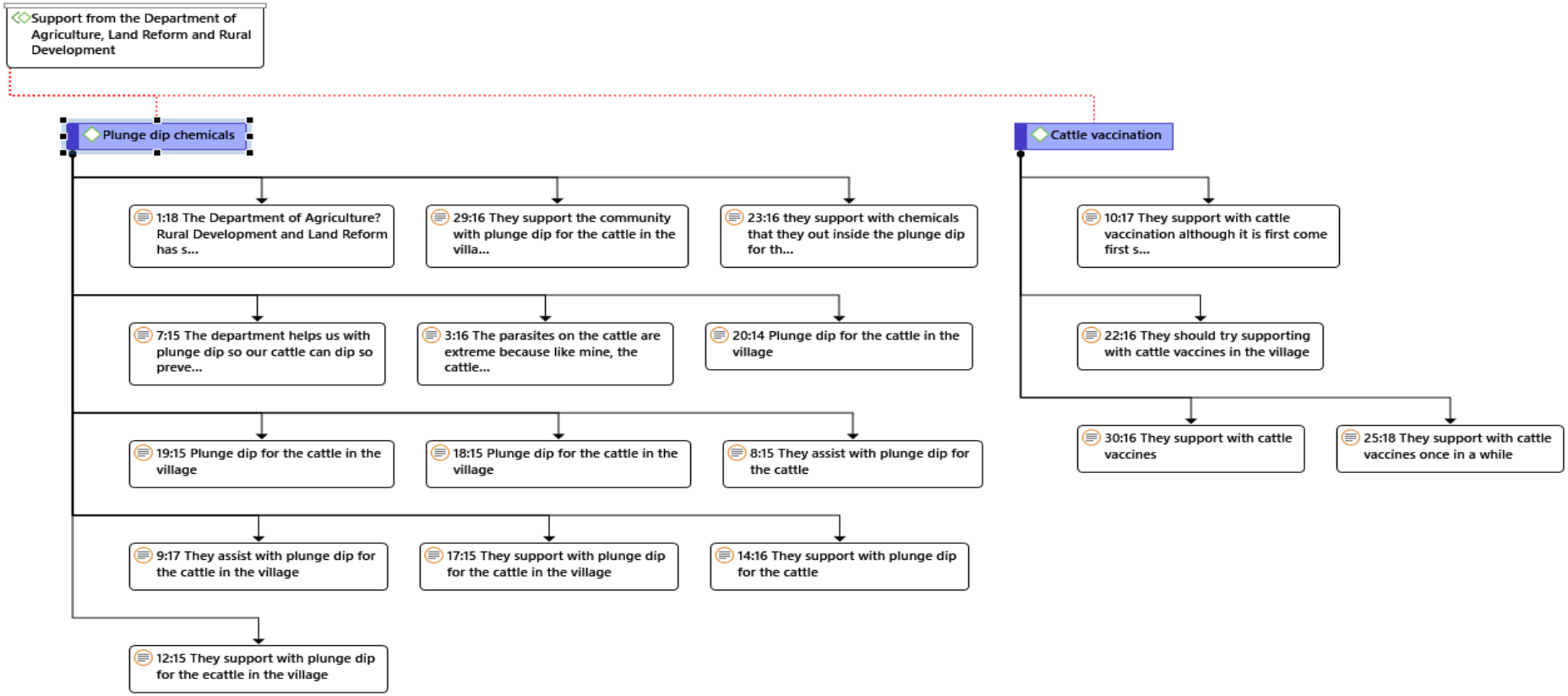
The study used face-to-face interviews to recommend relevant adaptive strategies to water scarcity for sustainable smallholder cattle farming. The detailed description of the methods and techniques used is fully outlined in Chapter 3. The results are presented below.

6.3. Results

The results in this chapter revealed the support to cattle farmers from the DALRRD, support required from the DALRRD and additions from respondents.

