

**STRATEGIES FOR COPING WITH WATER SCARCITY IN SMALLHOLDER CATTLE
FARMING SYSTEMS IN MAKHADO LOCAL MUNICIPALITY**

By

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DECLARATION

I, Vhuhwavho Wendy Siwadawada, hereby declare that this dissertation titled “**Strategies for Coping with Water Scarcity in Smallholder Cattle Farming Systems in Makhado Local Municipality**” 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 execution, and all reference material contained therein has been duly acknowledged.

Signature: 

Date 25 March 2025

ABSTRACT

Water scarcity poses a significant challenge to smallholder farmers, cattle, and overall agricultural sustainability. The challenge of water scarcity in cattle farming systems underscores the critical need for adaptive practices to safeguard cattle well-being and maintain livestock productivity. The study determines the coping strategies to address water scarcity effects on smallholder cattle farming in Tshikuwi and Tshirolwe, Makhado local municipality, Limpopo, South Africa. A mixed method was adopted in this study. The body scoring condition was collected using a BSC scale, and the interviewer used a semi-structured interview guide. The population of this study included cattle and members of the community, only cattle farmers who were 18 and older participated in the study. Qualitative data was analysed thematically using Atlas-ti 8 software, version 24.1.0 and quantitative data was computed through descriptive statistics using IBM Statistical Package for Social Sciences (SPSS) version 29. The participants expressed different perceptions of water scarcity, most respondents perceived water scarcity as a lack of water and a shortage of water to cover cattle farming. Smallholder cattle farmers employed different types of coping strategies to tackle water scarcity; the most common strategy used was natural water wells and boreholes. The study revealed a correlation between the distance to the water source and the body condition and health of the cattle (Bucks, $r=0.7002$, Does, $r = 0.9865$ and Weaners, $r=0.9582$). The study used a scatter plot to determine if there was a correlation between the distance (km), the body condition, and the health status of the cattle. The findings showed that bucks exhibit low correlation ($r^2 = 0.4903$), indicating greater variability in their BCS as distance increases and a linear trend of distance and FAMACHA, which does show a sharper decline (slope = -1.0606). The findings emphasised the significance of streams/rivers and boreholes as the main resource for coping with water scarcity. According to the farmers, behavioural changes are the biggest impact they have seen in their cattle. The study recommends educational initiatives to assist smallholder farmers in enhancing their management of water resources as well as government and agricultural producers to allocate resources towards developing infrastructure and technology that guarantees cattle access to water.

Keywords: Cattle, coping strategies, farming systems, rural, smallholder.

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DEDICATION

This work is dedicated to my son, Rofhiwa Junior Nengovhela, be inspired my boy.

ABBREVIATIONS AND ACRONYMS

BCS:	Body Condition Score
DAFF:	Department of Agriculture, Forestry, and Fisheries
DALRRD:	Department of Agriculture, Land Reform, and Rural Development
DEA:	Department of Environmental Affairs
DWS:	Department of Water and Sanitation
FAMACHA:	FAffa MAlan CHArT
FAO:	Food and Agriculture Organization
GDP:	Gross Domestic Product
GPS:	Global Positioning System
KM:	Kilometre
MLM:	Makhado Local Municipality
SA:	South Africa
SPSS:	Statistical Package for Social Sciences
Stats SA:	Statistic South Africa
TNA:	Thematic Network Analysis
Univen REC:	University of Venda Research Ethics Committee
WB:	World Bank

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CHAPTER 1: INTRODUCTION

1.1 Background

The concept “water scarcity” has been used widely by scholars and philosophers. Different scholars have tried to define the concept from different perspectives. Petruzzello (2023) defines water scarcity as a situation where the water demand exceeds the available supply in a region for a population. Water scarcity arises when the demand for water exceeds the available supply, which is generally caused by overuse, pollution, or climate-related issues (EcoWatch, 2025). It occurs when there is a lack of sufficient freshwater resources to meet the needs of various sectors and uses, such as domestic, agriculture, industry, and the environment. Agriculture is a major water-consuming sector and is not spared from water scarcity effects (Raeisi, 2019). Agriculture is responsible for producing the world’s food supply to meet the needs of the growing population, but water scarcity can lead to lower agricultural productivity and higher food prices, and some farmers may be forced to abandon their land (Tuong & Bouman, 2003). Water scarcity has a substantial impact on livestock and crops, both of which rely on water for hydration, irrigation, and ecosystem health. Insufficient water causes failed crops, lower soil fertility and decreased livestock productivity owing to dehydration, disease, and poor nutrition. According to Rulli *et al.* (2018), water scarcity in affected regions disproportionately impacts the most vulnerable population, particularly smallholder farmers, who face severe consequences. When water is scarce, it directly affects smallholder cattle farmers' access to safe drinking water for their livestock. Water scarcity in smallholder cattle production is a critical problem with broad effects. Limited access to water resources significantly hampers the ability of small-scale cattle farmers to maintain the health and productivity of their livestock (Amosi, 2019). Water scarcity has an extensive effect on cattle health and productivity, as proper water intake is critical to their overall well-being and performance. Dehydration caused by a lack of water can decrease feed intake, milk production, and reproductive efficiency (Smith *et al.*, 2021). Furthermore, cattle are more susceptible to heat stress under water-scarce situations, which can impair development and immunological function (Jones and Taylor, 2020). In the long term, these impacts might

cost farmers money since cattle become more sensitive to illnesses and productivity drops (Brown, 2019).

Water scarcity is an increasing global concern, with many countries experiencing severe water shortages that threaten food security and economic stability. South Africa's semiarid climate, expanding population, and the consequences of climate change all worsen the situation, threatening agricultural output and the livelihoods of farmers and pastoralists (Ziervogel *et al.*, 2020). The country is rated among the world's 30 driest countries in the world (Ngcamu, 2018). This is because of its low annual rainfall averages, irregular patterns, and substantial evaporation losses. The country receives less rainfall per capita than arid nations such as Namibia and Botswana (Matenge *et al.*, 2025. Mohamed (2022) claims that only 495mm of the world's yearly precipitation, with an average annual rainfall of 1033mm, falls in South Africa. Due to the uneven distribution of rainfall around the nation, only 35 percent of the country has a precipitation of 500mm or more while 21 percent has a precipitation of less than 200mm (Manungufala, 2021).

Malima (2022) argues that Makhado Local Municipality in Limpopo province is significantly affected by the country's overall water scarcity challenges. The low annual rainfall averages, irregular patterns, and substantial evaporation losses impact the water supply in Makhado, making it important for the municipality to address and manage its water resources effectively to mitigate water scarcity (Mothiba, 2024). Makhado has had significant difficulties due to a scarcity of water. Environmental change and infrastructure challenges have had a substantial impact on the area's water resources. Long years of drought, combined with variable rainfall, have decreased access to water from local sources such as rivers and dams (Makhado, 2020). Furthermore, the municipality's old water systems, along with inadequate maintenance, have contributed to the situation, resulting in frequent interruptions in water supply (Makhado, 2021). This has resulted in severe water scarcity affecting both urban and rural populations, raising the risk of waterborne infections among residents (Makhado, 2022).

The challenges posed by low annual rainfall not only affect the municipality's water supply but also extend to cattle production. Access to water is a vital aspect determining cattle health, and the distance to water sources has a substantial impact on their total body

condition. When water sources are far from grazing areas, cattle may result in poor body condition and increased susceptibility (Fisher *et al.*, 2020). Understanding the impact of distance from water sources on cow health and body condition is critical for improving cattle health, especially in areas with limited or variable water supplies.

Insufficient rainfall and water sources located far away can lead to dehydration, heat stress, reduced feed intake, reduced growth and weight gain, health risks, behavioural changes, and reduced reproductive performance, which have severe consequences for the health and well-being of animals. Water constitutes approximately 60 to 70 percent of an animal's life weight (Faries *et al.*, 1997). Domesticated animals can live about sixty days without food but only about seven days without water. Thus, cattle should have sufficient and cool drinking water to prevent stress and dehydration (Boyles, 2003) and sustain production and maintenance. Zondo *et al.*, (2024) recommends a water pump system and installing tanks that store rainwater to mitigate the inaccessibility of water challenges. Thus, smallholder livestock farmers in southern Africa (South Africa included) have been adopting water conservation practices, such as capturing and storing rainwater in ponds or tanks to ensure they have a reserve of water during dry periods.

According to Makhanthisa *et al.* (2022), over 70% of agricultural land in Limpopo province is suitable for livestock grazing. Livestock production contributes approximately 50% of the province's gross domestic income from agricultural products compared to the country, 2.1% of income derived from livestock products (DALRRD, 2020). Out of all the provinces in South Africa, Limpopo has recorded the highest number of agricultural households, owing to livestock. Cattle recorded 35,000 and goats 26,610 and the least that was recorded was sheep with only 2,014 (Census, 2017).

In the Vhembe District, the most common livestock species are cattle, with an estimated number of 80,673, 77,516 goats, 51,719 boilers, 21,818 pigs, and 17,477 sheep (Integrated Development Plan, 2021); it also indicates that cattle are the most selected livestock. Udeh (2024) states that cattle play a significant role in the district as they are a valuable source of food, providing meat (beef) and dairy products (milk, cheese & yoghurt). Moreover, about 70% of rural households' employment comes from smallholder agriculture, which also serves as their primary source of income, as is the case in both

Limpopo and Mpumalanga provinces (Hlatwayo *et al.*, 2021). This is because cattle provide employment opportunities such as milking, processing and butchering. Added to this is the fact that selling cattle and their products can generate income for farmers and contribute to the local economy. Thus, cattle serve as a safety net for the smallholder farmers. However, the livestock revolution is expected to slow during the next three decades as population, urbanization, and Gross Domestic Product per capita in developing nations are expected to increase more slowly than they have over the previous years (Latino *et al.*, 2020). Africa will be exceptional, where the livestock demand for meat and dairy consumption predicts a dramatic increase in demand for meat and milk, envisaged consequent opportunities for black smallholder livestock owners to contribute and grow from subsistence to market-based production (Greenwood, 2021). The increased demand for meat and milk stated in the Livestock Revolution (the increase in meat and dairy consumption) is driven by population and economic growth with accompanying higher incomes, increased consumption and urban migration (Latino *et al.*, 2020).

Food and Agriculture Organization (FAO), (2020) asserts that there are approximately 12 species of domesticated animals that dominate global livestock production. The most important are cattle, sheep and goats with a global approximation of 1.5, 1.3, and 1.1 billion, respectively. Livestock numbers continue to grow to meet the increasing demand for meat, particularly in Asia, Africa and South America (Liu *et al.*, 2023). In line with this, most people in the rural areas of South Africa depend on livestock farming for food security. (Department of Agriculture, Forestry and Fisheries (DAFF), 2018). Smallholder farms occupy about 62% of Africa's farmland (Pfeiffer *et al.*, 2022). At the primary production level, the South African red meat industry has a strong dualistic character, which stems from the existence of homeland states of the pre-1994 political dispensation.

When there is a water shortage, smallholder farmers' increase in cattle production becomes hard to achieve as water shortage heightens because it impacts livestock health and production (Schlink *et al.*, 2010). Based on the above facts, this study sought to determine the strategies for coping with water scarcity for smallholder cattle farming in Makhado Local Municipality, South Africa.

1.2 Statement of the research problem

Livestock production, particularly cattle, provides a steady income and reduces agricultural vulnerability, especially under global climate change (Banda & Tanganyika, 2021). In Makhado Local Municipality, most households rely on livestock farming for food and income. Makhado has significant potential to increase cattle production for local use and export (Materechera, 2022). Moreover, the growing human population drives a demand for high-protein diets, creating a profitable market for beef. This potential is further enhanced by export opportunities, hence improving agricultural trade balances. However, limited water availability directly affects smallholder cattle farming by reducing pasture growth, increasing disease and parasites, limiting herd expansion, and ultimately constraining productivity (Sivhiya, 2022). Water for agriculture is increasingly scarce, with a 20% reduction in most parts of Vhembe district and Limpopo (Mugego & Ncube, 2022). Rivers and dams in Makhado often run dry, and the water system cannot supply all areas simultaneously (Maharaj, 2022). In Makhado Local Municipality, cattle farming is a crucial economic activity, with approximately 60% of households engaged in livestock farming (Minyuku, 2022). The municipality has a cattle population of around 150,000, contributing significantly to the local economy (Minyuku, 2022). Thus, it was crucial to determine coping strategies to address water scarcity's effects on smallholder cattle farming in vulnerable communities including Makhado Local Municipality. This is key to maintaining cattle production and sustaining their socioeconomic contributions to small-holder farmers.

1.3 Justification / rationale of the study

Addressing water scarcity in small-scale farming systems remains a top priority for development organisations and researchers. Many rural farmers in South Africa are dependent on smallholder farming. Any negative effects on local agriculture could cause a fall in the GDP. The current study enables scholars to understand the effects of water scarcity on cattle and the strategies smallholder farmers adopt to mitigate the problem. Knowledge generation and exchange stimulate discussion on sustained cattle production

amidst water scarcity and promote the development of policy documents to influence policymakers and implementers. Adaption challenges gathered are useful in South Africa in general, and Makhado Local Municipality in particular.

