



Cape Peninsula  
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# **Communal based strategies for bush encroachment management in a savannah rangeland in Mafarana village in the Greater Tzaneen Local Municipality of Limpopo Province, South Africa.**

by

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Dissertation submitted in fulfilment/partial fulfilment of the requirements for the degree.

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Cape Town Campus  
December 2023

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## **DECLARATION**

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## **ABSTRACT**

The term "bush encroachment" refers to a change in the distribution of woody plants, which shifts the natural balance between the woody and herbaceous layers unfavourably. Globally, bush encroachment poses grave threats to savannah rangelands, but research indicates that this phenomenon is most prevalent in arid and semi-arid regions. Bush encroachment in Sub-Saharan Africa remains highly relevant due to its wide-ranging impact on the environment, economy, and society. Some of the key reasons for its continued relevance include but are not limited to biodiversity conservation, ecosystem services, land degradation, water resources, livestock farming, fire risk, climate change, invasive species, conservation management and ultimately the economic impact. On the other hand, the South African government has been actively involved in bush encroachment management through various policies, programs, and research initiatives. These policies aim to promote sustainable land use practices, including the control of invasive species and the restoration of degraded ecosystems. The concept is basically on alien invasive plant control and bush encroachment control. Methods such as mechanical, chemical and combination treatments are used to control and reduce the densities of woody plants.

The broader aim of this study was to investigate communal-based approach strategies for bush encroachment management in a savannah rangeland of Mafarana village in the Greater Tzaneen municipality of Limpopo Province, South Africa. The study was conducted in Mafarana village, focusing on bush encroachment management. The research was conducted using qualitative and quantitative research techniques approach, which was in a form of questionnaires, structured interviews as well as observational methods which were employed as tools for data collection. The sample size of 350 participants was determined using Slovin's formula. Validity and reliability were ensured through expert review and a pilot study with a satisfactory Cronbach's Alpha of 0.76. During the mixed methods analysis qualitative coding for thematic analysis was employed first, followed by quantitative analysis using International Business Machines- Statistical Package for the Social Sciences (IBM SPSS) version 26 for demographic and community perceptions data. Moreover, the questions not amenable to SPSS analysis were subjected to thematic analysis. The research involved a higher participation of females at 66.6% in comparison to their male counterpart, with most respondents being adults (64.8%), and 83.7% having lived in the village for over 20 years.

Findings from the study indicated that the community is aware of what *Dichrostachys cineria* (Sickle bush) is and it is considered a problem in Mafarana village. This knowledge on the plant can be associated with the elevated levels of education recorded within the community. The data on the high usage of Sickle bush also suggests that the community has had some type of indigenous knowledge on Sickle bush which has been transferred from one generation to another. Moreover, the findings of the current study indicate that the community also understands the phenomenon of bush encroachment has and its detrimental impact towards the environment, and humans.

Farmers in the community have adopted a distinct way of managing encroachment by Sickle bush which include cutting, uprooting, and burning of the plant. Although this method has proved to be effective and successful for them while waiting for government intervention, it has also said to be time consuming. Furthermore, the current study has discovered that there seem to be no government based nor community-based projects aimed at controlling or managing the problem of bush encroachment within the Mafarana community. Even if they were there, community members feel that they are not directly involved in such projects. From the results obtained in the study area it is evident that in Mafarana village, addressing bush encroachment requires a comprehensive approach. Local and provincial governments should conduct community workshops, participatory mapping, and integrate traditional practices aimed at addressing the issue. Likewise, collaboration with environmental agencies, establishment of a monitoring system, and incentive programs for successful management including controlled burning supervised by the community are vital.

## **ACKNOWLEDGEMENTS**

I extend my sincere gratitude to Mr. Maphanga T for his unwavering supervision and generous support throughout this research endeavour. His patience and words of encouragement have been invaluable, and I am truly thankful for the guidance he provided.

I would also like to express my special appreciation to Mr. Madonsela BS for his role as a co-supervisor. His sincere and valuable scientific guidance has been instrumental in shaping this research. I am deeply grateful for his assistance and acknowledge the sacrifices he has made to contribute to the success of this work.

Heartfelt thanks go to all the participants in this study. Your willingness to share knowledge and experiences has been crucial to the progress of this research, and I want to assure you that your contributions have not gone unnoticed.

Special recognition is extended to Mr. Mongwe QG for his invaluable assistance in data collection. I appreciate the dedication and effort put into supporting this research.

No words are adequate to express my indebtedness to my mother (Dr. Rakgoale MM) and my mother in-law (Ms. Ngobeni A) for their moral support, blessings, and good wishes. I owe this thesis to both as they have always stood by me and provided strength in pursuing this work. I would also like to express my appreciation to my work supervisor (Ms. Zwane NYT) for offering moral support throughout my master's studies and for granting me the time needed to concentrate on my academic endeavours.

Opinions expressed in this thesis and the conclusions arrived at, are those of the author, and are not necessarily to be attributed to the National Research Foundation.

## **DEDICATION**

I dedicate this dissertation to the memory of my late husband, Vongani Baloyi, who served as a guiding light, a source of inspiration, and a role model. He instilled in me a profound passion for learning, imparted the importance of discipline, and helped me understand the true value of life.

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## GLOSSARY

**Natural resource management (NRM)** - the sustainable and equitable management and utilization of natural resources, such as land, water, forests, wildlife, and minerals. NRM is concerned with maintaining the ecological integrity of natural resources while promoting economic, social, and cultural development (Grimble et al., 1997).

**Management strategies**- the specific actions and approaches that are employed to manage and mitigate various issues and challenges in a particular field or sector (Lockwood et al., 2010). In the context of natural resource management, management strategies could include a range of interventions aimed at addressing issues such as deforestation, soil degradation, climate change, and biodiversity loss.