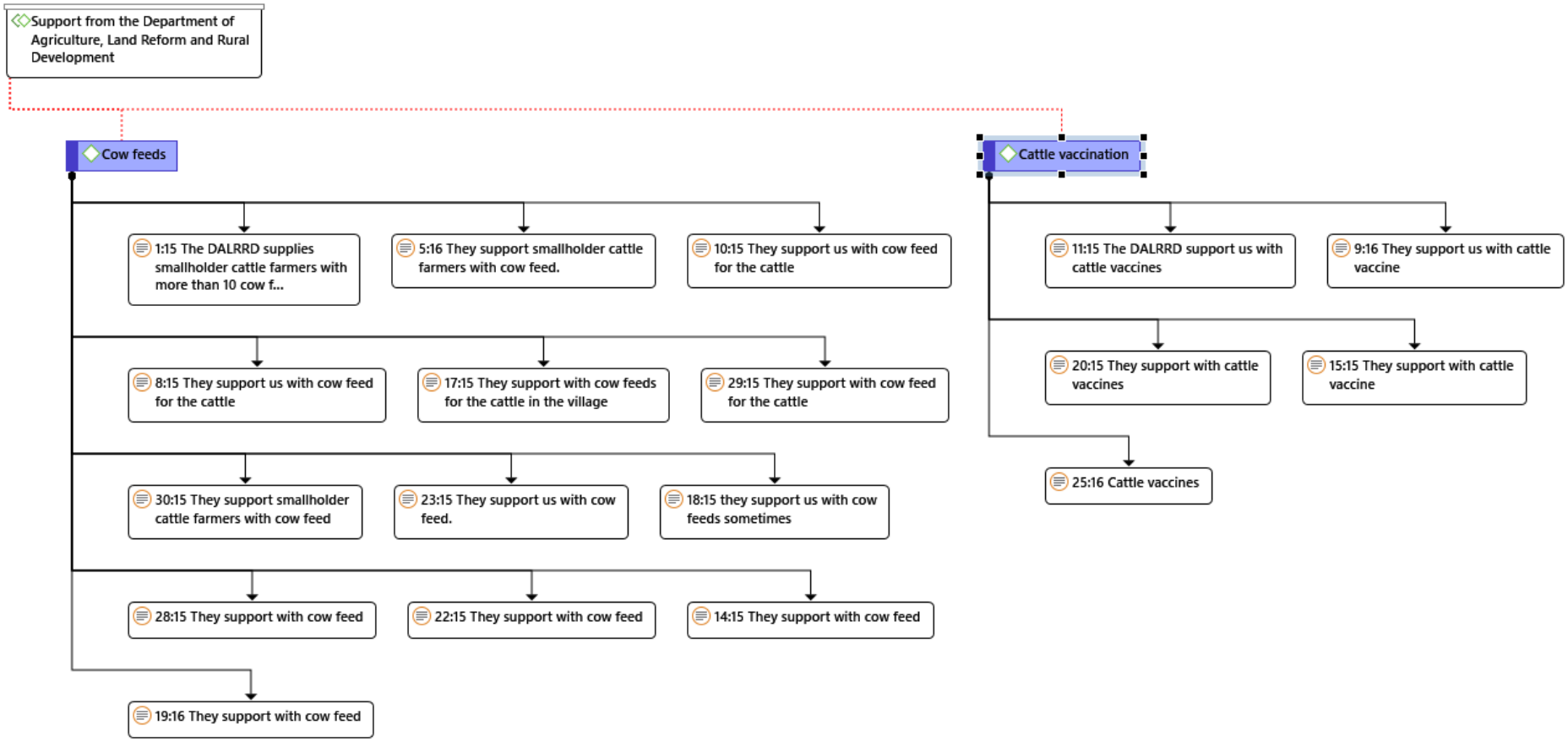
6.3.1. Support to cattle farmers from the Department of Agriculture, Land Reform and Development (DALRRD)

The findings disclosed that more than a quarter (28.3%) respondents from Mogapeng village stated that they received support from DALRRD and 18(3%) respondents from Shiluvane village received support from DALRRD. In total 58.3% respondents (Figure 6.1 and 6.2) that received support from DALRRD. 30% respondents received cattle vaccines while 21.7% received plunge dip chemicals for the cattle, it was also indicated that in Mogapeng village there is a plunge dip, where cattle farmers take their cattle to dip to control ticks on the cattle. About 21.7% respondents also received cow feed for their cattle. It further revealed that at least 21.7% and 20% respondents from Mogapeng and Shiluvane village did not respectively receive support from DALRRD.



- *Blue-shaded headings represent government support received by respondents*

Figure 6.1: Support received from Department of Agriculture Land Reform, and Rural Development in Mogapeng *village*