The study contributes to planning and developing water scarcity policies for development practitioners and helps decision makers such as the government (Department of Water and Sanitation, Department of Agriculture, Land Reforms and Rural Development) to adopt measures and intervention methods that would improve water security for livestock and humans not only for the Makhado Local Municipality but the entire country. Knowing how smallholder farmers perceive the effects of water scarcity leads to a better understanding of how other smallholder farmers should select strategies/ methods in response to water scarcity for cattle. Furthermore, the study adds value to the existing research on water scarcity and cattle farming. Hence, other researchers gain insight and make recommendations for further research.

1.4 Main research objective

The main research objective of this study was to determine the strategies for coping with water scarcity in cattle production. The specific research objectives were:

1.4.1 Research objectives

1. To determine farmers' perceptions of water scarcity in cattle production.
2. To determine the effects of distance to a water source on body condition and health status of cattle; and
3. To determine coping strategies for water scarcity in smallholder cattle farming.

1.4.2 Research questions

1. What are the perceptions of smallholder farmers on water scarcity for cattle production?
2. How does the distance to the water source affect cattle body condition and health status?

3. What coping strategies do smallholder farmers in Makhado local Municipality use to manage water scarcity in cattle production?

1.5 Operational definition of key concepts

1.5.1 Coping Strategy

A coping strategy is a method or approach farmers use to deal with challenges. In the context of this study, these are approaches used to address water scarcity for smallholder cattle farming (Limon *et al.*, 2017).

1.5.2 Livestock

Rowe *et al.* (2019) define livestock as domesticated animals raised in an agricultural context. Livestock, produce a variety of consumer goods. However, the phrase is sometimes used exclusively to describe animals raised for human food.

1.5.3 Smallholder farmers

Small-holder farmers own small-based plots of land on which they grow their animals communally and share resources, relying almost exclusively on family labour (Food and Agriculture Organization, 2013).

1.5.4 Water scarcity for cattle production

According to Petruzzello (2023), water scarcity for cattle production refers to the insufficient availability of water resources needed to meet the hydration, nutritional, and husbandry requirements of cattle.

1.6 Outline of the dissertation

The dissertation is divided into the following seven chapters.

1.6.1 Chapter 1: Introduction and background of the study

This chapter introduces the research, presents the background, statement of the problem, justification of the study, research questions, research objectives, definition of key concepts and the outline of the research.

1.6.2 Chapter 2: Literature Review

The literature review presents the theoretical background of the strategies for coping with water scarcity in smallholder cattle farming systems and response strategies adopted by smallholder cattle farmers.

1.6.3 Chapter 3: Research Methodology

This chapter presents the research methodology, particularly descriptive of the study area, research design, population, sampling procedure, data collection procedure, data analysis, and ethical considerations.

1.6.4 Chapters 4,5 and 6

In these chapters, the research findings are presented and discussed. Each objective of this study forms a chapter and adheres to the paper format structure.

1.6.5 Chapter 7

This chapter presents the synthesis of the key findings, results, discussion, conclusion, and recommendations of the study

Additionally, a list of references for sources used to substantiate facts in the dissertation, and appendices are presented.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

The chapter reviews the published literature on water scarcity coping strategies used by farmers. The objectives of the study informed the review of the literature. Therefore, this chapter is structured according to the objectives of the study. Journal articles, books, book chapters, and conference proceedings are the principal sources of this literature review. The keywords are based on the objectives of the study, namely the effects of water scarcity, cattle production, and coping strategies by smallholder cattle farmers. This literature is a scoping review; it intends to map the existing literature.

2.2 Definition of water scarcity

Water scarcity is defined as a situation where there is a lack of sufficient and reliable access to clean and safe water for both domestic and industrial purposes (FAO, 2016). It occurs when the demand for water exceeds the available supply. Winpenny (1995) defined water scarcity as a state where there is not enough water to gratify normal requirements. Water scarcity situations can have different origins, and they can be dealt with by countries that would face such situations. For example, Malima (2022) posits that the scarcity in Makhado water scarcity is due to the high frequency of water supply infrastructure breakdown (Malima, 2022). However, Maharaj (2022) stated that ageing, unmaintained water infrastructure and dysfunctional hydrants are major causes of water scarcity.

Scarcity in the context of human social, economic, and health needs arises in some places or at particular times when human water demand may exceed the stocks or flows of water on which those demands depend (Gleick *et al.*, 2021). Water supplies are affected by both natural hydrologic variability and a wide range of human activities that modify the hydrologic cycle, such as contamination of stocks, the construction and operation of water infrastructure, and human-caused climate change (Yang, 2022). Human demands for water also change over time, driven by population growth, economic activities, and social priorities and preferences (Mishra *et al.*, 2021).

Globally, the total stock of water is hundreds of thousands of times larger than even the largest estimate of human water demands. However, not all the water in those stocks is

accessible, and there are great disparities in when and where humans require fresh water to satisfy demands (Jackson *et al.*, 2001). Global water stock and the accessibility and distribution of water create challenges, leading to regional and local shortages (Shekwambana *et al.*, 2021). Smallholder farmers are particularly vulnerable to the impacts of water scarcity on cattle farming. Farmers often rely on rain-fed agriculture.

2.2.1 Physical water scarcity

Physical water scarcity occurs when natural water availability is inadequate to provide for a region's needs, such as those of ecosystems. Physical water scarcity is prevalent in arid and semi-arid regions where climatic conditions limit water supply. About 1.2 billion people globally reside in physically water-scarce regions, which usually leads to environmental degradation and lowering groundwater levels (Mekonnen, 2021).

2.2.2 Economic water scarcity

Economic water scarcity results from a lack of investment in infrastructure or technology to access available water resources. With sufficient natural water, inadequate infrastructure or funds hinder effective utilisation. This form of scarcity is prevalent in regions where water is abundant but cannot be accessed due to financial or infrastructural constraints, and thus, communities lack assured access to clean water (Mekonnen, 2021).

2.3 Water scarcity in South Africa

Water shortage directly affects the availability of pasture and water sources for their cattle. Limited financial resources constrain their ability to invest in alternative water supply systems. Water scarcity can be caused by a combination of natural and human-induced factors. South Africa is a water-scarce country (Roodbol, 2020). Government Communications (2015) reported that South Africa ranks as one of the 30 driest countries in the world, with an average rainfall of less than 40%. Limpopo and Mpumalanga are among the five provinces that were declared drought disaster in 2025. Water shortage is a complicated, multifaceted problem that impacts the development, livelihoods, and health of millions of people. Water scarcity affects South Africans who must overcome

financial or physical obstacles to get enough, safe, and dependable water. Masiya *et al.* (2019) suggest that the water supply in South Africa needs to be prioritised by the local government. To solve the issue of water scarcity in South Africa, several efforts and solutions have to be put into place, such as bettering water management, infrastructure, and governance, encouraging water conservation and reuse, and investing in renewable energy and innovation. To guarantee water availability for smallholder farmers, additional initiatives and collaboration are required from governments, civil society, and communities.

2.4 Causes of water scarcity

A growing worldwide concern, water scarcity occurs when freshwater demand outpaces availability, impacting ecosystems and human populations. It presents serious obstacles to daily living, business, and agriculture, especially in areas with scarce or inadequately managed water supplies.

2.4.1 Climate change and droughts

Climate change and water are deeply interconnected. Around 70 % of the surface of the Earth is covered by water, of which 2.5 % is fresh water and 97.5 % is salt water and accessible freshwater makes up less than 1% of this 2.5% mentioned (Mishra, 2021). Over the past 25 years, terrestrial water storage, including soil moisture, snow, and ice has dropped with major ramifications for water security (World Meteorological Organization, 2021). The complicated effects of climate change on water are well known. The most extreme climate change effects on water include erratic rainfall patterns, decreasing ice sheets, rising sea levels, floods, and droughts. One of the key causes of these issues is rising global temperatures (Rajak, 2021). The water cycle is impacted by climate change because it alters where, when, and how much precipitation occurs.

2.4.2 Agricultural expansion

Expanding agricultural areas require more water for irrigation. Angelakis *et al.* (2021) posit that to support agricultural and livestock development, farmers frequently need to draw more water from rivers, lakes and groundwater as they cultivate larger amounts of land.

Water shortages could result from a decreasing water supply caused by rising water demand.

Irrigating crops is a widespread activity. However, using subpar irrigation methods could cause significant water losses. If water is not used properly, a sizable amount can be lost through evaporation, runoff, and inefficient distribution systems. Another significant issue that may result in water scarcity is destroying forests and wetlands as it disrupts the hydrological cycle. Wetlands and forests play a key role in protecting water supply by regulating runoff and monitoring groundwater levels.

By limiting water retention, their removal may aggravate water scarcity. Sheil (2021) also implies that Africa's forests maintain and stabilize the region's hydrology and climate, offering significant advantages on numerous levels. If degraded, such benefits will decline and may be lost, with potentially severe consequences.

2.4.3 Lack of infrastructure

Lack of infrastructure plays a big part in the lack of water. Adequate infrastructure is required for the collection and treatment of water. Water scarcity problems originate from underdeveloped or poorly maintained systems. Communities might not have access to reliable water delivery systems if the correct infrastructure is not in place, during high demand or drought. Reservoirs and storage tanks are essential to an efficient infrastructure because they allow water to be stored during times of abundance and used during shortages (Sleet, 2019). Without these resources, water may be unavailable when it is needed. To reduce water losses from leaks or ineffective distribution, water distribution networks, including pipes and pumping stations, need to be well-designed and maintained. Scarcity can be made worse by inadequate infrastructure, which can result in severe water losses.

2.4.4 Water pollution

Unsafe and tainted water sources can have severe consequences for cattle, leading to various health issues and, in extreme cases death (Bendix, 2022). Water scarcity is a major concern, especially in smallholder farming, where access to clean and appropriate

water management may be limited. Furthermore, we only have access to less freshwater on the planet, and human activity is actively putting our water resources in peril. Numerous ways can pollute water, including sewage and wastewater, and industrial and agricultural runoff, where pesticides and toxic chemicals leach into the groundwater and nearby freshwater systems (Chowdhury *et al.*, 2020). There is less freshwater and drinking water available for cattle because of the contamination of irreplaceable water resources.

2.5 Effects of water scarcity on cattle production

The United Nations (2010) states that having free access to freshwater is a basic human right, and losing access to drinking water can be detrimental to human and cattle's health and lives, as we all need water to survive. Cattle can only survive for a short time without water but will eventually die if they do not have access to water. Water scarcity and shortage can lead to other serious impacts on the environment such as drier vegetation, increasing the risk of wildfires, and threatening global peace and security as well.

2.5.1 Physiological effects on cattle

Water plays a very important role in maintaining various physiological functions in cattle, like digestion, nutrient transport, waste excretion, and maintaining body temperature. Inadequate water intake affects these functions and leads to dehydration, decreased digestion, and diminished feed efficiency. This physiological stress can affect the overall health and productivity of cattle (Giri *et al.*, 2020).

2.5.2 Growth and productivity effects

Water deficiency affects cattle growth and productivity negatively. Inadequate water supply leads to insufficient feed consumption because water is required for the digestion of feeds and nutrient utilisation. Reduced feed intake decreases growth rates and weight gain directly and indirectly impacts meat and milk production. Cattle also waste more energy moving longer distances to access water, which further decreases growth and productivity (Fust and Schlecht, 2018).

2.5.3 Reproduction and susceptibility to disease

Adequate water intake is necessary to facilitate proper reproductive function in cattle. Insufficient water intake leads to a range of reproductive problems, including lower fertility rates and pregnancy problems. Dehydration weakens the immune system, thereby making cattle more vulnerable to diseases and infections. Furthermore, reliance on low quality water sources exposes cattle to waterborne pathogens that risk disease transmission, including leptospirosis, which negatively affects reproductive performance and milk yield (Lilenbaum & Martins, 2014).

2.6 Effects of water source on the health status

Cattle are extremely dependent on appropriate water supplies for their well-being and production; hence water scarcity can have major and negative consequences. One of the most severe and immediate effects of distance to water sources is dehydration. Water is required by cattle for a variety of physiological functions, including digestion, thermoregulation, and nutrition transfer. When there is little water available, cattle frequently consume less feed. Weight loss in cattle can be caused by reduced feed intake and dehydration (Wang *et al.*, 2023). Farmers may be affected financially by this, particularly those who raise cattle for meat production. It can directly impact various aspects of their operations and can lead to increased costs and reduced revenue. Farmers may need to provide supplementary feed to compensate for the lack of fresh forage; if they fail, it can result in reduced profitability (Balehegn *et al.*, 2022).

2.6.1 Effects on growth and body condition

Water point location significantly influences cattle growth and body condition. When water points are distant from grazing areas, cattle must expend additional energy to commute to and from water points, thereby utilising less time for grazing and feed intake. This may result in poor growth rates and body condition. Conversely, studies have proven that the provision of readily accessible, clean water sources, such as troughs, can boost the average daily gain in cattle. For instance, cattle that were provided with water troughs had an increased 29% average daily gain compared to those that drank water from ponds (Lardner *et al.*, 2005).

2.6.2 Hydration and nutritional intake

Readily accessible water sources help contribute significantly to adequate hydration and nutritional ingestion in cattle. Having easy access to water, cattle can reach optimum hydration levels, which enhance digestion and nutrient absorption. For their part, distant water points can lead to reduced water consumption, negatively influencing feed intake and nutritional status. Research has indicated that cattle with access to clean, proximal water sources such as troughs are more active in grazing and have improved feed efficiency compared to those using distant water sources or contaminated water sources (Lardner et al., 2005).