**Previously disadvantaged**- any person, category of persons or community, disadvantaged by unfair discrimination before the Constitution of the Republic of South Africa, 1993 (Act No. 200 of 1993) came into operation (Sedibe et al., 2011).

**Communal-Based** – activities or organized events occurring within a localized setting. For instance, they involve the management and utilization of natural resources, which are controlled, owned, and utilized by a community or a collective of individuals who share a mutual interest or objective (Selemani, 2014).

**Community participation**- Involvement of people in community projects to solve their problems. The active involvement and engagement of individuals and groups in decision-making processes and actions that affect their lives and communities. It involves a range of activities, such as consultation, collaboration, partnership, and empowerment that aim to ensure that the voices and needs of the community are heard, understood, and incorporated into decision-making processes and actions (Selemani et al., 2014).

## LIST OF ACRONYMS

PRISMA- the Preferred Reporting Items for Systematic Reviews and Meta-Analyses

FAO- The Food and Agriculture Organization of the United Nations

GIS- Geographical Information System

CSA- Conservation South Africa

K2C- Kruger to Canyons Biosphere Region

DEFF-The Department of Environment, Forestry, and Fisheries

# CHAPTER ONE: INTRODUCTION

## 1.1 Introduction

Savannah rangelands are defined as an area of natural vegetation which is predominantly grass, grass-like plants, forbs, and shrubs suitable for wildlife and livestock grazing (Hudak, 1999; James et al., 2003). According to Adedibu et al. (2001), savannah is a mixed woodland-grassland ecosystem characterized by the shrubs being sufficiently widely spaced so that the canopy does not close, allowing enough light to reach the ground to support an unbroken herbaceous layer composed primarily of grasses. These rangelands are important and cover approximately 51% of the earth surface and 33% of South Africa's land area (Mokgosi, 2018). Globally, bush encroachment poses grave threats to savannah rangelands, but research indicates that this phenomenon is mostly prevalent in arid and semi-arid regions (Ward, 2005; Symeonakis et al., 2016; Higginbottom et al., 2018). This phenomenon has been impacting natural savannah rangelands for over fifty years. The term "bush encroachment" refers to a change in the distribution of woody plants, which shifts the natural balance between the woody and herbaceous layers unfavourably (Archer et al., 2017).

In a study conducted by Yassin (2019), bush encroachment is considered as a major threat, challenge, and a leading cause to savannah rangeland degradation. The encroachment of woody vegetation in these rangelands is a result of several factors, including overgrazing, climate change, and human activities. The invasion of these woody species into previously open grasslands has serious implications for the ecological and socio-economic sustainability of these areas. Ecologically, bush encroachment can lead to changes in soil nutrient and nitrogen-poor environments are more prone to bush encroachment and this affects the biodiversity in a particular region (Archer, 2010). Socio-ecologically, bush encroachment can reduce the amount of grazing land available for livestock, which can in turn reduce the productivity and profitability of livestock (Mangani et al, 2020).

Grazing capacity on South African savannah rangelands is estimated to be reduced by 50 percent due to bush encroachment, according to Symeonakis et al. (2016). Approximately 17 percent of South African savannah rangelands are threatened by bush encroachment. There is a serious conflict between protected (commercial) and

communal areas in South Africa over rangeland degradation. According to Ward (2005) and Dougill et al. (2016), in Southern Africa bush encroachment is mainly observed in the grasslands and savannah rangelands. Furthermore, Kraaij and Ward (2006), stated that the dominant species responsible for this encroachment are: *Acacia mellifera*, *Acacia reficiens*, *Acacia tortilis*, *Acacia nilotica*, *Acacia karoo*, *Dichrostachys cinera*, *Termanalia sericia*, *Rhigozum trichotomum* and *Tarchonanthus camphoratus*, particularly in South Africa. Savannah rangeland degradation through bush encroachment is affecting large areas of South Africa and desertification has also been added as one of the causes of land degradation. One of the most common encroachment species is the *Dichrostachys cinera* which literature has classified as the most aggressive species in South Africa in terms of the rate of encroachment (Snyman, 2009; Snyman, 2013; Sibanda et al., 2016; Thondhlana & Muchapondwa, 2014).

*Dichrostachys cinerea*, commonly known as Sickle bush is a species of flowering plant in the family Fabaceae (Mangena et al, 2014). It is native to Africa and is commonly found in various regions across the continent, including savannas, grasslands, and woodlands. Sickle bush is known by several other names, including Chinese lantern tree, Bell mimosa, and Kalahari Christmas tree. This semi-deciduous shrub or small tree can reach a height of 5 to 7 meters and has distinctive sickle-shaped pods, which give it its common name. The leaves are bipinnate, with small leaflets that are arranged in a feathery pattern. The flowers are small, pale yellow to cream-coloured, and are arranged in dense cylindrical spikes (Bussa & Shibru, 2020; Fernández et al., 2015). Sickle bush is well adapted to drought conditions and can tolerate a wide range of soil types. It has nitrogen-fixing properties, which contribute to its ability to grow in nutrient-poor soils. The plant provides various ecological benefits, such as provision of food and shelter for wildlife, including birds and insects (Fernández et al., 2015; Fernández et al., 2020). In terms of medicinal uses, Sickle bush has a long history of traditional use in African folk medicine (Steenkamp, 2003; Chauke et al., 2015). Different parts of the plant, including the bark, leaves, and roots, are used to treat various ailments. It is believed to have antimicrobial, anti-inflammatory, and analgesic properties.