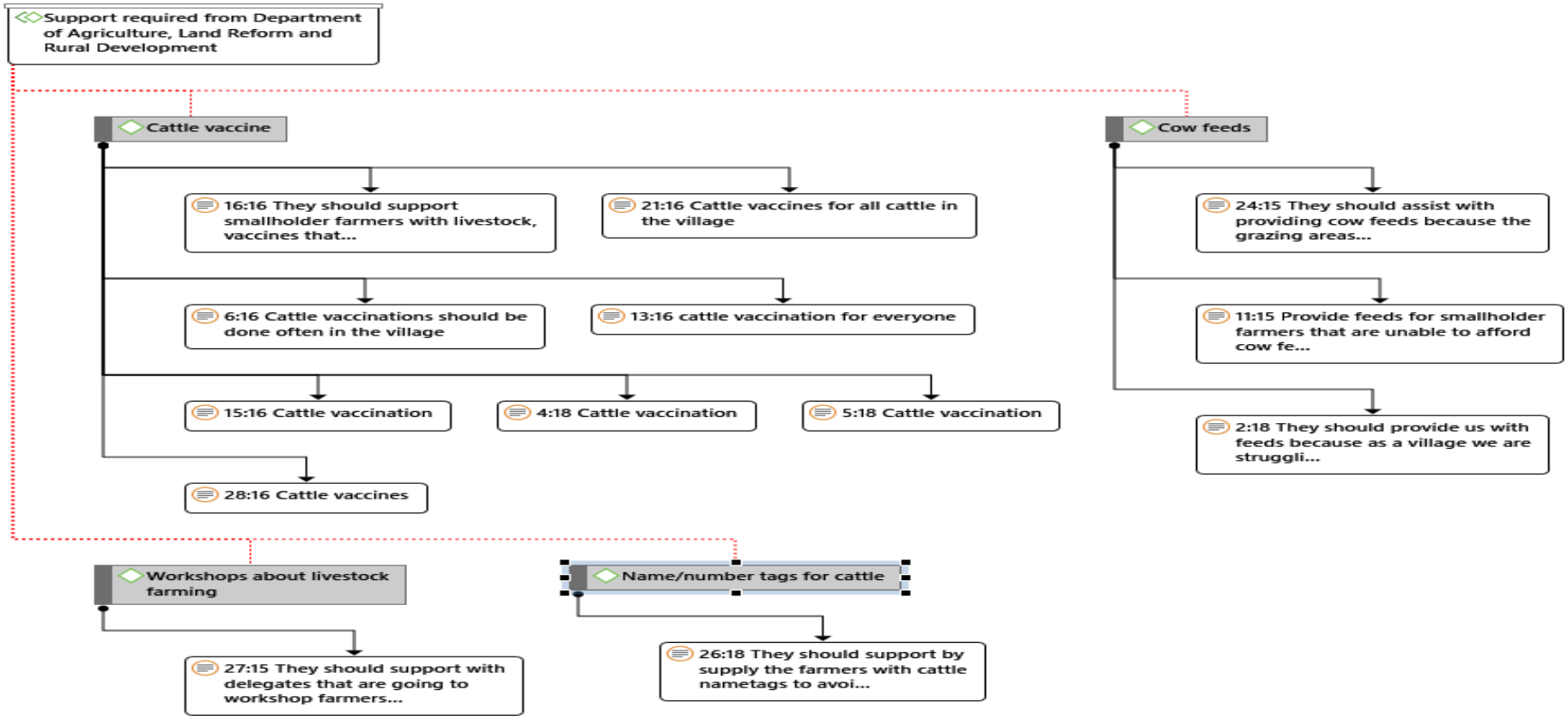


- *Blue shaded headings represent government support received by respondents*

Figure 6.2: Support received from Department of Agriculture Land Reform, and Rural Development in Shiluvane village