2.6.3 Vulnerability to diseases

Accessibility to water sources also affects cattle's vulnerability to diseases. Where cattle need to move long distances to access water, they clump around small water points, and the pathogen transmission risk increases. Moreover, reliance on natural water sources such as ponds exposes cattle to waterborne illness through faeces as well as environmental contamination. Providing clean water troughs not only reduces cattle's walking distance but also reduces exposure to bacteria and viruses, thereby enhancing herd health (Landefeld & Bettinger, 2021).

2.7 Water scarcity coping strategies

Water scarcity coping measures involve a range of strategies that aim to minimise the impact of water scarcity, enhance sustainable management of water, and enhance drought resilience.

2.7.1 Water conservation strategies

Water conservation efforts involve the proper management and utilisation of available water resources to preserve against wastage and attain sustainability. In South Africa's arid and semi-arid areas, the cultivation of indigenous, climate-resistant food crops has been promoted to maximize water conservation, as they naturally adapt to local climatic regimes and require less water compared to non-indigenous crops (Maseko *et al.*, 2023)

2.7.2 Alternative water sources

Pursuing alternative water sources is crucial in water scarcity management. Traditional knowledge systems have been instrumental in finding and managing alternative water sources. Tanzanian communities, for instance, utilise traditional knowledge to locate and manage groundwater resources, hence enhancing their access to water during scarcity (Liwenga, 2008)

2.7.3 Feed-based coping strategies

In agriculture, water coping strategies based on water are important to facilitate animal well-being during times of drought. Farmers apply indigenous knowledge as drought-resistant forage crop identification, intercropping maize with drought resistant crop, identification of indigenous forage crop, seed selection, and sowing, which offer sustainable livestock feed (Duguma & Janssens, 2021).

2.7.4 Efficient methods of utilizing water

The use of efficient water use practices is critical in optimising water use within agriculture. Traditional irrigation methods, such as the utilization of post-inundation residual water and swamp traditional farming, have been practiced by farmers in Africa for improving water use efficiency during dry seasons (Zvobgo, 2022)

2.7.5 Indigenous knowledge-based strategies

Indigenous knowledge-based practices form the core of water conservation and management. In South Africa, practices such as rainwater collection, check dam construction, and preservation of sacred water sites have contributed significantly to rural water security, reducing up to 30% of water scarcity in regions such as Limpopo and the Karoo (Maseko *et al.*, 2023). Such traditional, culture-embedded practices ensure cost-effective and sustainable water scarcity measures.

2.8 Water management

According to Beede (2005), water management needs to be done correctly to reduce the effects of water scarcity on cattle. Farmers should ensure that cattle always have access

to clean and sufficient water. This could entail making investments in effective water distribution and storage systems as well as putting plans in place to preserve water in times of scarcity. Effective water management improves productivity and income, prevents dehydration and poor performance in cattle, and lowers the risk of waterborne diseases and other illnesses that can affect cattle in smallholder cattle farming (Wang, 2019). Beede (2005) further alludes to the benefits extended to the health of the cattle as well as the sustainability of the farming operation overall.

2.9 Types and characteristics of cattle in Makhado Local Municipality

Smallholder cattle production in Makhado Local Municipality, within Limpopo Province, predominantly follows an extensive grazing model reliant on natural pastures and seasonal water availability. This production system is highly susceptible to climate variability and drought, which frequently leads to feed shortages and reduced productivity (Lamega, 2021). Indigenous breeds such as Nguni and Afrikaner dominate due to their superior drought resilience: they exhibit efficient water use, low feed demands, and resistance to parasites—traits that make them well-suited to semi-arid environments (Mapiye, 2018; Nyamushamba, 2016). The Limpopo Industrial Development Corporation's Nguni cattle project, which supports about 62 smallholder farmers including in Makhado, highlights both the adoption of drought-tolerant genetics and ongoing challenges like limited infrastructure and market access (Mapiye, 2018). However, smallholder producers frequently lack access to improved breeding stock and extension services, hindering broader uptake of these resilient breeds (Shikwambana., 2022). Breed choice also plays a crucial role in coping strategies alongside supplemental feeding, herd reduction, and water storage interventions—yet many existing coping strategy studies primarily focus on water and feed, with minimal emphasis on the adaptive significance of cattle genotypes (Ncube, 2020; Lamega, 2021). Thus, integrating breed selection into adaptation frameworks is a critical but underexplored element in building resilience within water-scarce, smallholder cattle systems in Makhado.

2.10 Summary of the literature review

In conclusion, the chapter provides a comprehensive review of the literature on coping strategies for promoting smallholder cattle production, specifically focusing on the effects of water scarcity. The effects of water scarcity on cattle are elucidated, including its impact on body condition and health. Water scarcity poses a significant threat to cattle well-being, leading to issues such as nutritional deficiencies. The visual assessment and scoring of cattle's body condition are also discussed, emphasising the importance of maintaining proper body condition for cattle. The chapter further explores the coping strategies employed by smallholder cattle farmers to address water scarcity. The goal of this study was to determine the strategies for coping with water scarcity in cattle production in Makhado Local Municipality. The next chapter presents the approach that was used to accomplish the objective of the study.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

Research methodology refers to the range of approaches used in research to gather data, which is used as a foundation for interpretation, explanation, and prediction (Veal, 2017). Pandey & Pandey (2021) also define research methodology as the specific procedures or techniques used to identify, select, process, and analyse information about a topic. Thus, in this chapter, the research methodology that was used for the study is presented. Firstly, the description of the study area is presented, followed by the research design, and population and sampling procedure. Immediately after this, data collection tools and techniques, as well as data analysis procedures, are outlined. Ethical considerations and expected outcomes occupy the last section of this chapter.

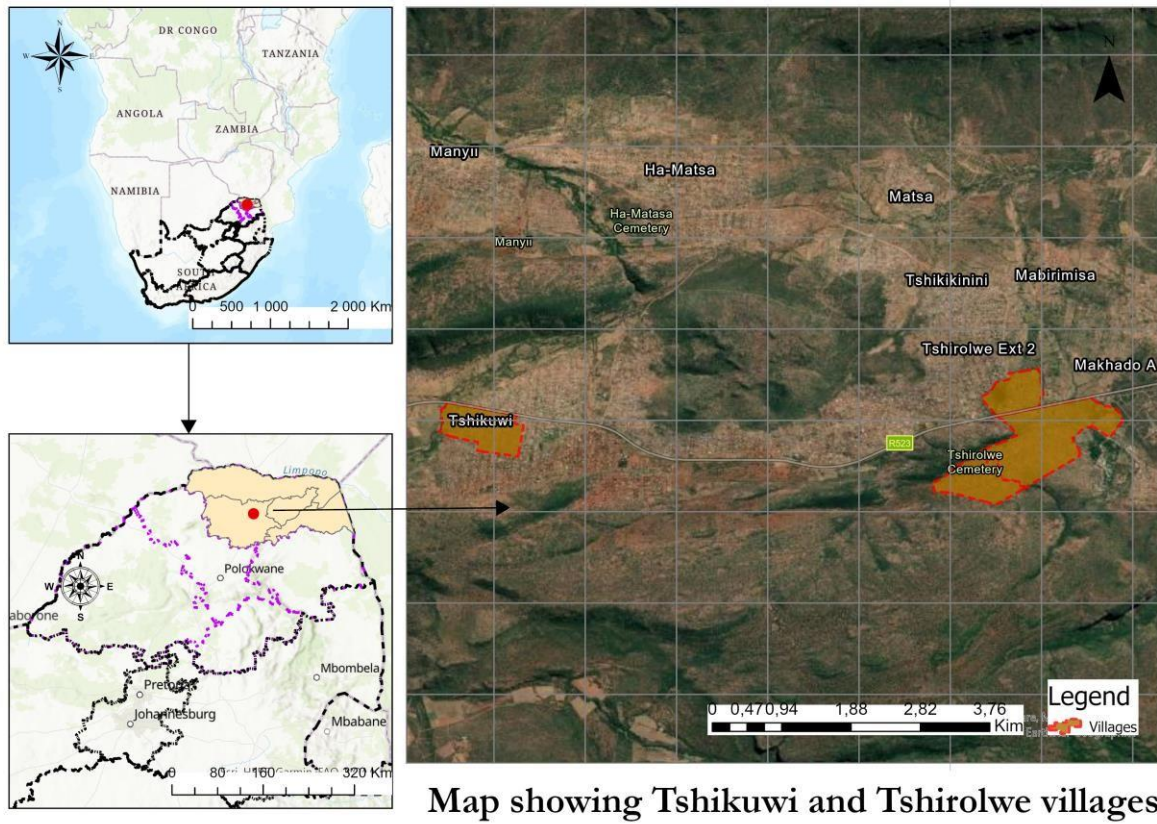
3.2 Description of the study area

This study was conducted in Tshikuwi and Tshirolwe rural villages of Makhado Local Municipality in South Africa (Figure 3.1). These villages were selected because of the existence of a group of smallholder cattle farmers who are facing the challenge of water scarcity. The land area of Tshikuwi village is about 4.26 km². Tshikuwi village has a population of 5 909 which consists of 1 444 households and a GPS coordinate of 22.901 S, 29.9516 E (Stats SA, 2011). Tshirolwe village, covers a land area of approximately 2.88 km². According to the 2011 Census by Statistics South Africa, the village has a population of 2,697 people living in 666 households. The village is situated at GPS coordinates 22.8985° S and 30.0042° E

3.3 Research design

Vogt *et al.* (2012) define research design as a plan and procedure for research that spans the decisions from broad assumptions to detailed methods of data collection and analysis. Thus, in this study mixed-methods research design was adopted. According to Creswell & Plano Clark (2017), mixed-method designs give a complete understanding of the matter

in question and enable corroboration of results from different methods. The design also enables comparison of data from different respondents at multiple levels.



Map showing Tshikuwi and Tshirolwe villages

Figure 3. 1 Map showing Tshirolwe and Tshikuwi villages in Makhado Municipality

Source: [Limpopo bing.com/maps](https://www.bing.com/maps)

This approach was deemed appropriate for this study because it allowed for the validation of findings from many methods, as well as a thorough comprehension of the subject at hand, as Creswell & Clark (2023) indicated. Additionally, descriptive design makes it possible to compare data at various levels from respondents.

3.4 Population and sampling procedure

The target population of this study was women, and men who are involved in cattle farming because they are the relevant sources of data. Purposive sampling techniques were used to select a total of 100 respondents and 20 households. The qualitative method was employed on 60 participants who are smallholder cattle farmers, and the quantitative method was employed on 40 cattle. In each of the 20 households, two selected cattle were observed. Amongst the respondents, there were registered and non-registered farmers. In addition to purposive sampling, the snowball sampling technique was also used to reach other smallholder cattle farmers. The Department of Agriculture, Land Reform and Rural Development assisted with the list of the registered farmers and snowball sampling was employed to acquire the other group.

Purposive sampling is a non-probability sampling technique, and the respondents were selected based on their willingness and availability to participate in the study. Non-probability sampling is a sampling technique in which the researcher selects participants based on the subjective judgment of the research rather than random selection, and not all members of the population have a chance to participate in the study unlike probability sampling, where each member of the population has a known chance of being selected (Bhat, 2019).

3.5 Community entry

The community entry procedure is a crucial phase that requires careful planning and execution to establish meaningful and collaborative relationships with the target community. To build genuine and cooperative ties with the target community, the community entry procedure is an essential step that needs to be carefully planned and carried out. The University of Venda Research Ethics Committee (UNIVEN REC) issued an ethics certificate, Ethical clearance no: FSEA/23/IRD/09/0909 (Appendix 1) that was used to apply for permission from all the responsible authorities of the selected villages, the Department of Agriculture, Land and Rural Development, and

the Local Traditional Council. The purpose of the study was explained fully to all these authorities. Once this permission was granted, informed consent and voluntary participation were sought from the participants before conducting the study. The researcher first introduced herself to the community leaders and members courteously and openly. the participants were provided with a detailed explanation of the research purposes, processes, and rights of participants in the local language to ensure clear understanding. Sessions of orientation were held to acquaint the community with the objectives, procedures, and possible advantages of the research.

3.6 Data collection

Quantitative data was collected through visual observation. Observation of pin codes and FAMACHA was used to evaluate the body condition of cattle using the body scoring chart that consisted of non-numerical aspects (Appendix 2). The FAMACHA chart consisting of five colour-coded categories that accurately matched the cattle's eyelid colour to the correct score. A semi-structured interview guide (Appendix 3) was used to collect the farmers' perceptions of water scarcity, cases, and effects of water scarcity on cattle production. The FAMACHA was handled using a head gate to safely contain the animal.

Gill (2008) define a semi-structured interview as a qualitative method of inquiry that combines a pre-determined set of open questions with the opportunity for the interviewer to explore themes or responses further. The semi structured interview does not limit respondents to set a pre-determined answer. To gather quantitative information from respondents, a questionnaire was employed as the data collection instrument, and a transect walk was employed to count the sources of water for cattle. By employing a questionnaire to gather the data, quantitative information may be controlled and logically organised for analysis. (Secucu & Maslaka, 2020). Transect walks allowed the researcher to observe water sources while collecting data in the study areas. According to Mwale (2018), transect walks are spatial observations of a community or place. Khoa *et al.* (2023) define data collection as the process of gathering and measuring information on targeted variables in an established system, which then enables one to answer relevant questions and evaluate outcomes. Data collection consists of components of research in all fields of study including physical and social (Pandey & Pandey, 2021).