Several studies have been conducted which argue that local communities have a crucial role to play in managing bush encroachment, as they have traditional

knowledge and practices that can be used to control the spread of woody vegetation (Würsig & Würsig 2018; Kgosikoma et al., 2018; Bacci et al., 2018; Conradie et al., 2018; Musiwa & Palmer, 2018; Nangole & Skidmore, 2017). The study by Würsig (2018), used a participatory approach, with the local community involved in decision-making and implementation of management strategies. This was successful in reducing bush encroachment and improving rangeland productivity. Socio-economic benefits for the local communities highlighted in this study ranged from creation of employment opportunities, promotion of community involvement and ownership, and strengthened social networks. Failures of such approaches were also highlighted by Cornwall and Brock (2005). Such failures and potential challenges include the lack of inclusivity and underrepresentation of certain social groups (gender, social hierarchies, or power dynamics). Participatory process can also be influenced by power imbalances among different stakeholders. Certain individuals or groups within the community may have more influence or decision-making power, leading to their preferences dominating the process.

Management strategies for bush encroachment in Southern African rangelands have traditionally focused on top-down approaches such as government-led programs. A typical example of such approaches is the Working for Water program of the Department of Forestry, Fisheries, and the Environment. These approaches typically involve large-scale interventions driven by government departments or other centralized authorities. However, these approaches have been criticized for their limited effectiveness and lack of community involvement (Rukuni & Mhanda, 2011). Bush encroachment has reduced the grazing capacity of large areas in South African savannah rangelands, making livestock and wildlife unprofitable (Graw et al., 2017; O'Connor et al., 2007). Smit and Rethman (1992) discovered that bush encroachment in South Africa's Limpopo Province escalated over a span of 52 years, irrespective of grazing management. However, they noted a significant acceleration in encroachment in areas subject to overgrazing, particularly during the growing season.

Thus, the overall goal of the study was to determine communal based strategies for bush encroachment management in a savannah rangeland in Mafarana village in the Greater Tzaneen Local Municipality of Limpopo Province, South Africa

## 1.2 Problem statement

Bush encroachment management is a global challenge with implications for various aspects including ecology, agriculture, biodiversity, and socio-economic factors (Shikangalah & Mapani, 2020; Ayelew & Muluaem, 2018). South Africa is no exception because of factors such as the changes in fire regimes, overgrazing by livestock, and changes in rainfall patterns within the savanna vegetation structure and composition (Kgosikoma & Mogotsi, 2013). This phenomenon of encroachment is a significant environmental problem that occurs when the density of woody vegetation increases in savanna and grassland ecosystems, resulting in a decline in biodiversity, soil fertility, and plant productivity. The problem of bush encroachment is particularly acute in arid and semi-arid regions, where overgrazing, climate change, and other factors have contributed to the proliferation of woody vegetation. In communal rangelands, bush encroachment of the savanna biome poses a significant threat to the agricultural productivity, biodiversity, and livelihoods of local communities.

According to Moleele et al. (2002), woody vegetation i.e., Sickle bush consumes more water compared to grasses, which can lead to reduced water availability in bush-encroached areas. This scarcity of water can have a significant impact on local communities that depend on water sources for drinking, irrigation, and livestock watering. Encroacher species such as Sickle bush can also increase the risk and intensity of wildfires (Mariani et al., 2022). The accumulation of dry woody biomass provides fuel for fires, which can cause damage to grazing land, crops, and infrastructure (Chingono & Mbohwa, 2015; Nepstad, 2001). Local communities may lose their livestock, agricultural fields, and even their homes, leading to severe economic losses. Despite their pivotal role, savannah ecosystems still face threats like bush encroachment caused by the intense proliferation of the woody plants at the expense of herbaceous vegetation (Yassin, 2019). The presence of uncontrolled Sickle bush rural communities can have a significant impact on livelihoods, wildlife, and conservation efforts. In many African countries, particularly in savannah rangelands, poor land management and unsustainable land use are contributing to land degradation and encroachment by Sickle bush. Mafarana village found in the Greater Tzaneen Municipality of Limpopo Province is no exception as it faces threats to bush encroachment.

## **1.3 Research questions**

- What are the main factors contributing to bush encroachment in savannah rangelands of Limpopo Province, South Africa?
- What are the perceptions of communal farmers on bush encroachment management in savannah rangelands?
- What are the communal-based approach strategies for bush encroachment management?
- What are the strengths and weaknesses of communal-based approach strategies for bush encroachment management?
- Are there any existing government-based strategies that aim to manage bush encroachment in this area?

## **1.4 Aim and Objectives**

### **1.4.1 Aim**

- The aim of this study is to investigate communal-based approach strategies for bush encroachment management in a savannah rangeland of Mafarana village in the Greater Tzaneen municipality of Limpopo Province, South Africa.

### **1.4.2 Objectives**

- 1 To assess indigenous knowledge associated with the main factors contributing to bush encroachment in a savannah rangeland.
- 2 To determine the indigenous communal-based approach strategies for bush encroachment management.
- 3 To investigate the perceptions of communal farmers on bush encroachment management in savannah rangelands.
- 4 To evaluate the strengths and weaknesses of communal-based approach strategies for bush encroachment management in savannah rangelands.

## CHAPTER TWO: A REVIEW OF COMMUNAL APPROACHES TO BUSH ENCROACHMENT MANAGEMENT IN SOUTHERN AFRICA'S SEMI-ARID SAVANNAH RANGELANDS.