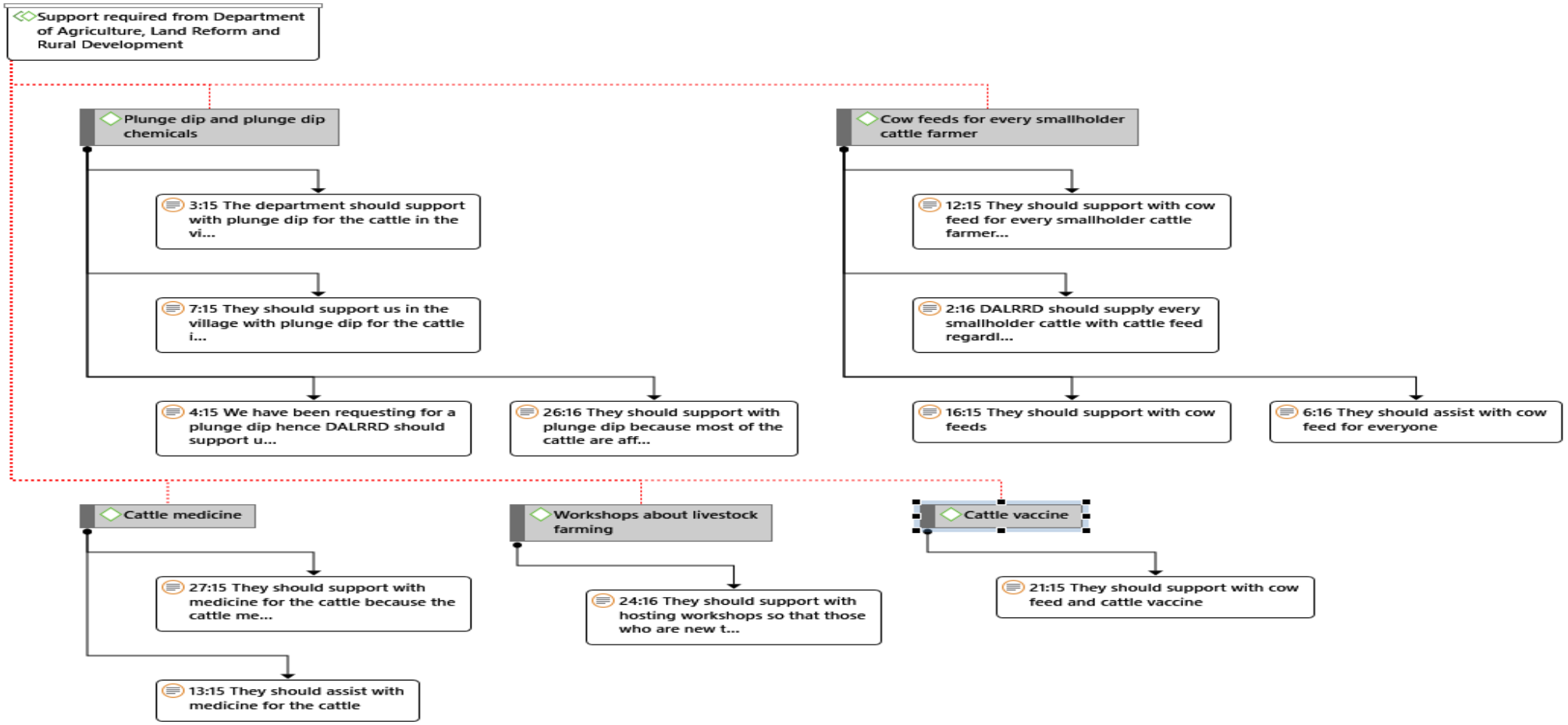
6.3.2. Support required from the Department of Agriculture, Land Reform, and Development

The study findings show that only 41.7% respondents did not receive any support from DALRRD. As indicated in Figure 6.3 and 6.4, 15% respondents required cattle vaccine as support from DALRRD, 11.7% respondents required cow feeds for every smallholder in both villages. About 6.7% respondents required plunge dip and plunge dip chemicals while at least 3.3% respondents required workshops about livestock farming as a form of support. Only 1.7% respondents required name or number tags for cattle as a form of support.



- *The grey shaded headings represent government support required by respondents*

Figure 6.3: Support required from the Department of Agriculture, Land Reform, and Development in Mogapeng village



The grey-shaded headings represent government support required by respondents

Figure 6.4: Support required from Department of Agriculture, Land Reform, and Development Shiluvane village

6.3.3. Additions from respondents

More than a half of the respondents 53.3% did not add anything to the bonus question. About 15 respondents added that they should supply cow feed, plunge dip, and cattle vaccine for all smallholder farmers with cattle. It further shows that 13.3% respondents added that *"With researchers from the University, there is hope for the future of livestock"*. At least 10% respondents added that DALRRD should support every smallholder livestock farmers with livestock products and 5% respondents added that DALRRD should host workshops on livestock farming for livestock farmers that want to start livestock farming. At least 3.3% respondents added that the findings should be reported to the DALRRD office.

6.4. Discussion

The results revealed that more than half of the respondents indicated that they received support from the DALRRD. It was revealed that respondents who received support from the DALRRD received plunge dip chemicals as a form of support. It further revealed that respondents received vaccination for the cattle as a form of support and some respondents received cow feed. Wilson, (2023) highlights that producers are battling an unravelling state of disaster facing the livestock sector. They face the possibility of losing up to 50% of their herds due to their inability to protect their herds by vaccinating them against deadly diseases such as bluetongue. The equine industry is also at risk of higher mortalities due to a shortage of African Horse Sickness vaccines.

The results also show that there are respondents who did not receive any support from DALRRD but required support. It revealed that cattle vaccine and cattle medicine were required from DALRRD since they were not distributed to every smallholder cattle farmer. Some respondents required cow feeds as the cow feed was given only to those with more than 10 cattle. In support of the findings, Masiwa, (2022) stated that through its livestock development program, the Eastern Cape Department of Agriculture, Land Reform and Rural Development and Agrarian Reform stepped in a few years ago to assist struggling farmers. Many of these farmers suffered major losses at that stage due to drought, veld fires, feed shortages, and rundown feedlots.

It further revealed that some respondents required workshops to be hosted about cattle farming, some mentioned that name/ number tags should be supplied by the DALRRD. The findings concur to those of Fernandez, (2012) who highlighted that identification of cattle is needed for any type of record system. Cattle records may range from a simple inventory list of cattle to calving records or performance records. The two components of a cattle

identification system are the numbering system and the method of marking or numbering cattle.