3.7 Data analysis

Data analysis is a process of inspecting, cleansing, transforming, and handling data to discover useful information, inform conclusions, and support decision-making (Calin 2020). Thematic Network Analysis (TNA) was used to analyse qualitative data.

Thematic analysis is particularly suitable to questions related to people's perceptions, views, and experiences and involves identifying common themes (topics, ideas, and patterns) that come up repeatedly in a dataset (Braun & Clarke, 2006). All of the recorded interviews were transcribed onto a Word document. Atlas-ti 8, version 24.1.0 software was used to perform thematic network analysis. Quantitative data was analysed using IBM Statistical Package for Social Sciences (SPSS) version 29. Descriptive statistics, cross-tabulations, and correlation were computed. Descriptive and cross-tabulations were used to analyse the categorical variables and correlation was employed to determine if there is an association or not between walking distance and the body condition of a cattle.

3.8 Ethical considerations

The University of Venda Research Ethics Committee (UNIVEN REC) was consulted to obtain permission to conduct the study. Since the research used humans and animals as its subjects the UNIVEN REC ensured that, according to the methodologies of the research, subjects are not going to be harmed or exposed to any harmful circumstance in any way. The UNIVEN REC certificate (Appendix 1), informed consent form (Appendix 4), and letter of authority were used to apply for permission from all the responsible authorities of the selected villages. All the authorities received a thorough explanation of the study's purpose.

Participation in the study was voluntary. Participants had the right to stop participating in this research. Privacy was kept (no name or other identification was disclosed), rights of the participants were observed. The data which was collected was used for educational purposes only. No personal information was used during the discussion of the research. All personal data was removed when analysing the data.

CHAPTER 4: ESTABLISHING FARMER'S PERCEPTIONS OF WATER SCARCITY FOR CATTLE PRODUCTION IN SMALLHOLDER FARMING

Abstract

In South Africa, resource-limited farmers are likely to suffer water scarcity as they do not have adequate and reliable coping strategies. Despite the pivotal role cattle play in smallholder farming systems, particularly in rural economies, where they serve as a key asset for both livelihood and economic stability, they are adversely affected by water scarcity. The study established the farmers' perceptions of water scarcity for cattle production in smallholder farming. Employing a qualitative approach the research aimed to understand different perceptions of the smallholder cattle farmers in Tshikuwi and Tshirolwe. A semi-structured interview guide was used to collect the data. The results revealed the demographic characteristics of the farming population, indicating the predominance of middle-aged (50%) and male farmers (68.33%). Salary was the popular source of income, accounting for 40%, while grants are the second most common source, comprising (20%). Furthermore, a large percentage of smallholder cattle farmers in the two communities possess formal education to some degree and only 6.67% have no education. Smallholder cattle ownership ranges from 3 – 43 and most people appear to own between 10 and 30 cattle. The finding further revealed that water scarcity is perceived by farmers as a lack or shortage of water, reduction of fresh water and a major obstacle to cattle farming, affecting productivity, cattle health, and long-term sustainability. The study revealed that smallholder cattle farmers primarily relied on natural water sources such as rivers and streams, with a significant reliance on boreholes. Despite facing these challenges, farmers demonstrate resilience through various coping strategies.

Keywords: Demographic factors, coping strategies, perceptions.

4.1 Introduction

In Sub-Saharan Africa, 75 % of the population lives in remote areas and is thus faced with challenges of water scarcity (Global Economy, 2025). South Africa is a semi-arid country and is known for extended dry and wet conditions that create extreme temporal and spatial availability of water (Matimolane *et al.*, 2024). Water scarcity has been made worse in many places by climate change and unpredictable rainfall patterns, which have detrimental effects on livestock and farming. Lack of water is a key obstacle to cattle farming. Smallholder farmers' perceptions of water scarcity in cattle production are determined by the immediate challenges they face regularly. For smallholder farmers, water scarcity is becoming a more serious problem, especially in areas where producing cattle is a major source of livelihood.

Cattle play a significant role in smallholder farming systems, contributing significantly to the economic and social life. Cattle are a valuable source of revenue through commercial milk, meat, and other by-products such as hides and manure (Havard, 2017). Moreover, in most rural communities, cattle serve as draught power, enabling land cultivation and minimising the use of costly machinery (Havard, 2017). Besides their economic importance, cattle are also socially and culturally valuable in various societies, with the animals featured in ceremonies and being utilised as a means of wealth conservation (Havard, 2017). Therefore, cattle serve a multipurpose function in smallholder production systems, enhancing economic resilience along with the dietary security of rural households. It is, thus, crucial to establish the farmer's perception of water scarcity in cattle production.

Insufficient water provision may lead to reduced cattle productivity and increase the risk of cattle mortality from dehydration and starvation (Nguyen *et al.*, 2020). Moreover, water scarcity is capable of weakening cattle's immune systems, predisposing them to illnesses and reducing overall cattle health (Ochieng *et al.*, 2019). Mekonnen *et al.* (2021) emphasize that farmers who recognize the severity of water scarcity are more likely to adopt adaptive practices. The effects of water scarcity on cattle production are especially significant for smallholder farmers, who frequently lack access to resources and facilities (O'Mara, 2020). For example, in sub-Saharan Africa, areas such as South Africa and Namibia have faced increased difficulties because of frequent droughts that drastically cut down on the amount of water available for farms and cattle (Dube,

2017). Yet, cattle have a pivotal role to play in rural economies. Understanding the perception of water scarcity by smallholder cattle farmers is crucial for developing effective strategies to address the challenges they face. Smallholder farmers' perceptions directly influence their coping strategies. Smallholder farmers need to develop a clear understanding of how water scarcity affects cattle production to implement effective strategies and better tackle the challenges they encounter due to water scarcity.

4.2 Methodology

The study used a semi-structured interview guide to understand the farmers' perception of water scarcity, cattle per household, and the sources of water. The results are presented below. A detailed description of the methodology is presented in Chapter 3.

4.3 Results

The findings are logically presented, commencing from the demography, followed by water sources and cattle ownership, and ending with the perception of farmers to water scarcity. The variables were critical to build up towards the perceptions as they influence farmers' perception of water scarcity and its effects on cattle as well as subsequent coping strategies.

4.3.1 Demographic distribution of the study respondents

4.3.1.1 Gender representation

As shown in Table 4.1 below, gender representation includes both females and males. There are 19 females out of a total of 60 participants. This accounts for 31.67% of the total. As a result, the majority of participants in this sample were male, accounting for 68.33% of the total. Although women are increasingly becoming involved in agriculture, the historical and cultural roots of cattle farming are dominated by men.

Table 4. 1: Demographic distribution of the study respondents

<i>Variable</i>	<i>Frequency</i>	<i>Percentage (%)</i>
Gender		
Female	19	31.67
Male	41	68.33
Total	60	100
Age		
18-35	14	23.33
36-60	30	50
60	16	26.67
Total	60	100
Source of Income		
Rental Income	1	1.67
Self-employed	3	5
Wages	4	6.67
Pension	8	13.33
Unemployed	8	13.33
Grant	12	20
Salary	24	40
Total	60	100
Education Level		
No education	4	6.67
Honours	5	8.33
Matric	6	10
Diploma	7	11.67
Degree	11	18.33
Secondary	12	20
Primary	15	25
Total	60	100%

4.3.1.2 Age distribution

Table 4.1 depicts the age distribution of the research participants. The highest share of the sample, 50%, is between the ages of 36 and 60. The second largest group is individuals aged 60 and above, accounting for 26.67% of the sample. The youngest group, aged 18 to 35, accounts for 23.33% of the total. This shows that the sample is primarily middle-aged, with a sizeable proportion of older people and a lower representation from younger age groups. The distribution shows a fair mixture of people being middle-aged or older engaging in smallholder cattle farming.

4.3.1.3 Source of income

Table 4.1 shows sources of income. Salary is the popular source of income for individuals, accounting for 40%. Grants are the second most common source, comprising 20% of the sample. Other important sources include pensions; many smallholder farmers rely on grants and pensions to supplement their income. Wages and self-employment are less common. The least prevalent source is rental income, accounting for only 1.67% of the sample. This distribution indicates that salaries and grants are the predominant sources of income, whereas pensions and self-employment are underrepresented.

4.3.1.4 Educational level

Table 4.1 shows the educational levels of smallholder cattle farmers. The majority (25%) attained primary education. Matric holders account for 16.67% of the sample, whereas degree holders account for 20%. A lesser fraction of people has Honours, whereas only 6.67% have no education. This distribution shows that the majority of people have attended primary school or secondary school or acquired a diploma, with fewer holding higher qualifications such as degrees or Honours. The presence of people who have no schooling demonstrates a minor but significant disparity in educational achievement within the group. Only a small portion of the participants lack formal education. This implies that a large percentage of smallholder cattle farmers in the two communities possess formal education to some degree, which can enhance their capacity to adapt easily to coping strategies and understand the content of the study.

4.3.2 Cattle ownership

Figure 4.1 shows the number of cattle owned by the interviewed farmers. Cattle ownership ranges from 3 - 43. Both villages had the same range of 6–10 and 11–15, per the data shown in Figure 4.1. The largest number of households, ranging from 6–10 and 11–15, are found in Tshirolwe. Some households own between 4 and 6 cattle, while others own 33, 37, or 42. The distribution indicates that the majority of smallholder farmers in this category own an average amount of cattle, with a skew of extremely few or many cattle. With a few exceptions on either side, overall, most people appear to own between 10 and 30 cattle.

4.3.3 Source of water for smallholder cattle farmers

Table 4.2 shows sources of water for smallholder cattle farmers. The participants indicated that they currently depend on rivers/ streams, boreholes, and municipality taps to provide water for their cattle. Streams and rivers are the most often used water sources, making up 50%, followed by boreholes (36.67%), and municipal taps (13.33%). Despite being less common than streams and rivers, boreholes nonetheless make up a sizable fraction, indicating their significance in places where natural water sources are unreliable or scarce. The low usage of municipal tap water emphasises its limited application in cattle farming and its limited supply. The reliance of agricultural operations on self-managed and natural water sources is generally highlighted in the study. Below are the perceptions of farmers on water scarcity and its effects on cattle production.

4.3.4 Farmers' perception of water scarcity for cattle production

Farmers were also asked to share their opinions on how they view water scarcity (Figure 4.2). In the discussion, it became clear that farmers perceive water scarcity as a major threat to their cattle production. *Water scarcity is a growing concern among farmers, triggered by variable rainfall patterns, extended dry spells, and a reduction in freshwater availability.*

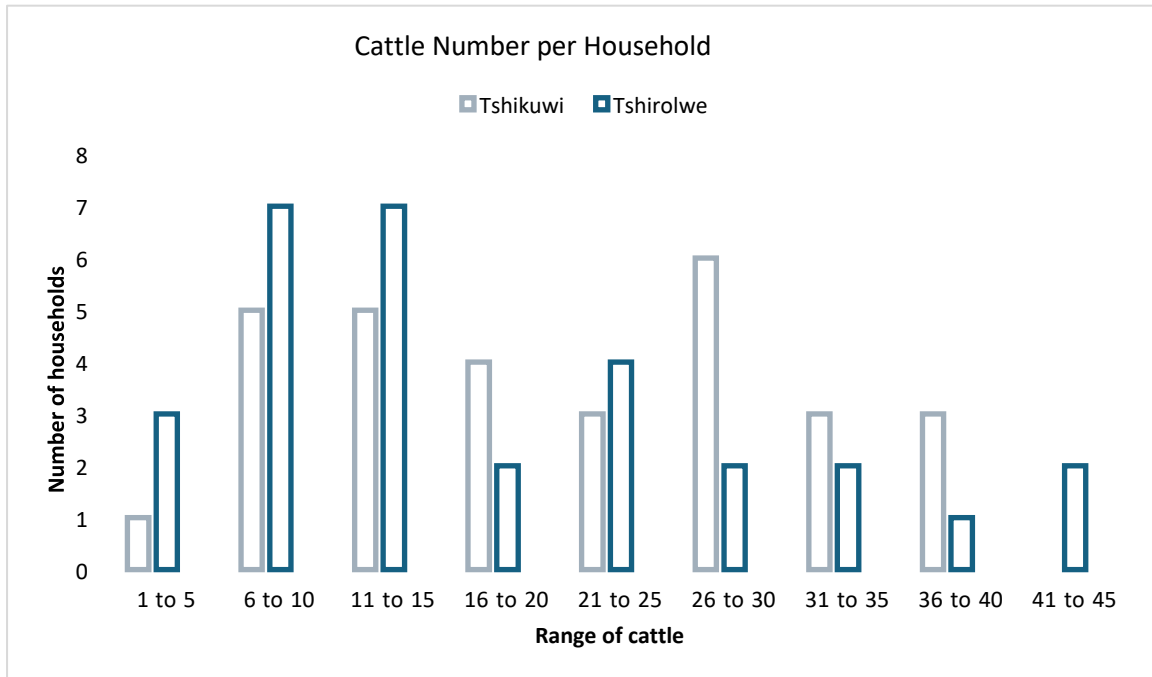


Figure 4. 1: Cattle owned by smallholder cattle farmers per household in Tshikuwi and Tshirolwe villages