This chapter is based on the following publication:

**Tshidi Mokgatsane Baloyi**, Thabang Maphanga, Bennett Siyabonga Madonsela, Xolisiwe Sinalo Grangxabe, Karabo Concelia Malakane, Babalwa Gqomfa, Lawrence Munjonji, Terry Takalani Phungela (Under review). A review of communal approaches to bush encroachment management in Southern Africa's semi-arid savannah rangelands. *Human Ecology* (Submission ID 603bedf4-568f-4291-9ecc-914853151e8b)

### 2.1 Abstract

There are distinct management approaches for communal properties and commercial agricultural properties with regards to bush encroachment. The utilization of community-based knowledge possesses the capacity to enhance our comprehension of localized circumstances and provide valuable experience in endeavours targeted at supporting local communities. The perception of bush encroachment control as a sustained endeavour rather than a singular occurrence is of utmost importance. This may include considering other solutions that may not always be the most convenient or cost-effective. The objective of this study was to evaluate the predominant methods employed by rural communities in semi-arid savannah rangelands in Southern Africa to manage bush encroachment. The systematic review was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines. This methodology aims to uphold the principles of impartiality, clarity, and dependability in research. The findings of this



study indicate that the predominant and commonly utilized management strategy for mitigating bush encroachment include the extraction of the plant for medicinal applications. Indigenous and traditional knowledge systems have played a pivotal role in communal bush encroachment management. Utilizing community knowledge as a foundational framework for comprehending the impact of historical shifts in land use on rangelands is a significant methodological approach in evaluating communities' adaptive responses to evolving land use patterns. In addition, it is worth noting that local knowledge has the potential to contribute valuable insights that might enhance scientific comprehension.

**Keywords:** *Dichrostachys cinerea*, Rural communities; Indigenous knowledge; Contemporary control, Management practices.

## 2.2 Introduction

Rangelands refer to regions that possess a natural or indigenous presence of grasses, grass-like vegetation, or forbs, which are subject to grazing or browsing activities (Hudak, 1999; James et al., 2003). In addition, rangelands offer supplementary resources, such as firewood, forage, medicinal flora, and even water (Asner et al., 2004). It is important to note that rangelands also play a significant role in supporting the livelihoods of rural communities, as they provide a wide range of ecosystem services that are derived from these areas (Zerga, 2015). The FAO (2011) reports that savannah rangelands play a significant role in sustaining approximately 50 percent of the worldwide livestock population, while also serving as a crucial source of livelihood for over 250 million households worldwide. The management and conservation of savannah rangelands is significant, as it plays a crucial role in ensuring the survival of both livestock and wildlife populations. Additionally, it contributes to the overall preservation of biodiversity and the long-term sustainability of livelihoods.

Despite their crucial role in supporting livelihoods, savannah rangelands are currently experiencing significant degradation because of bush encroachment (Palmer & Ainslie, 2007). The degradation of savannah rangelands primarily arises from inadequate or non-existent grazing management strategies, the extraction of vegetation for fuelwood, and often the absence of well-defined ownership rights over rangeland areas, particularly in rural communities throughout Africa (Zerga, 2015). According to Czeglédi and Radácsi (2005), when the animal population surpasses the land's carrying capacity, it leads to the over-utilization of grasses, resulting in a

lack of regeneration for a significant portion of these grasses. Consequently, the palatable grasses are gradually replaced by thorny scrub bushes. The encroachment of rangelands directly affects a substantial population of over 250 million people, spread across more than 100 countries, as highlighted by Adger and Vincent in 2005. This is due to the fact that rangelands primarily serve as a crucial source of livestock feed (Zerga, 2015). Consequently, bush encroachment has detrimental consequences on the well-being and livelihoods of these individuals, as underscored by Kellner et al. (2022).

Bush encroachment is a widely studied phenomenon in the field of ecology and land management (Ayelew & Muluaem, 2018). It is a term used to describe the progressive expansion of woody vegetation, typically shrubs and small trees, into grasslands and savannas (Smit, 2004; Saintilan & Rogers 2015; Archer, 2010). This phenomenon is characterized by an increase in the density, cover, and height of woody plants within these ecosystems. The encroachment of woody vegetation can have significant ecological, economic, and social implications (Archer, 2010; Mangani et al., 2020). Bush encroachment is a complex process influenced by various factors, including climate change, land use practices, fire suppression, and changes in grazing patterns (Roques et al. 2001). While some level of woody plant expansion is a natural process in certain ecosystems, human activities have accelerated and intensified this encroachment in many regions (Rose, 2017; Londe 2022; Archer and Stokes, 2000).

Several studies have investigated the causes and consequences of bush encroachment in different parts of the world, including Africa, Australia, and the United States (O'Connor et al., 2014; Scholtz et al., 2022; Luvuno et al., 2018; Li et al., 2022; Mariani et al., 2022). There are various methods that have been used to monitor and assess the causes and impact of bush encroachment such as remote sensing and spatial information, climate and weather analysis, fire analysis, hydrological changes, human or communal activities, long-term ecological research, and modelling approaches (Trollope 1980; Symeonakis & Higginbottom, 2014; Cao et al., 2019; Maphanga et al., 2022;). However, a few studies are available on how communities manage bush encroachment at a grassroot level. This paper aims to assess the prevalent bush encroachment management strategies employed by rural

communities in the Southern African semi-arid savannah rangelands. The objective is to provide insights for subsequent research endeavors to delve deeper into these methods, examining their efficacy and efficiency. Additionally, the discoveries from this investigation could inform governmental decisions to allocate resources towards supporting the approaches adopted by local communities.

## **2.3 Research Methodology**

### **2.3.1 Search strategy**

The literature search included English peer-reviewed articles and relevant reports. All information used in the evaluation and review was collected from extensive project reports, published papers and websites. The Google Scholar database and Semantic scholar were used to identify all the relevant articles and reports. The criteria for selection included the following: (1) the assessment of bush encroachment in rangelands (savannah; (2) methods for monitoring and assessment of bush encroachment; (3) communal based approaches on bush encroachment management in savannah areas; (4) the impact of bush encroachment on communal savannah rangelands; (5) common strategies and techniques that have been employed to curb bush encroachment (6) relevance of bush encroachment in South Africa, just to mention few. However, the literature search focused on shrubs (woody plants), tree and bush encroachment, communal based approaches in unprotected areas i.e., communal areas only. Each article was assessed according to the accuracy of its results, and the systematic review and meta-analyses used for the selection of articles are included in our discussion.