Some respondents from Shiluvane village required plunge dip and that plunge dip chemicals should be supplied because only Mogapeng village had a plunge dip so cattle farmers from Shiluvane village travelled to other village to access the plunge dip. In support of the findings, Nellia, (2020) emphasized that plunge dip tanks are the preferred method of dipping large numbers, especially beef cattle. If constructed and used correctly plunge dips ensure a complete wetting of the animal, particularly the important areas such as inside the ears and under the tail where ticks are found. They may have to be physically thrown into the dip and prevented from turning around once in the dip tank. This method is widely used to mitigate economic losses that are instigated by ectoparasites. These parasites live outside the host and have adverse effects on a farmer, such as loss of livestock to parasite infestation and infection.

The results further revealed that respondents have added adaptive strategies in response to water scarcity for sustainable cattle farming. It was revealed that respondents added that they should support every smallholder cattle farmer with farming products, construct a plunge dip, and supply plunge dip chemicals sufficient enough for all livestock. Holdsworth, (2022) further stated that plunge dips must be correctly used and maintained to ensure adequate tick control. They are expensive to construct and to maintain, it is essential to keep accurate dipping and replenishment records; understrength dipping leads to inadequate tick control and tick resistance to acaricides. Evaporation and dilution by rain can cause inaccurate readings. Every animal, except very small calves and heavily pregnant cows must be dipped every day. Any animal not going through the plunge must be hand-sprayed or dressed.

Also, it was added that cow feeds should be supplied to all the cattle farmers who cannot afford to purchase at the local markets. It was also added that DALRRD should host workshops about livestock farming and respondents added that the findings should be reported to the DALRRD office. In support of the results, Tamako *et al.* (2022) indicated that to help farmers build their skills, International built networks of Farmer Support Agents who work within rural communities to provide training to farmers. These networks help farmers learn about best practices, give them somewhere to turn when they have questions about their crops, and connect them to reputable buyers and suppliers. This training is critical to improving smallholder farmers' yields and in turn, addressing hunger and poverty in rural Africa.

6.5. Conclusion

The study recommended relevant adaptive strategies in response to water scarcity. It emerged that some of the respondents were able to recommend adaptive strategies for a sustainable cattle farming. The results revealed that cattle farmers suggested that DALRRD should support every smallholder cattle farmer with farming products, construct a plunge dip, and supply plunge dip chemicals sufficient enough for all smallholder farmers in the villages. Also, it was mentioned that cow feeds should be supplied to all cattle farmers who cannot afford to purchase at the local markets. It also highly suggested that DALRRD should host workshops about cattle farming and cattle farmers recommended that the findings should be reported to the DALRRD office. The respondents also added that when research is still conducted in the rural areas, there is hope for the future of cattle.

CHAPTER 7: GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

7.1. Introduction

The chapter presents the discussion of the findings based on the study objectives. However, the demographic profile of respondents was discussed first. The conclusions drawn from the study findings are outlined to synthesize the results. Lastly, recommendations on what could be done to strengthen the adaptive strategies by smallholder cattle farmers in response to water scarcity in the areas were also given.

7.2. Discussions

In general, respondents in the current study were predominantly men. This could be explained by the fact that men are usually the herders of cattle in the family structures while women stay at home and care for the household and children. Pitikoe, (2018) highlights that most Basotho males assume the herding role at a very tender age, as young as 3 years when they are legally expected to begin their pre-primary education. For Basotho males, livestock herding satisfies both the social and economic needs. For instance, some males join the herding fraternity as an alternative employment where the proceeds become a resource for poverty alleviation. Cattle farmers over 48 years old were the majority age group. This is an indication that most cattle farmers are individuals who are retired, and pensioners. Majority of the respondents were married, and unemployed. This indicated that most cattle farmers are at home hence some are pensioners, retirees and older. Lastly, the results showed that majority of respondents had reached tertiary education.

Farmer`s used different adaptive strategies by smallholder cattle farmers in response to water scarcity in villages under Greater Tzaneen Municipality. It emerged from the findings that all the respondents were cattle owners and majority of the respondents had organic cattle. This indicated that organic cattle production is preferred. It further implies that respondents indicated that conventional feed is expensive compared to organic cow feed. This is because most farmers fell under the category of self-employed and unemployed. Respondents chose organic cattle because organic cow feed is affordable and easily accessible. Some respondents resorted to organic cattle because the Department of Agriculture Land Reform and Rural Development (DALRRD) only supplies organic cow feed. Sanders, & Heß, (2019) conventionally held animals rarely to never have access to the outdoors. Most of these animals will never live to experience fresh air and sunlight, which are basic needs of all creatures. Organically reared animals also have more space available to them. Conventional farming and breeding have produced high-yielding animals. But at the same time, these animals are much more prone to diseases than they used to be. Therefore, they need medical treatments more often. In addition to that, Sanders, & Heß, (2019) further emphasized that the excessive