Table 4. 2: Type of water source used by farmers

Water Source	Frequency	Percentage (%)
Municipal tap	8	13.33
Borehole	22	36.67
Streams/Rivers	30	50
Total	60	100

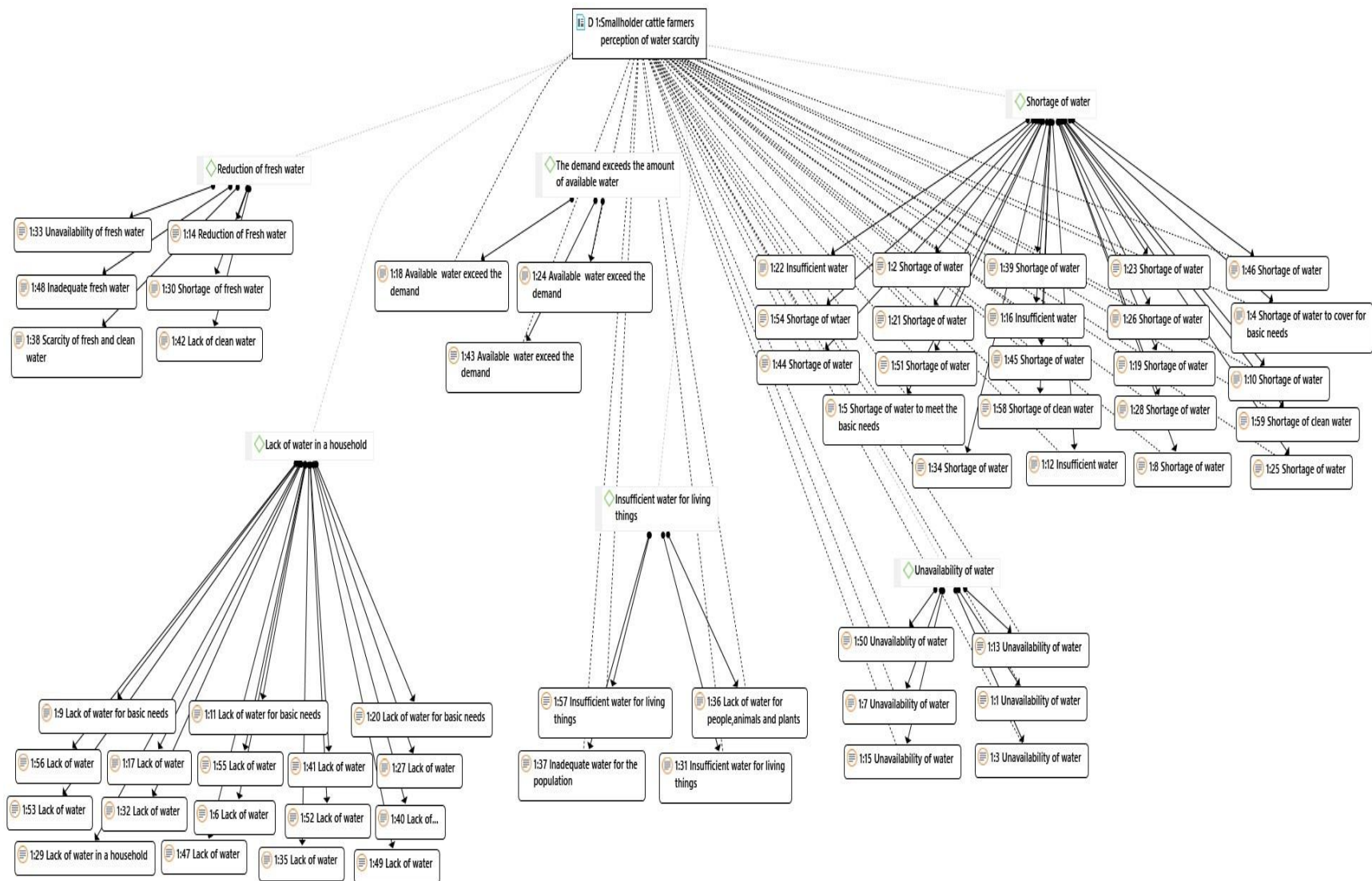


Figure 4. 2: Farmers' perceptions of water scarcity for cattle production

Figure 4.2 shows that respondents have different ways in which they perceive water scarcity. Many of the smallholder cattle farmers perceive water scarcity as a lack or shortage of water for cattle farming, reduction of fresh water, and the demand exceeding the amount of available water. The farmers indicated that unreliable access to water is a growing concern, and it lowers production.

Furthermore, the perception of water scarcity is linked to broader worries about the sustainability of cattle farming in the face of climate change, with some farmers expressing uncertainty about future water availability and its impact on their ability to maintain cattle production over time.

4.4 Discussion

The data showed that men constituted most of the sample, reflecting broader socioeconomic patterns. Mashamba (2023) indicates that cattle farming in Limpopo, South Africa, is predominantly male-dominated due to traditional gender roles that assign men the primary responsibility for livestock management. It focuses on the organisation of society rather than individual traits (Riley, 2019). The over representation of middle-aged adults and the comparatively low proportion of younger participants indicates that the agricultural community is ageing, which could have repercussions for the future of smallholder cattle farming. In order to encourage and assist younger generations in smallholder cattle farming, this issue can be resolved by offering financial incentives and training courses.

According to DAFF (2017), smallholder cattle farmers' dependence on government programs like social grants and pensions indicates financial limitations that prevent them from investing in necessary infrastructure like water tanks and boreholes, which also hinders the sustainability and expansion of their farming operations. Education, particularly in rural areas, is key as it dictates the ability of farmers to adopt coping strategies and adapt to pressure (Mekonnen *et al.*, 2021).

The study's findings show that the majority of the farmers own an average of 10 – 30 cattle. Smallholder cattle farmers usually possess fewer cattle than largescale commercial farmers for several reasons, such as low financial resources and limited

access to resources (Ouma *et al.*, 2019). Smallholder cattle production is at the heart of rural economies, with cattle embodying not only a source of income in the form of milk and meat but also social and cultural value, particularly in traditional societies (Havard, 2017). The economic value of cattle as a means of survival and as a means of investment and wealth storage also emphasises the necessity to cope with water scarcity. Livestock rearing as a livelihood option cannot persist without adequate water, and the resilience of farmers is questioned. The study's findings show that farmers are flexible through expanding their water sources and adapting to coping strategies, even if they still depend on natural water supplies. To protect cattle production, however, more resilient and sustainable solutions are required, as water scarcity is still seen as the biggest danger to cattle farming (Nguyen *et al.*, 2020).

The results also show that smallholder cattle farmers primarily utilise natural water sources such as rivers, streams and boreholes. While these water sources are crucial, their availability is not something that can be depended on, particularly where water scarcity is already a problem. That only a few farmers are supported by municipal taps reflects the small role played by formal water supply infrastructure in these rural towns, validating the need for local water management interventions (DAFF, 2017).

The findings indicate that smallholder farmers perceive water scarcity primarily as a significant shortage or lack of water needed for cattle farming. This view is based on everyday experiences and overall environmental concerns like climate change and the uncertainty of water supplies. The farmers in the study were more concerned about the future availability of water, as they were worried that changing and declining freshwater resources would compromise their ability to keep their cattle in the long term. As Mekonnen *et al.* (2021) note, farmers who recognise the severity of water shortage are more likely to implement adaptation measures, highlighting the necessity to foster awareness and support of adaptive water coping strategies. In addition, improving access to secure and sustainable sources of water, either through infrastructure or improved management of natural water sources, will be key to securing the long-term sustainability of smallholder cattle farming in South Africa.

4.5 Conclusion

Farmers perceive water scarcity as more than just a water shortage, it is also an increasing threat to cattle health, productivity, and long-term economic stability. While they display resilience through diverse strategies for coping such as changing water sources. Given the significant role of cattle in smallholder livelihoods and the rural economy, mitigating water scarcity is key to ensuring the sustainability of cattle farming in the face of climate change and environmental stresses. This could include improving local water distribution systems, developing coping strategies, and raising farmers' understanding of climate change's effects. This allows smallholder farmers to better protect their livelihoods and preserve the long-term viability of cattle farming in rural communities.

CHAPTER 5: THE EFFECTS OF DISTANCE TO WATER SOURCE ON BODY CONDITION AND HEALTH STATUS OF CATTLE

Abstract

Access to water is an important aspect of cattle health, particularly in smallholder farming systems. Water shortage is a crucial and diverse problem that has an impact on the development, lives, and health of millions of people. South African smallholder cattle farmers are impacted by water scarcity and must overcome physical or economic obstacles to obtain enough clean, safe water. The study investigates the effects of walking distances to water sources on the body condition and health status of cattle in smallholder farming systems. Using a combination of a questionnaire and observational approaches, the study investigates changes in behaviour, reduced body condition, grazing patterns, reduced water intake, and overall body condition of cattle in relation to distance to water sources. The study used a scatter plot to determine if there was a correlation between the distance (km) and the body condition and health status of the cattle. The findings showed that bucks exhibit low correlation ($r^2 = 0.4903$) and the steepest fall (slope = -0.6779), indicating greater variability in their BCS as distance increases. The findings further show a negative linear trend of both distance and FAMACHA, which does show a sharper decline (slope = -1.0606), indicating that as distance increases, their FAMACHA scores decrease more significantly. The study also indicates a relationship between water cleanliness ratings and institutional support. The respondents who rated water cleanliness as Good were more likely to report receiving assistance (44.12%) than those who ranked it as Fair (20.69%) or Bad (18.18%). The findings of the study revealed that when the walking distances increase, the cattle body conditions decrease. The findings underscore the need for coping strategies to reduce walking distances and improve access to water for smallholder farmers to sustain good cattle productivity and health.

Keywords: Body condition, distance, health status, water source.

5.1 Introduction

Water is essential to cattle, particularly in body temperature maintenance, digestion, and energy balance. Cattle must conduct simple functions such as grazing, lactation, and growth (Nakajima & Yayota, 2019). Cattle's reduced water intake affects grazing, processing of nutrients, and keeping body condition at a peak level. With inadequate water, cattle are susceptible to dehydration, starvation, and overall health decline. It is an established fact that cattle without routine and easy access to water might experience increased stress, fatigue, and low energy levels (Aubé, 2022).

Distance to the water point also affects cattle productivity. Cattle that have to walk far for water not only experience a reduction in body condition but also a reduction in productivity in terms of milk yields, weight gains, and reproduction. Erasmus (2021) observed that additional energy expended on walking long distances takes away the energy from other functions of necessity, such as growth, reproduction, and lactation.

The body condition of cattle is directly related to the distance travelled to a water source. Long distances covered by cattle to reach sources of water can lead to fatigue, which weakens the ability of the cattle to graze, draining away energy reserves and, as a result, lower body condition (Nguhiu-Mwangi, 2023). Studies have shown that when cattle must travel long distances in a quest for water, they lose a significant amount of energy that would otherwise be utilised in grazing or body weight gain (Bacéninaitė *et al.*, 2022). The loss of these energy reserves tends to result in weight loss and poor body condition, as the cattle become thinner and more prone to illness. In some cases, mortality could occur within days. Therefore, determining the effects of distance to water sources on the body condition and health status of cattle is important to maintain productive cattle.

5.2 Methodology

The study used a questionnaire and observation to determine the effects of distance to water sources on the body condition and health status of cattle. A detailed description of the methodology is presented in Chapter 3. The results are presented below.

5.3 Results

The findings in this chapter commenced with the effects of distance to the water source on the body condition, followed by the impact of walking distance on body condition, correlation analysis between the distance that cattle have to travel to access the water source and their body condition, the cleanliness of water consumed by cattle and institutional support for smallholders' cattle farmers.

5.3.1 Effects of distance to water source on body condition

The smallholder farmers commented on the effect of distance to the water source on what they witnessed occurring with their cattle. According to Table 5.1, 35% (21 out of 60 responses) of the respondents identified behavioural change as the most common result of walking further to water sources. The farmers are not pleased with the way the cattle behave due to distance. *"When cattle have to travel far just to get water, you can really see their behaviour change. They get more restless, sometimes even a bit aggressive, and they don't seem to interact with each other as much. You can tell it's not good for them—it affects their well-being and even how productive they are."* Adopting coping strategies for maintaining healthy and productive cattle can be a preferable alternative since increased stress is frequently a direct reaction to stress and exhaustion brought on by the extra energy needed to travel long distances.

Table 5.1 shows that the second most often stated effect, accounting for 25% (15 out of 60 replies), is reduced body condition. The energy required for other vital processes like grazing, production, or weight increase may be diminished as a result of longer walking distances to water sources. Smallholder cattle farmers are concerned about this effect because it may result in decreased productivity and financial losses.

"Reduced body weight means more money coming out from our pockets". Overexerting themselves, walking can also wear down cattle, which reduces their ability to use the water and feed supplies that are available.