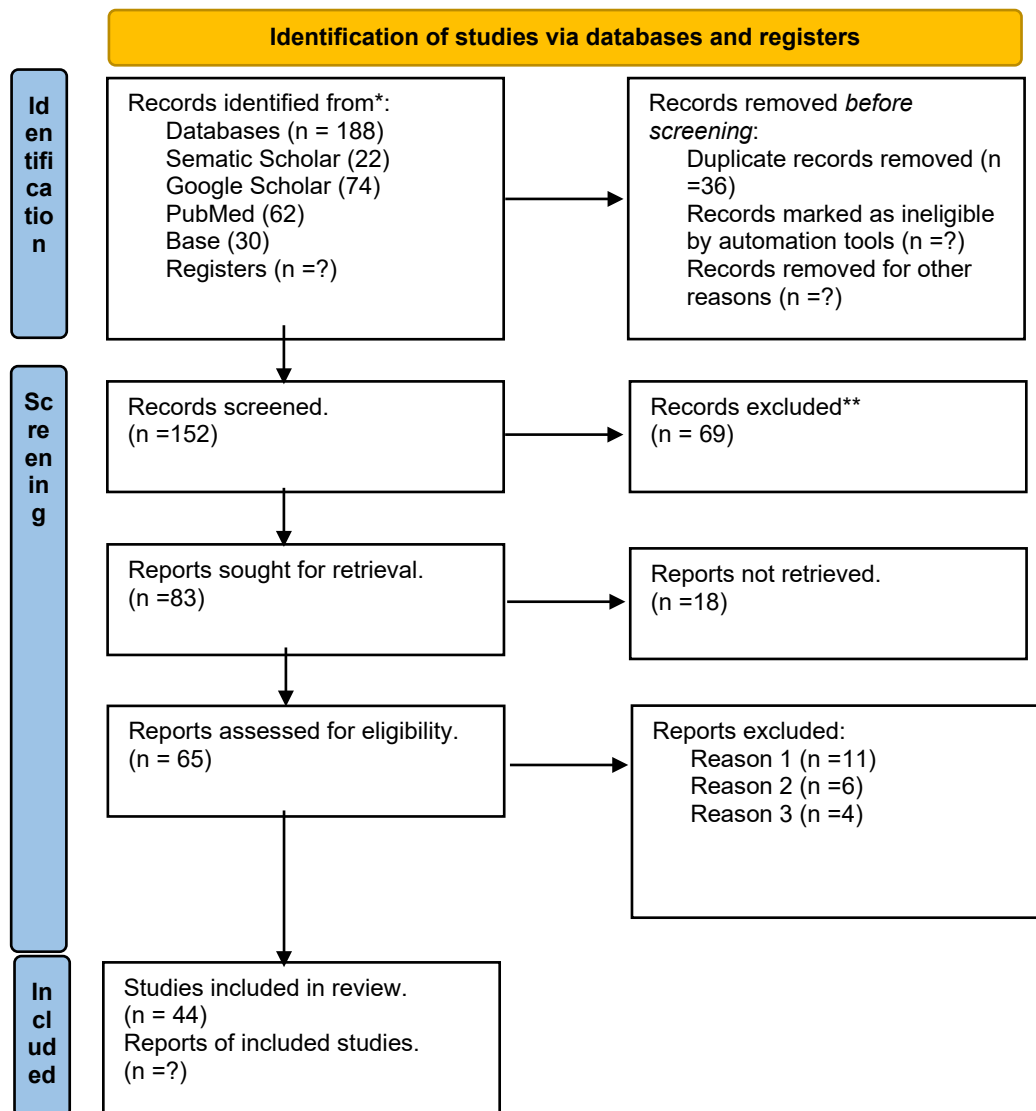


Figure 2.1. Methodology for Study Selection: PRISMA Principles.

### 2.3.2 Data Extraction and Selection of studies

Despite containing the keywords in their titles and/or abstracts, all studies focusing on bush encroachment in protected areas were excluded during the screening process because they were irrelevant to the study and lacked relevant data. The relevance verification in this review was carried out by three writers who reviewed the titles and abstracts. In cases of conflict, the third author was consulted to ensure correctness. After removing studies that were not relevant, two reviewers collected data from the studies that met the inclusion criteria. They obtained and evaluated the complete reports of publications that were considered eligible for inclusion by either reviewer. A total of 83 studies were found and evaluated for eligibility reports.

However, 18 studies were excluded because the full papers could not be obtained. In the present study, a total of 65 publications were selected for inclusion in the analysis. Subsequently, the whole texts of the remaining 65 reviews were meticulously scrutinized. Therefore, 21 reviews were excluded from the analysis due to their failure to fulfil the predetermined eligibility criteria. Various reasons were identified for their elimination. A total of eleven records were excluded from the analysis due to their antiquated nature and insufficient coverage of Savannah rangeland, which predominantly consists of grassland. Another justification for excluding an additional six articles was their exclusive focus on Geographic Information Systems (GIS), remote sensing, and modelling, without any consideration of community engagement. Furthermore, four papers were excluded due to their emphasis on wildlife management and national parks, which fell beyond the purview of the current study.