numbers and high density at which animals are held allow diseases to spread more easily on conventional farms. Organic farmers generally choose more robust, locally adaptiveanimal breeds. They are more often allowed to be outside and graze on fresh pasture grass and are given more space. That in itself prevents many diseases in organic livestock. The results show that majority of farmers have lost their cattle in the last 24 months. It implies that cattle mortality rate that hit cattle farmers were different causes. Some of the causes were sickness, injury, and drought that resulted in water scarcity. Salih *et al.* (2023) stated that cattle agriculture is harshly vulnerable by ticks and tick-borne diseases (TBDs); with anaplasmosis (gall-sickness), babesiosis (red water), and ehrlichiosis (heart water) being considered among the most severe TBDs. The societal also financial affliction of a sickness in livestock generally refers to the impact a sickness has on society, as determined by variables such as financial cost, morbidity, or death.

As indicated above, most farmers have experienced cattle death, which also mean that majority of the respondents have experienced value of the total loss. Almost half of respondents have lost total of between R10 000 and R20 000. This indicated that the cattle are mostly used for cattle beef, bride price, etc by cattle farmers. All the respondents mentioned varied adaptive strategies used to avoid cattle mortality amongst their cattle in response to water scarcity. The effects of water scarcity caused cattle mortality amongst the cattle farmers hence the need to have adaptive strategies. Bahta & Myeki, (2021) report that agricultural drought-induced changes to social, economic, and environmental resources affect the livelihoods of smallholder cattle farmers unless adequate measures are taken through adaptation and coping strategies. The adaptation and coping strategies, agricultural drought resilience, and sustainability of the agricultural sector, including livestock sectors, depend on economic, social, institutional, environmental, and community factors.

Some of the strategies include changing grazing areas weekly/fortnight/ monthly. This implies that the grazing area used by herders becomes overgrazed, hence the need to change the grazing area to allow the area to grow grass and enable the cattle to graze. Cattle migration was also mentioned as a strategy. This indicated that the cattle are taken to the mountains or farms to stay there to allow them to feed and access water from the nearby rivers. Ekwem *et al.* (2023) in humid and sub-humid zones, cattle are more often sold in the wet season due to the higher market value of fattened animals, whereas in arid and semi-arid zones high mortality associated with frequent droughts in the dry season drives sales, and the livestock is migrated to another area.

All respondents mentioned factors that influenced their choice of adaptive strategies in response to water scarcity by smallholder cattle farmers. Majority of respondents were

influenced by insufficient grazing areas, grazing areas with poisonous plants, and lack of proper kraal. Some cattle farmers were influenced by inconsistent supply of medicine and cow feed from DALRRD, no cow feed supply, and cattle theft. This indicated that the DALRRD does not supply all the farmers from both villages. In Mogapeng village, only farmers with more than 10 cattle were provided with cow feed. It emerged from the results that almost 80% of farmers travelled a distance to access water for cattle consumption. Some farmers travelled a distance between 1km and 15km every day, some 16km to 30km. This suggests that farmers would travel with the cattle to the nearby river near the grazing areas to access water. Some 18% of the farmers did not travel any distance to access water, and this indicates that farmers had boreholes in which they used water for cattle consumption. Bartlett & Gould, (2012) revealed that providing a clean, convenient water source in pastures separate from surface waters will benefit both livestock and water quality. Livestock perform better with clean water. Cattle will spend most of their grazing time close to a water source

It emerged from the results that more than half of the farmers received support from DALRRD, and a minority of the farmers did not receive any support. The support received from DALRRD to farmers included cattle vaccines, plunge dip chemicals for the cattle, and cow feed for the cattle. The results show that some farmers recommended adaptive strategies for sustainable cattle farming. The recommendations included supplying cow feed to cattle farmers, cattle vaccines, cattle medicines, hosting livestock workshops and constructing a plunge dip structure in Shiluvane village. This indicated that only Mogapeng village had a plunge dip structure and farmers from Shiluvane village had to travel to Mogapeng to access the plunge dip. It further indicates that government aid is required by farmers because the structure is expensive to construct and maintain. Nyamushamba *et al.* (2017) highlights that government, and its development partners would do well as part of livestock development to consider constructing new dipping infrastructure. The structure may also need to be modernised such as provision of a solarised water reticulation system for easy filling up of the dip tank and holding dipping sessions.