Table 5. 1: Effects of walking distance to water source on cattle

Effects of walking distance	Frequency	Percentage (%)
Reduced water consumption	10	16.67%
Grazing patterns	14	23.33%
Reduced body condition	15	25%
Behavioural change	21	35%
Total	60	100%

The data also showed how walking distance affects grazing patterns at (23.33%) and reduced water intake at (16.67%). Reduced grazing duration or changed forage behaviour are examples of changes in grazing patterns that occur when cattle put water access ahead of food. This can further lower output and result in poor nutrition. Reduced water intake is also a serious problem because it can result in dehydration and related health hazards, even though it is less commonly reported. This response does not completely offset the adverse effects of dehydration, and the stress of long-distance movement can further decrease their inclination to drink at regular intervals. With all the effects considered, the data emphasises the necessity of effective coping strategies to lessen the negative impacts of long travelling distances on the productivity and health of cattle.

5.3.2 Impact of walking distance on body cattle condition

Some of the smallholder cattle farmers indicated that they are not accurate about the distance their cattle travel to the water sources, but they can approximate a close range. Figure 5.1 shows the correlation between the distance walked to a water source and the cattle's body condition, with scores ranging from 1 (very thin) to 5 (Obese). The study noted that with every increase in walking distance, the body condition of the cattle deteriorated. Increased walking distances to access water result in greater physical strain, causing a decline in the cattle's overall body condition.

The body condition score of cattle was determined through visual assessment and observation the backbone, hips, ribs, tail head, and body outline. For the three categories of Buck, Doe, and Weaner, the scatter plot displays the correlation between Body Condition Score (BCS) and Distance (km). Every category exhibits a negative linear trend, meaning that the BCS decreases with increasing distance. The strength of these associations is indicated by the regression equations and r^2 values. Bucks exhibit low correlation ($r^2 = 0.4903$) and the steepest fall (slope = -0.6779), indicating greater variability in their BCS as distance increases. Does indicate a steady trend with a strong correlation ($r^2 = 0.9732$) and a mild drop (slope = -0.4106). The strongest link ($r^2 = 0.9199$) is maintained by weaners, who show the least drop (slope = 0.2375). According to these findings, BCS is significantly impacted by distance, with weaners being the least influenced and bucks the most.

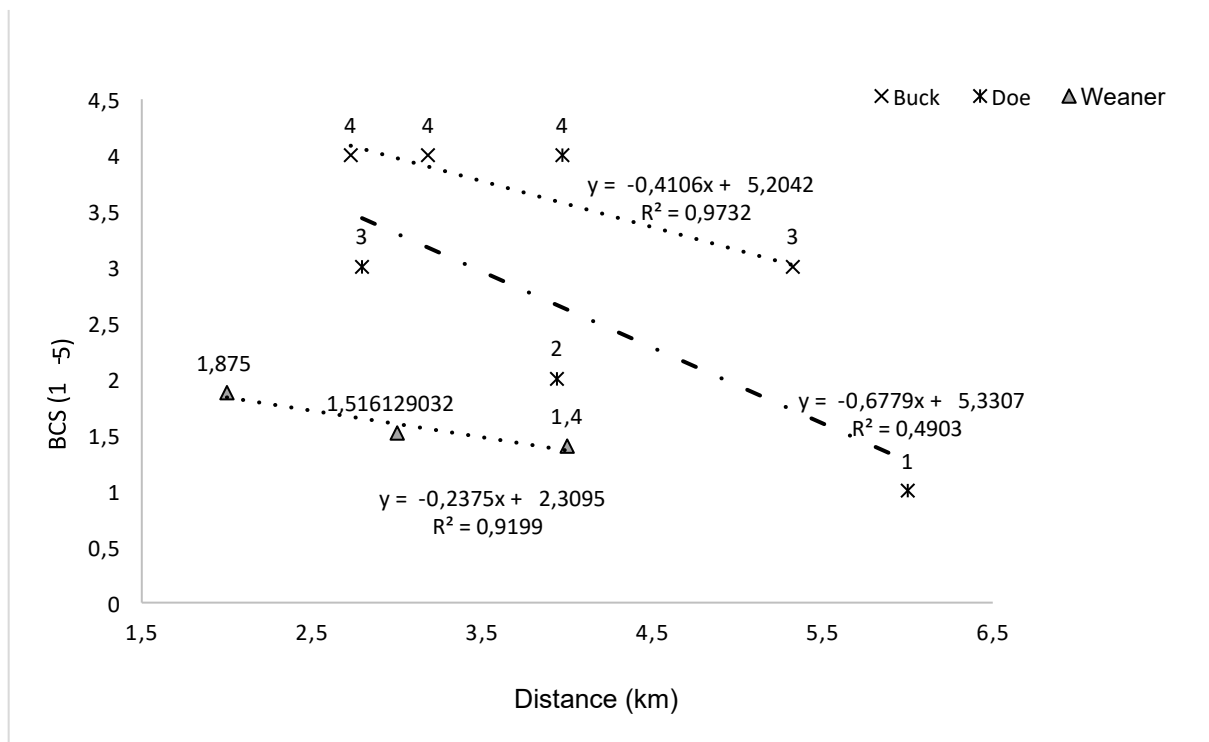


Figure 5 1: Impact of distance on the body score condition (bcs)

5.3.3 Impact of walking distance and health status (Famacha)

The FAMACHA score was obtained by observing the colour of the lower eyelid of cattle. The mucous membranes were categorised into five categories as stated in the FAMACHA eye chart. Score 1 indicates Great while score 5 indicates bad. The scatter Figure 5.2 shows how distance (km) and FAMACHA scores (1–5) relate to does and weaners. There is a negative linear trend in both categories, indicating that FAMACHA scores fall with increasing distance. Does show a sharper decline (slope = -1.0606), suggesting that as distance increases, their FAMACHA scores decrease more significantly. Conversely, weaners have a significantly lesser fall (slope = -0.0854), indicating that as distance rises, their FAMACHA scores stay mostly constant. The Does are more affected by distance than Weaners, which may indicate variations in resilience, physiological response, or vulnerability to variables influencing FAMACHA scores.

5.3.4 Cleanliness of the water consumed by cattle

According to the data, most respondents (45%) gave the water's cleanliness a Fair rating, followed by Good (40%) and Bad (15%). Even if a sizable percentage of respondents think the water quality is good, there is still an opportunity for improvement, especially for the 15% who think it is poor. The high number of "Fair" ratings indicates that many people have a moderate concern about the purity of the water (Table 5.2).

5.3.5 Institutional support for smallholder cattle farmers

Regarding institutional support, 66.67% reported receiving none, while 33.33% reported receiving assistance. Among those who got assistance, government entities were the principal providers (90%), with only a tiny proportion (10%) identifying private sponsors (Figure 5.3). This demonstrates the prominent position of government entities in assisting with water-related concerns, yet the general lack of help for the majority of respondents remains a huge concern.

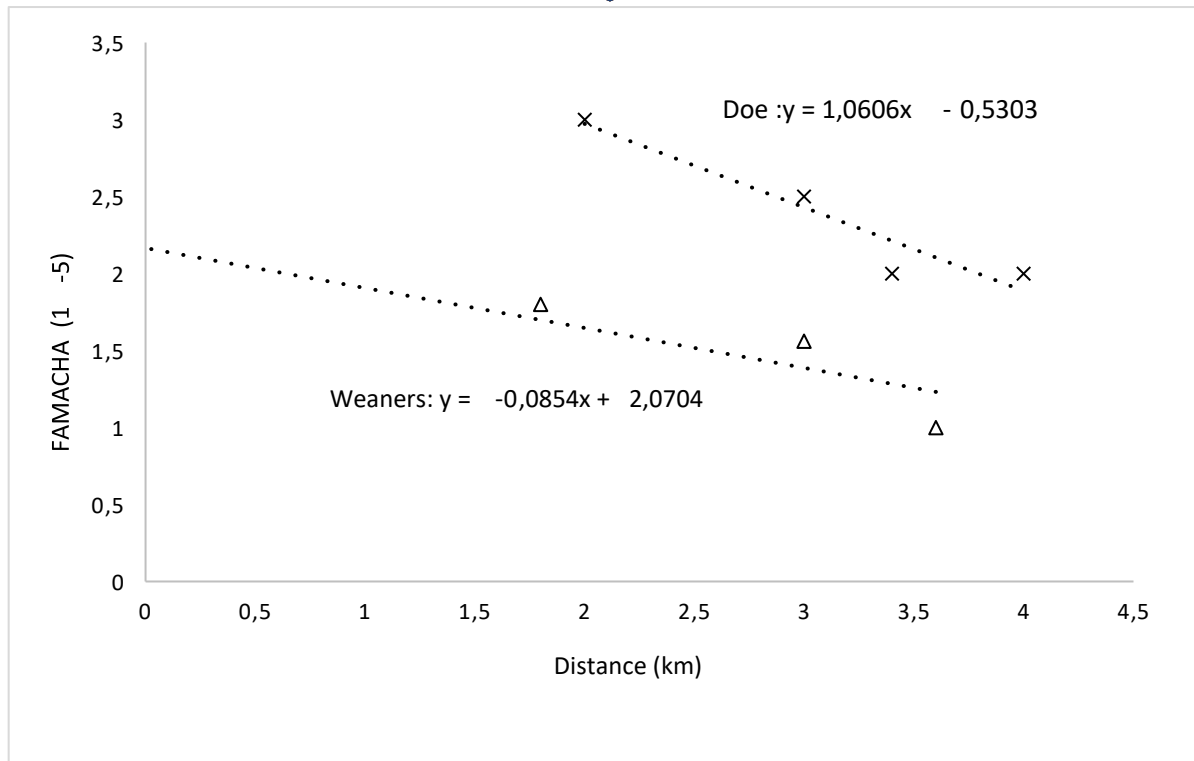


Figure 5 2: Impact of walking distance and health status (famacha)

Table 5. 2: Rate of cleanliness of water

Rate	Frequency	Percentage (%)
Bad	9	15%
Good	24	40%
Fair	27	45%
Total	60	100%

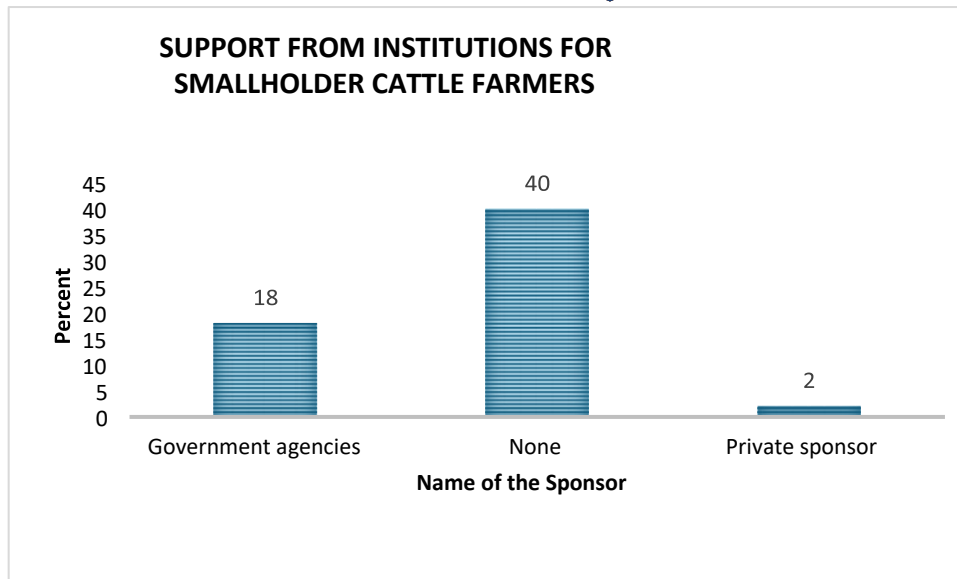


Figure 5 3: Support from institutions for smallholder cattle farmers

5.4 Discussion

The findings from this study indicate an association between the distance to a water source and the body condition of the cattle. The results show that a greater distance to water sources is associated with poorer physical conditions in cattle, as well as increased physical stress and increased stress that negatively impact the cattle's productivity and well-being. Damtew *et al.* (2018) observed that long-distance travel could cause anxiety and exhaustion, which supports the observed trends in this study. The findings from this study are consistent with Maurya (2012), whereby increased walking distance caused stress and reduced feed and water intake. A greater walking distance also resulted in much poorer body condition, with even more cattle representing thin or very thin conditions when the distance was greater. This demonstrates once more that cattle's physical condition is impacted gradually by longer distances, as postulated by Damtew *et al.* (2018). The findings showed that the farther the travel distance, the lower the number of animals with good or obese body conditions, again validating the negative impact of longer walking distances on the cattle's health. Strategies to shorten walking distances are needed to address this problem, such as placing water supplies nearer grazing areas.

The correlation emphasises the necessity of improving smallholder cattle production coping strategies and supports the importance of adapting to protect the health and productivity of cattle. Water quality, while rated generally as fair to good by the majority of respondents, means that there is room for improvement, particularly for the 14.86% of respondents who rated it as poor.

Additionally, institutional assistance to smallholder cattle farmers is not available, as over two-thirds of the respondents reported no support. Institutional assistance to smallholder cattle farmers is often lacking, limiting their access to essential resources, veterinary services, and market opportunities (Ngwenya & Khoza, 2020). A tremendous void that has to be filled is the absence of support from both the private and government sectors. Even though there is some government assistance, it is insufficient to mitigate the negative effects of inadequate water access on cattle wellbeing. A study by Musemwa *et al.* (2008) highlights that smallholder cattle farmers in South Africa face significant challenges due to inadequate support from both government and private sectors. This lack of assistance exacerbates issues such as

limited access to water resources, adversely affecting cattle health and overall productivity.