### **2.3.3. Overview of the impact of bush encroachment on communal savannah rangelands in Sub-Saharan Africa**

The causes behind the widespread occurrence of bush encroachment in various grasslands and savannahs across Africa and other regions remain poorly understood, despite extensive documentation of the phenomenon (Ward, 2005) particularly within the semi-arid regions (Naidoo et al. 2016). The inadequate administration of the shared resource pool has often resulted in adverse consequences for the long-term viability of collective savannah rangelands. The African communal rangelands are characterized by conflicts pertaining to land use and land cover changes (Selemani, 2020; Mariani et al., 2022). The negative impacts on the sustainability of communal savannah rangeland resources are believed to be associated with both centralized and local control over these resources (Schafer & Bell, 2002). Hardin (1968) argues that the degradation of common properties is an inevitable outcome unless measures are taken to convert the property into private or public ownership with limited access rights. According to Schafer and Bell (2002), the delegation of resource control to communities is posited to offer substantial motivation for the sustainable management of said resources. In a significant number of common property resources, clan leaders have been bestowed with the privilege of land ownership, which is subsequently upheld by community elders (Selemani et al., 2013). The poor organization of institutions responsible for managing communal rangelands, coupled with changes in land tenure policies, is the primary cause of the

gradual degradation of these rangelands (Beyene, 2009). In essence, degrading land can be attributed to the weakening local communal land management system, particularly the weakening tribal councils (Kgaphola et al., 2023).

Bush encroachment in Sub-Saharan Africa remains highly relevant due to its wide-ranging impact on the environment, economy, and society (Mugasi et al., 2000; Mitchard & Flintrop, 2013; Stafford et al., 2017; Sebatloane et al., 2020). Bush encroachment has been demonstrated to diminish the carrying capacity of arid grasslands in southern Africa for cattle due to the selective overgrazing of grasses by cattle (Jeltsch et al., 1997). Furthermore, land degradation caused by bush encroachment has a negative impact on the surrounding community's ecosystem services, which often gives rise to socio-economic challenges such as a loss in income and insufficient production to keep livestock (Sebitloane et al., 2020). It is envisaged that improved livestock productivity will have a positive effect on ecosystem services and, by inference, on the well-being of the surrounding community.

Another study by Angassa (2005) showed the ecological impact of bush encroachment on the yield of grasses in a rangeland ecosystem. Non-encroached communal grazing areas had relatively increased grass yields that varied from 106% to 150% in comparison with bush-encroached areas that had lesser yields. This was also evident in a study by Gobelle and Gure (2018) which depicted the effects of bush encroachment on plant species composition, diversity, and its contribution to carbon stocks. Bush encroachment ultimately led to a reduction in rangeland productivity in Borana rangelands of southern Ethiopia. The influence of ecosystems on human culture is substantial, with changes in ecosystems potentially exerting a profound effect on cultural identity and societal stability. Many indigenous communities have cultural and traditional connections to the savannah landscapes and bush encroachment can alter these landscapes, affecting local cultural practices, spiritual and religious beliefs (Rudolf de Groot et al., 2005). Indigenous communities often rely on savannah rangeland landscapes for various traditional activities such as hunting, gathering, and agriculture. Indigenous cultures often have rituals, ceremonies, and cultural practices that are closely tied to the natural environment, including savannah landscapes. Changes in the landscape due to bush encroachment can impact these cultural practices and beliefs, as they are intimately connected to specific features of the landscape.

### 2.3.4 Historical communal based bush encroachment management

Historically, it has been observed that bush encroachment was most rapid on small, protected areas, intermediate under commercial tenure, and slowest under communal tenure (O'Connor, 2014). Many communities have developed communal approaches to address this issue, drawing on their traditional knowledge and local resources. These approaches often involved a combination of cultural practices, land management strategies, and community cooperation. In the savannah rangelands of Southern Africa, woody plants have played a crucial role in various aspects of local communities' lives. These woody plants have been utilized for multiple purposes, including as a source of firewood, construction timber, charcoal production, and wood carving (Smit, 2004). This utilization of woody plants has proven effective in managing and restraining the spread of woody vegetation within communal areas, offering distinct advantages to these communities (Wigley et al., 2009). Furthermore, for many rural communities, wood remains the primary source of fuel for both cooking and heating. Among the diverse savanna woody species, certain ones, particularly those with dense heartwood, such as *Dichrostachys cinerea*, are renowned for their exceptional fuel properties (Smit, 2002). There is also evidence that this species was harvested for medicinal purposes and used by communal communities for the following: fever reduction, antimicrobial properties, anti-inflammatory effects, gastrointestinal relief, respiratory issues, wound healing, and antioxidant properties to name a few (Sáez & Alfayate, 2020). Spiky branches obtained from woody plants such as *Acacia tortilis* and *Acacia erubescens* serve as essential materials for building enclosures known as kraals (Dingaana, 2018). These kraals are designed to safeguard livestock from potential threats, as documented in Smit (2004).

In the past, local livestock farmers in many southern African countries heavily depended on two primary traditional rangeland management strategies, which are burning and mobility. Other recognised rangeland management strategies include (d) the harvesting parts of the plant for firewood or animal feed (Table 2.1). However, it's important to highlight that the practice of burning was largely discontinued in these regions after 1974/75 as reported by Solomon et al. (2007). Communal livestock farmers employed burning as a means of controlling the proliferation of bushes and preserving the grass. Presently, these farmers have shifted away from using any form of control methods, as burning, once a prevalent method for bush control, has

largely ceased to be a practiced technique (Admasu et al., 2010). During dry seasons, livestock farmers would collect leaves and pods from woody plants to use as livestock feed. This practice served multiple purposes, including alleviating the pressure on fodder production, supporting sustainable land management, and acting to prevent the potential invasion of woody plant encroachment. (Marius et al., 2017; Avornyo et al., 2018). Table 2.1 shows an overview of the most popular or mostly used community-based approach to manage the phenomenon of bush encroachment.