7.3. Conclusions

The study investigated the adaptive strategies of smallholder cattle farmers in response to water scarcity in Limpopo, South Africa. The results showed that cattle mortality due to water scarcity is considered a serious community challenge that is negatively affecting cattle farmers. This resulted into farmers losing money. It was also revealed that farmers travelled a distance to access water for cattle consumption. The study further identified adaptive strategies in response to water scarcity. The adaptive strategies include changing grazing areas, cattle migration, and buying cow feed from local markets. Most smallholder farmers were influenced by the insufficient grazing areas in the village, so they resorted to cattle

migration, etc. Another factor that influenced the cattle farmers was the inconsistent cow feed and medicine supply from the DALRRD. This implies that the DALRRD did supply only to specific cattle farmers and also there were days that the medicine and cow feed were not supplied. It also emerged that some farmers received support from the government, and some did not receive support. The farmers who received support received support like supply of cattle vaccine, medicine, and cow feed. The support required is feedlots and cattle vaccine. It emerged that farmers recommended that government should construct a plunge dip structure in Shiluvane village.

7.4. Recommendations

This section presents recommendations to policy based on the implications of the study findings to future researchers and stakeholders;

a. Urgent establishment of an animal health biosecurity plan, which should include alternative options to ensure biosecurity such as vaccination to control the spread of diseases.
b. Establishment of an animal disease emergency fund, and an evaluation and assessment of the management of key staff in the national and provincial veterinary offices (Department of Agriculture, Land Reform and Rural Development).
c. There is a need for stakeholders (including farmers and researchers) to further identify the adaptive strategies in response to water scarcity to improve decision-making on the methods to use and resource allocation.

7.5. Future research work

a. Conducting similar studies in other regions and areas will assist in better informing relevant stakeholders, farmers and policymakers.

b. There is a need to conduct an economic analysis of the adopted strategies currently used and envisaged for decision-making on adaptation strategies to be adopted that are effective in terms of cost, and time. Moreover, it is vital that more work and more efficient methods are created to help smallholder farmers improve their managed financial problems that was a result of water scarcity.

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LIST OF APPENDICES

Appendix 1: Research questionnaire

INSTRUCTIONS

(i) Please answer all questions.

(ii) Choose the answer(s) that is applicable by ticking X inbox(es) provided.

(iii) Write down the information required in the space provided on the lines.

(iv) All answers are correct from the participants. There is no wrong or right answer.

Demographics

1. Gender

1.	Female	
2.	Male	
3.	Other	

2. Age

1.	Below 18 years	
2.	19-28 years	
3.	29-38 years	
4.	39-48 years	
5.	Over 48 years	

3. Marital status

1.	Single	
2.	Married	
3.	Divorced	
4.	Separated	

5.	Widowed	
6.	Living together	

4. Employment status

1.	Employed (formal)	
2.	Employed (informal)	
3.	Unemployed	

5. Education level

1.	No formal Schooling	
2.	Primary school	
3.	Secondary school	
4.	Grade 12	
5.	Tertiary	

6. What other type of livestock are you involved in

1.	Sheep	
2.	Goats	
3.	Pigs	
4.	Chickens	
5.	Other	

7. Are you the household head

1.	Yes	
2.	No	

8. Source of income

1.	Pension	
2.	Farming	
3.	Part-time job	
4.	Full-time	
5.	Social grant	
6.	Remittances	

Section B: Adaptive strategies used by smallholder cattle farmers

1. Are you a smallholder cattle farmer?

1	Yes	
2	No	
3	Other (Specify)	

If yes how many cattle do you have? _____

2. What type of Cattle do you own? Tick the correct answer

1	Conventional	
2	Organic	
3	Both	

Kindly give reason for your answer:

3. How many of your cattle died due to water scarcity in the past 12 months? _____
4. Cause of death _____
5. What is the value of total loss in the past 12 months? _____
6. What is the distance in Km to your water source? _____
7. How do you access water? _____
8. What type of water source do you access? _____
9. What do you use accessed water for? _____
10. What strategy do you use to avoid cattle death? _____
11. What influenced the choice of the type of strategy used to avoid cattle death? _____
12. Briefly explain how the strategy is implemented _____

13. How does the strategy contribute towards the survival of cattle? Please briefly explain _____
14. Do you receive any support from the Department of Agriculture/ Rural Development and Land Reform or any other? _____
15. If yes. What type of support? Explain briefly _____
16. If No. What support would you need from Department of Agriculture/ Rural Development_____ _____
17. Do you have any other thing that you may want to add? _____

Thank you for your support and cooperation in this interview

_____

Appendix 2: Informed consent

LETTER OF INFORMATION AND CONSENT

Dear participant,

My name is Dollen Mahlo. I am a student at the University of Venda (UNIVEN) registered for the Masters of Rural Development (AGMARD) degree programme within the Institute for Rural Development (IRD). I am conducting a research on ***Adaptive Strategies to Mitigate Water Scarcity Among Smallholder Cattle Farmers in Vulnerable Areas of the Greater Tzaneen Local Municipality***. You are kindly requested to participate in this study. University of Venda has given me consent to conduct research on adaptive strategies to water scarcity by smallholder cattle farmers in vulnerable areas of Greater Tzaneen local municipality. My study will take place in both Mogapeng and Shiluvane village. As part of the agreement, the university has given me permission to conduct research and avail any relevant information that will lead to identifying the adaptive strategies used by smallholder cattle farmers in response to water scarcity.