5.5 Conclusion

This study emphasises how cattle's body condition, behaviour, and general health are strongly affected by the distance they have to travel for access to water. Long walking distances and deteriorating cattle conditions have a strong association, with both behavioural and physiological effects. The study highlights the importance of placing water sources conveniently in grazing areas and encouraging cattle to adopt beneficial methods of coping to minimise stress as expanded in the chapter 6.

CHAPTER 6: SMALLHOLDER CATTLE FARMERS COPING STRATEGIES TO MANAGE WATER SCARCITY IN MAKHADO LOCAL MUNICIPALITY

Abstract

The livelihoods of many smallholder farmers depend greatly on cattle farming, especially in emerging nations where farmers frequently struggle with issues that include market volatility, resource scarcity, and climate change. In such a setting, farmers' capacity to overcome these obstacles becomes essential to their prosperity and survival. The study determined the coping strategies employed by smallholder cattle farmers to cope with water scarcity on cattle production in Makhado local municipality. Semi-structured interviews were employed to learn more about the various strategies that farmers use. Data was analysed thematically using Atlas. ti version 8 to build themes. The findings indicate that smallholder farmers predominantly rely on groundwater-based sources, such as boreholes and natural water wells, as their primary coping mechanisms. However, the study recognises the significance of municipal taps as one strategy to address water scarcity. These strategies offer a more dependable and independent water supply, especially in areas where surface water sources like rivers and streams are scarce or seasonal. Despite the availability of government water relief, these sources are less frequently utilized, highlighting a preference for self-managed solutions due to their cost-effectiveness and accessibility. The study emphasises the importance of improving water infrastructure and management practices to support the resilience of farming communities, particularly in the face of climate change.

Keywords: Cattle, coping strategy, smallholder farmers, rural community.

6.1 Introduction

Coping strategies in smallholder farming for water scarcity include various adaptive and mitigation measures to manage limited water resources effectively (Meinzen-Dick, 2014). Coping strategies for water scarcity may include changes in management, adoption of new technology, diversification of income, or adjusting herd size (Giller *et al.*, 2023). An important part of the solution to the water scarcity problem is to put people who are vulnerable at the centre 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 contributions (Kumar, 2020).

There are several success stories about adaptation among the most vulnerable. One notable success story of adaptation among vulnerable communities comes from the smallholder farmers of Burkina Faso, a developing country severely affected by water scarcity and land degradation. In response to persistent droughts and declining agricultural productivity, local farmers revived traditional water conservation techniques, such as Zai pits and stone bunds (Zougmore, 2014). While some farmers may employ traditional approaches, such as changing grazing patterns or increasing cattle mobility, others may employ more modern approaches, such as introducing drought-resistant cattle breeds or engaging in market-driven production (Ntuli, 2023).

It is important to understand the determinants of the choice of these strategies to develop effective interventions that can enhance the resilience of smallholder cattle farmers. As such, examining social, economic, and environmental contexts in which these strategies are being developed is crucial to their understanding of sustainability and effectiveness (Kumwenda *et al.*, 2021). It is vital to understand the strategies that farmers are using to determine whether they are effective for them or to suggest more suitable strategies that can be implemented.

6.2 Methodology

The study used semi-structured interviews to determine the coping strategies for water scarcity for smallholder cattle farmers. The detailed description of the methods and techniques used is fully outlined in Chapter 3. The results are presented below.

6.3 Results

This chapter only consists of the coping strategies that smallholder cattle farmers are currently adapting to cope with water scarcity for cattle production.

6.3.1 Coping strategies to water scarcity adopted by smallholder cattle farmers

Sixty participants participated in this study and were solely cattle farmers. Most of them were male (41). Figure 6.1 presents different strategies that smallholder cattle farmers use to cope with water scarcity. The coping strategies included, installed or drilled boreholes, dams, natural water wells, municipal taps, rivers, purchasing water, and rainwater harvesting. Boreholes and natural water wells were the most often reported coping mechanisms for withstanding water constraints. One farmer stated, "*Boreholes are the only way we can ensure water for our cattle throughout the year.*" This suggests that boreholes are an alternative, owing to their capacity to supply a continuous and generally dependable source of water, particularly in locations where surface water is sparse or seasonal. Boreholes are frequently viewed as long-term investments that provide independence from fluctuations in water availability in rivers, streams, or municipal systems. Their widespread use emphasises their significance in alleviating the effects of water scarcity, particularly among smallholder farmers and rural populations.

Natural water wells were the second most popular technique in the study area. One of the farmers explained, "*I rely on natural wells because they are easy to access and at no cost*" Natural water wells are commonly used because they are inexpensive and do not require much infrastructure or maintenance. However, their dependability can be jeopardized during extended droughts or locations with diminishing groundwater levels. The widespread usage of natural water wells demonstrates the reliance on groundwater resources in areas where surface water is scarce or unreliable. This reliance creates issues about the long-term viability of groundwater extraction, especially in places with overuse or environmental degradation.

Other coping strategies included collecting water from municipal taps, rivers, and rainwater. One respondent noted, "*When wells fail, I fetch water from the river, but sometimes it is dry too.*"

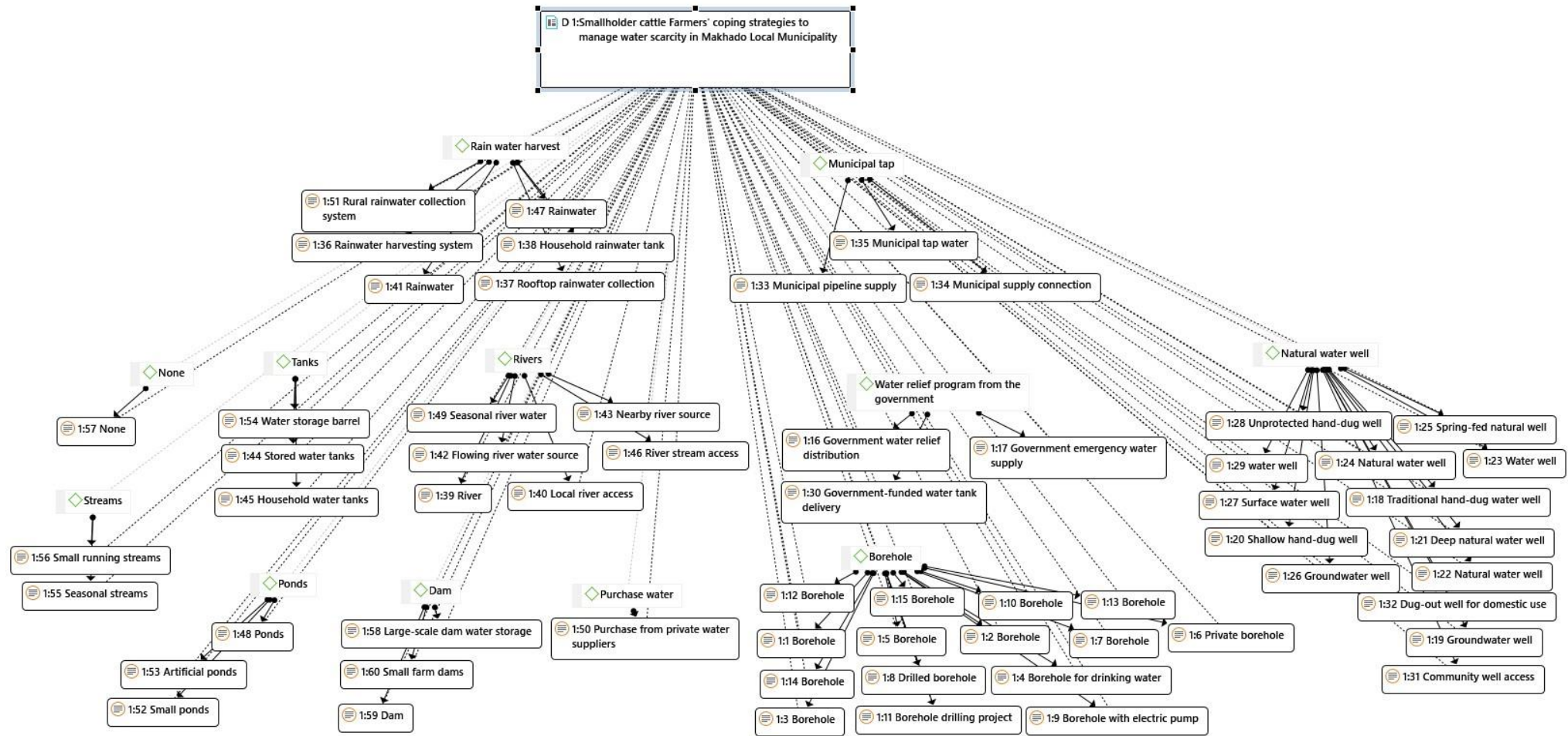


Figure 6 1: Coping strategies for water scarcity in Makhado Local Municipality

Although rainwater harvesting is a sustainable method to collect and keep rainwater for future use, its efficiency depends upon seasonal patterns of precipitation. Even though they are a natural source of water, rivers can be unpredictable in areas affected by climate change, especially during dry seasons. The low usage of municipal taps, although being as a source of water, may be attributed to their restricted accessibility. A farmer commented, *"Municipal taps are too far, and we cannot always depend on them."*

Additionally, government water relief is an example of more formal or emergency-based alternatives; nonetheless, their infrequent occurrence indicates that these options are not readily available or not relied upon. One farmer remarked, *"I wait for government water relief, but it doesn't come often enough."* Although the data shows a wide variety of coping strategies, self-managed and groundwater-based alternatives such as natural water wells and boreholes are mostly preferred. Figure 6.1 below above the coping strategies for water scarcity in Makhado Local Municipality.

6.4 Discussion

Water scarcity is described as a gap between available supply and demand for freshwater in a certain domain, based on institutional arrangements (including resource pricing and retail charges) and infrastructure conditions (Pereira et al., 2009). The findings emphasise the significance of boreholes and natural water wells as a main resource for coping with water scarcity for smallholder cattle farming.

Natural water sources are preferred and are crucial for smallholder activities, especially in rural locations where other options may be scarce. It is extremely important to keep in mind that over-extraction and continuous drought are resulting in groundwater being harder to find in South Africa (Harvard, 2020). Agricultural drainage, mining, and industrial waste contamination have also drastically lowered water quality (Harvard, 2021). Although many rural people depend on groundwater, its safety is further threatened by pollution from poor sanitation systems (Harvard, 2019). Despite possible hazards, including seasonal variations and water quality issues, the heavy reliance on rivers and streams indicates that farmers are using easily accessible and reasonably priced water sources to support cattle production.

Boreholes play a crucial role, particularly in areas with water scarcity or erratic rainfall patterns, boreholes provide a more regulated and reliable water supply. Even though surface water is more commonly used, boreholes are a valuable substitute for smallholder farmers who want a consistent supply of water, particularly in areas where surface water may be unreliable or insufficient for their requirements. Study results indicate that smallholder farmers are more dependent on natural and self-managed water sources, which offer more accessible and reasonably priced options for cattle care.

Farmers' selections of sources of water have important effects. Farmers can lessen dependence on expensive or unstable external water supply systems by prioritising natural water wells and boreholes. However, factors like water governance, infrastructure investment, and environmental circumstances affect how sustainable these decisions will be in the long run. In times of severe drought or pollution events, the continuous reliance on self-managed sources may cause concerns in the absence of institutional support and infrastructural improvements (Mwendera *et al.*, 2020).

Despite this, only three people are using the municipal tap. One potential alternative that might decrease the distance cattle must travel to obtain water is a municipal tap. A municipal tap can provide a consistent and accessible water source, reducing the distance cattle must travel and minimising energy loss (Pereira and Cordery, 2021). Tap water is often treated, ensuring better quality and reducing the risk of waterborne diseases in livestock (Praveen, 2016). Reliable municipal water access supports cattle health and productivity, especially during dry seasons when natural sources may be scarce (Van Koopen *et al.*, 2006). Integrating municipal taps into smallholder farming can enhance sustainability and resilience against water shortages (Bazaanah & Mothapo, 2023).

6.5 Conclusion

The findings of the study highlight the crucial role of groundwater-based coping strategies, such as boreholes and natural water wells, in alleviating the effects of water scarcity, particularly in rural areas and among smallholder farmers. These methods provide a reliable and independent water supply, especially where surface water is insufficient or unpredictable. The study also reveals that, despite the formal water relief programs, many smallholder farmers prefer self-managed water sources due to their

affordability and accessibility. However, the study recognises the significance of municipal taps as one strategy to address water scarcity. To ensure the long-term viability of agricultural communities, it is essential to improve access to sustainable and cost-effective water solutions such as borehole development and municipal taps. Moreover, further investment in water infrastructure and management practices is needed to address the growing challenges of water scarcity and ensure the resilience of smallholder farming communities in the face of climate change. The final chapter below synthesizes the key findings of the study to extract important recommendations for policy, practice and future research.

CHAPTER 7: GENERAL DISCUSSION, CONCLUSION AND RECOMMENDATIONS

7.1 Introduction

The chapter presents a discussion of the findings based on the study objectives. The conclusion drawn from the study findings is outlined to synthesize the results. Lastly, recommendations are given.