Table 2.1: An Overview of Communal Based Bush Encroachment Management Practices.

<b>Communal approach</b>	<b>based Region</b>	<b>Author</b>
<b>Traditional Livestock Mobility</b>	This method involved herd mobility which was traditionally been used to respond socio-ecological problems such as bush encroachment in the Leliefontein pastoral area which is about 192 000 ha in size and straddles the Kamiesberg mountain range in the Namaqualand, South Africa.	Samuels et al. 2019.
<b>Harvesting and/or collection for firewood</b>	In the Venda region of South Africa's Limpopo province, various components of the <i>Dichrostachys cinerea</i> plant, particularly its bark and roots, were harvested for their medicinal properties. In D’Nyala Nature Reserve and Shongoane Village, Lephalale, South Africa, <i>Dichrostachys cinerea</i> plant is mainly used as firewood for cooking and heating.	Tshisikhawe 2012. Mangani et al., 2020
<b>Burning</b>	It was common for livestock farmers to burn rangeland to maintain grass dominance in Botswana until burning was banned in 1980.	Reed et al. 2007.
<b>Animal feed</b>	Livestock farmers in Namibia collected <i>Dichrostachys cinerea</i> leaves and pods to feed their animals particularly goats during the dry period.	Marius et al. 2017.

### **2.3.5 The contemporary control of bush encroachment through community and governmental interventions.**

The South African government has been actively involved in bush encroachment management through various policies, programs, and research initiatives. The Department of Environment, Forestry, and Fisheries (DEFF) has formulated policies and guidelines related to bush encroachment and land management (Chauke et al., 2015). These policies aim to promote sustainable land use practices, including the control of invasive species and the restoration of degraded ecosystems (Canavan et al., 2021). The concept is basically on alien invasive plant control and bush encroachment control. Methods such as mechanical, chemical and combination treatment are used to control and reduce the densities of woody plants. In other cases, biological control methods are used to suppress the growth and reproduction of encroaching species (Trollope, 1980; Mampholo, 2006; Smit et al., 2016; Liu, 2019; Mangani et al., 2020). Many successful bush encroachment management programs employ integrated approaches that combine multiple techniques. For example, a combination of prescribed burning, mechanical clearing, and selective herbicide application may be used to achieve the desired control of woody vegetation. Integrating various methods has increased effectiveness and provide long-term management benefits (Hobbs & Humphries, 1995).

The government, in collaboration with research institutions and conservation organizations, conducts studies and assessments to better understand the extent and impact of bush encroachment. These research efforts help in developing evidence-based management strategies. Ongoing research and monitoring are crucial for understanding the dynamics of bush encroachment and evaluating the effectiveness of management interventions (Thomas & Twyman, 2004; Angassa, 2005; Eldridge et al., 2011). Monitoring vegetation changes, animal performance, and ecological indicators can guide adaptive management strategies and improve future management decisions. This also includes conducting awareness campaigns to educate the public about the importance of bush encroachment management and its impacts on the environment, biodiversity, and livelihoods. Communities in South Africa are engaged in various initiatives to address bush encroachment and its impacts on their environment and livelihoods. These community-driven efforts play a crucial role in complementing government and conservation organization actions (Frazer et al., 2006). Some of the activities and approaches that communities are undertaking to combat bush encroachment include participatory land management:

community-based conservation projects funded by the government, which include collaborative partnerships, livestock management, awareness and education and sustainable utilization.

## **2.4 Discussion**

Bush encroachment is a significant issue impacting agricultural productivity and biodiversity across 10-20 million hectares of South Africa (Roques et al., 2001), along with approximately 13 million hectares of savannah rangeland in the country (Ward, 2005). Unfortunately, communal communities often lack the resources and capacity to effectively address this problem. Consequently, it is imperative for African governments to empower these communities in managing bush encroachment. Regrettably, some of the least developed African governments, such as Tanzania, are falling short in providing even basic training and skills development related to bush encroachment (Selemani, 2020). While some developing nations, like South Africa, have made efforts by providing resources such as community-based funding, training, awareness campaigns, and ongoing research on bush encroachment, these initiatives have not yielded the desired results due to insufficient community engagement. To address this issue comprehensively, environmental programs like "Working for Water" have been established (Chauke et al., 2015). The initiative involves the elimination of Alien Invasive Plants and other troublesome plant species via the engagement and education of local populations. Consequently, the program effectively addresses a multitude of fundamental issues, including land degradation, poverty, skills enhancement, and eventually, the attainment of food security. However, it is crucial to involve communities not only in environmental awareness and education but also in the development of communal-based approaches to managing and controlling bush encroachment (Mampholo, 2006). This holistic approach would be more effective in tackling the problem and ensuring the sustainability of the efforts made to combat bush encroachment.

Indigenous or communal-based approaches to bush encroachment management receive less research attention primarily because of constrained research funding, which is frequently allocated based on the priorities set by governments, non-profit organizations, and academic institutions (Gxasheka et al., 2013). Moreover, a lack of awareness among researchers and policymakers regarding the efficacy of indigenous management practices for addressing bush encroachment further

contributes to this neglect (Ndlela, 2022). When these traditional practices are not adequately documented or acknowledged on a broader scale, they tend to receive less research focus (Tobler et al., 2003). Additionally, modern techniques for managing bush encroachment, such as mechanical clearing and the use of chemical applications, are often preferred. In numerous regions, indigenous communities hold deep-rooted traditional knowledge and practices that have been transmitted across generations (Mokgotsi, 2018). The incorporation of this traditional ecological wisdom into the management of bush encroachment offers invaluable insights and novel approaches. This integration approach acknowledges the significance of local wisdom and advocates for culturally relevant strategies in addressing the issue of encroaching vegetation (Kgosikoma & Mogotsi, 2013).