It is within this background that this questionnaire is being administered to you to obtain data on various adaptive strategies used in Mogapeng and Shiluvane village.

Kindly note that your participation is voluntary, and you may dis-engage from the study or may contact the university to remove your data from kept records at any time without any prejudice. Kindly read all questions in the questionnaire, understand and answer them to the best of your knowledge. The information will only be used for the purpose of this research.

Signature of Researcher: D Mahlo_____ **Date**_____

I…… have read and understood the contents of this invitation to participate in the study. Thus, I hereby voluntarily consent to participate in the research.

Respondent signature: _____ **Date**_____

Appendix 3: Ethical clearance certificate

ETHICS APPROVAL CERTIFICATE

ETHICS APPROVAL CERTIFICATE

FACULTY OF SCIENCE, ENGINEERING AND AGRICULTURE RESEARCH ETHICS COMMITTEE

NAME OF RESEARCHER/INVESTIGATOR: Mahlo Dollen

STAFF/ STUDENT NO: 18021489

PROJECT TITLE: Adaptive strategies to water scarcity by smallholder cattle farmers in vulnerable areas of Greater Tzaneen local municipality

ETHICAL CLEARENCE NO: FSEA/22/IRD/16/1707

SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS

NAME	INSTITUTION & DEPARTMENT	ROLE
Dr Oloo G	University of Venda, Institute for Rural Development	Supervisor
Dr Marizvikuru MM	University of Venda, Institute for Rural Development	Co-supervisor
Mbusiseni M.V	University of Venda, Institute for Rural Development	Co-supervisor

Type: **Student research**

Risk: **Minimal risk to humans, animals, or environment (Category 1)**

Approval Period: **November 2022-January 2025**

The Faculty Research Ethics Committee (FREC) of the Faculty of Science, Engineering and Agriculture hereby approves your project as indicated above.

University of Venda

PRIVATE BAG X5050, THOHOYANDOU, 0950 LIMPOPO PROVINCE SOUTH AFRICA
TELEPHONE (015) 962 8504/8313. FAX (015) 962 9060

"A quality driven financially sustainable, Comprehensive University"

ETHICS APPROVAL CERTIFICATE

General Conditions

While this ethics approval is subject to all declarations, undertakings and agreements incorporated and signed in the application form, please note the following.

- **The project leader (principal investigator) must report in the prescribed format to the REC:**
  - **Annually (or as otherwise requested) on the progress of the project, and upon completion of the project**
  - **Within 48hrs in case of any adverse event (or any matter that interrupts sound ethical principles) during the project.**
  - **Annually, research projects may be randomly selected for auditing.**
- **The approval applies strictly to the protocol as stipulated in the application form. Should a change to the protocol be deemed necessary during the project, the project leader must apply for approval of these changes before their implementation. Should there be a deviation from**

the study protocol, without the necessary approval for the change, the ethics approval is automatically forfeited.

- **The date of approval indicates the earliest date that the project may begin. Should the project have to continue after the expiry date; a new application must be made, and a new approval received before or on the expiry date.**
- **In the interest of ethical responsibility, the FREC retains the right to:**
  - **Request access to any information or data at any time during the course or after completion of the project,**
  - **To ask further questions; Seek additional information; Require further modification or monitor the conduct of your research or the informed consent process.**
  - **withdraw or postpone approval if:**
  - **Any unethical principles or practices of the project are revealed or suspected.**
  - **It becomes apparent that relevant information was withheld from the REC or that information has been false or misrepresented.**
  - **The required annual report and reporting of adverse events was not done timely and accurately,**
  - **New institutional rules, national legislation or international conventions deem it necessary**

ISSUED BY:
FACULTY OF SCIENCE, ENGINEERING AND AGRICULTURE RESEARCH ETHICS COMMITTEE

Date considered: November 2022

Chairperson: Prof. P.O Bessong

University of Venda
PRIVATE BAG X5050, THOHOYANDOU, 0950 LIMPOPO PROVINCE SOUTH AFRICA
TELEPHONE (015) 962 8504/8313. FAX (015) 962 9060