7.2 Discussion

The demographic distribution of the study respondents reveals key characteristics of smallholder cattle farmers in Tshikuwi and Tshirolwe villages. Gender representation indicates a male-dominated sector, reflecting the historical and cultural roots of cattle farming. Age distribution shows that the majority of farmers are between 36 and 60 years old, highlighting a generational gap in cattle farming participation. The majority of participants in a study that focused on community cattle farmers in Ga-Matlala, Limpopo Province, South Africa, were 55 years of age or older indicating that the sector is predominantly managed by older adults.; this group made up 80% of respondents in Phetole and 73.33% in Phofu communities (Monkwe *et al.*, 2023). This shows that more men than women engage in cattle farming.

Regarding income sources, salaries, and grants were the most common, suggesting a reliance on formal employment and social support. Educational attainment was varied, with most participants having at least a primary education or secondary education. Cattle ownership was widespread but varied significantly, with most farmers owning between 6 and 15 cattle, though some possessed much larger herds. Water access remained a critical issue, with 50% relying on streams and rivers, and 36.67% on boreholes, emphasising the importance of natural and self-managed water sources. These findings illustrate the socio-economic and environmental challenges shaping smallholder cattle farming in the region, A study on small-scale farmers in Limpopo Province found that social grants, including old age and child support grants, were significant income sources, highlighting a reliance on formal employment and social support (Makondo & Ross, 2024).

The first objective explored how smallholder farmers perceived water constraints and how this affected cattle production. According to the results, most farmers believed that a lack of water poses a serious threat to cattle productivity, health, and long-term financial viability. Rivers, boreholes, and municipality taps were the main water sources, with boreholes being the most often used source. The study emphasised how poor cattle health and higher costs were caused by insufficient water availability. Additionally, farmers showed resilience by using coping strategies such as grazing rotation and water storage. To create effective strategies that address water scarcity, the study highlighted how crucial it is to understand farmer perspectives. A study by Hlongwane *et al.* (2014) found that more sustainable solutions can result from integrating farmer viewpoints into water management plans. Solutions can be customised to local circumstances, such as accessible water supplies and farming methods, by actively including farmers in decision-making processes. Van Averbeké (2013) stated that farmer's knowledge of nearby water sources, like streams, boreholes, and rainwater gathering devices, is crucial for locating weak points in the water supply chain.

The relationship between cattle health parameters such as body condition scores and FAMACHA scores and the distance to water sources was assessed. According to the study, walking distance has a major negative effect on cattle bodily health; longer walks result in more fatigue, dehydration, and decreased output. Cattle have been observed to exhibit behavioural changes, such as shorter grazing periods and elevated stress levels, according to farmers. Cattle that consume water from nearby, cleaner sources also have higher general health, according to the study. With many farmers depending on self-managed solutions, institutional assistance for addressing these issues is still scarce. The results highlight the necessity of better water accessibility to maintain the production and health of cattle. A report by Thornton *et al.* (2020), indicates that fair access to water is essential for smallholder cattle farmers, especially in areas susceptible to drought. Research conducted by Bazaanah & Mothapo (2023) further highlights that having access to clean and dependable water is essential for the health and productivity of livestock.

Smallholder farmers' adaptation strategies for coping with water scarcity are the subject of the final goal. The finding revealed that the main coping strategies were natural water wells and boreholes, which offer a consistent supply of water even during

seasonal variations. Although less reliable, farmers also use river access and rainfall harvesting as coping strategies. Some people depend on government water assistance programmes, but these are few and fall short of demand. Numerous rural and underserved areas face challenges in obtaining clean water, as government initiatives have failed to adequately grow to address the requirements of these communities. As stated by the South African Water Research Commission (2020), the growth of water aid initiatives is crucial for promoting social fairness, particularly in light of the historical legacy of water disparity in South Africa. To effectively help smallholder farmers, the study emphasized the necessity of improved infrastructural development, such as the extension of municipal water supplies. For long-term sustainability, addressing water scarcity calls for both institutional and self-reliant strategies.

7.3 Conclusion

Smallholder cattle farming is being severely impacted by water scarcity, which has an impact on the general resilience of rural farming communities as well as the health and economic viability of cattle. Farmers view water scarcity as a significant problem and have implemented a number of coping mechanisms. Long walking distances to water sources still have an adverse effect, though. Self-managed strategies predominate, and institutional assistance is minimal, underscoring the necessity of legislative actions to improve water sustainability and accessibility.

7.4 Recommendations

The study recommends farmers to ensure that there is adequate water access and improve water quality; this is essential for fostering sustainable agricultural practices and improving livelihoods in areas affected by water scarcity. Addressing these recommendations will be beneficial as it will enhance the well-being and productivity of cattle.

- a) Educational initiatives ought to be established to assist smallholder farmers in enhancing their management of water resources. This encompasses instruction on techniques for water conservation.
- b) Governments and agricultural producers ought to allocate resources towards the development of infrastructure and technology that guarantees cattle access to clean and uncontaminated water supplies.

7.5 Future research work

- a) The size of cattle owned by the farmers is determined by the health of the cattle. Water is very important to support the health and lifespan of the cattle and that results in a positive contribution to the livelihood of smallholder cattle farmers. It is vital to further investigate how smallholder cattle farmer's livelihood is affected by water scarcity.
- b) The government especially at the local level, needs to come up with strategies in which they can fully support smallholder cattle farmers. It is important to investigate ways in which the government can offer support to smallholder farmers in this crisis.
- c) Additional investigation is required to assess the effectiveness of different coping strategies and their influence on the health and productivity of cattle.

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APPENDICES

Appendix A: ETHICAL CLEARANCE CERTIFICATE

ETHICS APPROVAL CERTIFICATE		RESEARCH AND INNOVATION OFFICE OF THE DIRECTOR
NAME OF RESEARCHER/INVESTIGATOR: Ms VW Siwadawada		
STAFF NO: 18000152		
PROJECT TITLE: Strategies for coping with water scarcity in smallholder farming systems in Makhado local municipality		
ETHICAL CLEARANCE NO: FSEA/23/IRD/09/0909		
SUPERVISORS/ CO-RESEARCHERS/ CO-INVESTIGATORS		
NAME	INSTITUTION & DEPARTMENT	ROLE
Prof M Manjoro	UNIVEN, Institute for Rural Development	Supervisor
Dr MA Malhaulula	UNIVEN, Institute for Rural Development	Co-supervisor
Dr MV Mkwana	UNIVEN, Institute for Rural Development	Co-supervisor
Ms VW Siwadawada	UNIVEN, Institute for Rural Development	Investigator-student
Type: Masters Research		
Risk: Minimal risk to humans, animals or the environment (Category 2)		
Approval Period: September 2024 – September 2025		
The Research Ethics Social Sciences Committee (AEBREC) approves your project as indicated above.		
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 course of the project. - Annually a number of projects may be randomly selected for an external audit. - The approval applies strictly to the protocol as stipulated in the application form. Would any changes to the protocol be deemed necessary during the course of the project, the project leader must apply for approval of these changes at the REC. Would there be deviation from the project protocol without the necessary approval of such changes, the ethics approval is immediately and automatically forfeited. - The date of approval indicates the first date that the project may be started. Would the project have to continue after the expiry date; a new application must be made to the REC and new approval received before or on the expiry date. - In the interest of ethical responsibility, the REC 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 any 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: UNIVERSITY OF VENDA, RESEARCH ETHICS COMMITTEE Date Considered: September 2024		
Name of the AEBREC Chairperson of the Committee: Prof IEJ Barnhoorn		
Signature: 		
 PRIVATE BAG 10701, THOHoyANGOU, 9801, LIMPOPO PROVINCE, SOUTH AFRICA TELEPHONE 015 950 9500 FAX 015 950 9500 "A quality driven financially sustainable, rural-based Comprehensive University"		
 UNIVERSITY OF VENDA OFFICE OF THE DIRECTOR RESEARCH AND INNOVATION 2024-09-09 Private Bag X5050 Thohoyangou 0950		

Appendix B: Data collection tool for body scoring condition

This body scoring chart seeks to evaluate the body condition of the cattle at Makhado Local Municipality with the view of determining the effects of distance to water source on cattle body and health status. The information that will be recorded will be solely used for research purposes and will be treated in a confidential manner.

1. HOUSEHOLD NO ____ OF ____

2. NUMBER OF CATTLE PER HOUSEHOLD _____

Respond below by using a cross [X] where appropriate

1. BODY SCORING CHART FOR CATTLE

Body Condition Score	Description of condition	Condition	Score
BCS 1	Very Thin	Backbone prominent, Hips and shoulders bone prominent, Ribs clearly visible, Tail-head area recessed & Skeletal body outline	
BSC 2	Thin	Backbone visible, Hips and shoulder bones visible, Ribs visible faintly, Tail-head area slightly recessed & Body outline bony	
BSC 3	Moderate	Hip bones visible faintly, Ribs generally not visible, Tail-head area not recessed & Body outline almost smooth	

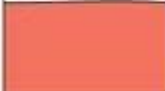
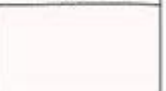
BSC 4	Good	Hip bone not visible, Ribs well covered, Tail-head area not slightly lumpy & Body outline rounded	
BSC 5	Freshly	Hip bones showing fat deposit, Ribs very well covered, Tail-head area very lumpy & Body outline bulging due to fat	

2. Pin Bones Scoring chart

Body condition score	Rear view	Score
1. Severe condition		
2. Frame obvious		
3. Frame and covering balanced		
4. Frame as visible as covering		
5. Severe over conditioning		

3. FAMACHA SYSTEM

Eye colour chart

GREAT! No Treatment	GOOD! No Treatment	QUESTIONABLE Consider Treatment	POOR Needs Treatment	DEATH! Needs Immediate Treatment
				

4. FAMACHA scoring chart

Category	Eye lid colour	Condition	Score
1	Red	Great	
2	Red-pink	Good	
3	Pink	Questionable	
4	Pink-white	Poor	
5	White	Bad	

Reflection:

.....

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Appendix C: DATA COLLECTION TOOL FOR SMALLHOLDER CATTLE FARMERS

INTERVIEW GUIDE FOR SMALLHOLDER CATTLE FARMERS

The interview guide seeks to identify strategies for coping with water scarcity in smallholder cattle farming at Makhado Local Municipality. The information that will be provided by the respondents will be solely used for research purposes and will be treated in a confidential manner. Participants are requested to provide honest answers since the correctness of responses will lead to achieving the intended goal of the study.

Welcome to this interview session.

Please respond to the question given below by using a cross [X] where appropriate.

Section A: Demographic Information of the participants

Gender

1.	Male	
2.	Female	

Age of the respondent

1.	18-35	
2.	36-60	
3.	60 +	

3. Highest level of education

.....

4. Source of income

.....

5. Average household monthly income

.....

Section B: Smallholder cattle farming, Water Scarcity and Coping Strategies

6. What is your understanding of water scarcity?

.....

7. How many cattle do you currently have?

.....

8. Have you lost cattle due to water scarcity?

.....

8.1 Economic effect and production

How many cattle died? [DEAD]	
How many cattle sold? [SOLD]	
How many slaughtered and consumed? [EATEN]	
How many disappeared? [LOST]	

9. State the water source that you use for your farm/ for cattle

1.	Borehole	
2.	Streams/ Rivers	
3.	Municipal tap	
4.	Other, specify	

10. Please indicate the number of years that you have been involved in cattle farming

.....

11. When is the scarcity predominant during the year?

.....

12. What are the effects of water scarcity on smallholder cattle farming?

Production performance	
Weight loss and development	
Health risk	
Feed production	

.....

13. How far do cattle generally have to travel to reach water?

.....

14. How many times a day do your cattle go to the water source?

.....

15. Does the distance to water change during different seasons? If yes, how?

.....

16. What are the effects of walking distance to water source on cattle?

Behavioural changes	
---------------------	--

Energy expenditure	
Grazing patterns	
Water consumption	

.....

17. How do you rate the cleanliness of the water?

1.	Good	
2.	Fair	
3.	Bad	

18. During dry seasons, do you receive support from any institutions?

Yes	No
-----	----

If yes, which agency do you receive help from?

Government agencies	
NGOs	
Other, specify	

.....

19. Which coping strategy do you use to survive with water scarcity for cattle production?

.....

20. Do you think the adaption of coping strategies can have a good impact on cattle production and smallholder farmers?

Appendix D: LETTER OF INFORMED CONSENT FORM

My name is Siwadawada Vhuhwavho Wendy. I am a student at the University of Venda doing a master's degree in Rural Development. I kindly request your participation in this research by expressing your perception on water scarcity to cattle production. The main objective of this study is to identify coping mechanisms for smallholder cattle farmers to mitigate the challenges that smallholder farmers endure due to water scarcity.

Participation is voluntary. If you feel like you cannot continue, you have the right to stop participating in this research. Your privacy will be kept (no name or other identification will be disclosed), and your rights will be observed. The data which will be collected will be used for educational purposes only.

No personal information will be used during the discussion of the research. All personal data will be removed when analysing the data. You can use your home language when answering questions.

Signature of the researcher..... Date.....

I have understood everything explained to me by the researcher. I understand and consent the researcher to include me in the study.

Name.....



Signature.....

Date.....