The communal based bush encroachment management practices indicated in Table 2.1 above are noted to be less sustainable currently due to the reason that they are not practiced collectively (Reed et al., 2013). Different regions have adopted and prefer different management practices. These methods mentioned can work effectively and efficiently when combined and used as a single way of managing bush encroachment, this because the use of one method can either fail to control encroachment whilst another method can have detrimental effects to the soil and other important species (Roques et al., 2001).

The woody vegetation that thrives in the savannah of Southern Africa exhibits a multitude of utilitarian purposes, encompassing the provision of firewood, the procurement of irregular building lumber, the facilitation of charcoal manufacturing, and wood carving. Wood continues to be the predominant energy source for household needs in several isolated regions. A multitude of tree species found in savanna ecosystems are highly esteemed for their abundant heartwood, which serves as a valuable fuel resource. The loss of critical woody vegetation and re-invasion can be attributed to either the high expense or the ineffectiveness of the strategy employed. Within this setting, it is imperative to make a clear distinction between the patterns of land use and the resources that may be realistically obtained (Selemani et al., 2020). Effectively managing bush encroachment necessitates a sustained commitment of time and effort, rather than a singular endeavour. This may require the utilization of procedures that are not necessarily the most expedient or cost-effective. The method of shrub (bush encroachers) removal that incurs the lowest cost is typically not the most economically efficient approach. The removal of mature shrubs within an ecosystem can lead to a notable increase in instability,

hence requiring landowners to combat a rapid resurgence of vegetation consistently and purposefully, often consisting of new and potentially more hazardous woody species (Angassa and Oba, 2008; Wigley et al., 2009). The current phenomenon of partially privatizing community rangelands through the introduction of alternative land uses, such as semi-private and communal range fencing and crop cultivation, has resulted in the fragmentation of grazing lands and significant disruptions to traditional grazing systems (Selemani, 2014). Shikangalah & Mapani (2020) posits that community-based knowledge exhibits more adaptability and relevance in the context of ecological impact assessments and other environmental concerns when compared to a majority of alternative sources of information. To mitigate environmental degradation, the integration of community-based knowledge into scientific research and land use policy has the potential to enhance understanding of local circumstances (Tokozwayo, 2016; Mokgotsi, 2018).

The primary and widely employed management approach for addressing bush encroachment involves the harvesting of the plant for medicinal purposes. This method has gained popularity due to the extensive knowledge transfer within communities, with traditional healers and village elders acquiring information about the uses of medicinal plants from their peers and previous generations through oral tradition (Chauke et al., 2015). In this context, the utilization of the plant extends beyond mere extraction of specific components like leaves and bark; often, the entire tree is uprooted (Danley, 2006; Malami et al., 2020). This comprehensive approach is considered effective in preventing the regrowth of the plant, making it a preferred management technique (Malami et al., 2020).

## **2.5 Conclusion**

Communal approaches to bush encroachment management in Southern Africa's semi-arid savannah rangelands have proven to be promising and effective in addressing this significant ecological challenge. Indigenous and traditional knowledge systems have played a pivotal role in communal bush encroachment management. Local communities possess a wealth of knowledge about their ecosystems, which, when integrated with modern scientific approaches, can result in more effective and sustainable management practices (Kgosikoma & Mogotsi, 2013). The assessment of community reactions to alterations in land utilization was greatly enhanced by employing a methodological framework that relied on the utilization of indigenous knowledge pertaining to the long-term impacts of land use change on

grazing pastures. The current study posited that traditional land use techniques exert an influence on the overall dynamics of rangelands. It is recommended that communal approaches to bush encroachment management in Southern Africa's semi-arid savannah rangelands can harness the power of indigenous knowledge while benefiting from modern scientific insights, ultimately leading to more effective and sustainable management practices. This can be accomplished by fostering community involvement and active participation, facilitating the exchange of knowledge, enhancing skills and expertise, preserving, and safeguarding indigenous wisdom through documentation, and harmoniously blending traditional and scientific methodologies.

## **CHAPTER THREE: RESEARCH METHODOLOGY**

### **3.1 Introduction**

This chapter looked at the complexities of communal-based strategies for effectively managing bush encroachment in savannah rangelands (Sporton & Thomas, 2002). The methodology used is grounded in a comprehensive approach, combining ecological principles with community engagement i.e. direct questioning and engagement of the community members (Samaddar et al., 2021). Utilizing a mix of qualitative and quantitative methods, the study was able to investigate communal dynamics, interactions, and perceptions regarding Sickle bush, along with the ecological impact of bush encroachment (Hendren et al, 2023). The primary goal is to offer insights into community perceptions and management approaches toward Sickle bush, which is crucial for the implementation of sustainable solutions to tackle the prevalent issue of bush encroachment in Mafarana village.

### **3.2 Methodology**

#### **3.2.1 Study area**

The study was conducted at Mafarana village which is located within the Greater Tzaneen local municipality of the Mopani District, Limpopo province as shown in figure 3.1. This study area is a rural area located near Letsitele town which is surrounded by other previously disadvantaged communities. Mafarana village falls under the jurisdiction and leadership of Chief Mohlaba of the Nkuna tribe. This village is located (GPS coordinates: 23.9594 S, 30.3563 E) on the southeastern side of Tzaneen main town. It neighbours Lenyenye, Nkowankowa and Letsitele townships and covers an area of 2.02 km<sup>2</sup> with an estimation population of 2554 (StatsSA, 2011). The dominant population group is black Africans speaking Xitsonga language which is the widely spoken language i.e., 92% of the population in the area speaks Xitsonga. Farming remains the primary land use within this community, encompassing both crop cultivation and animal husbandry. Rangeland grasses cover a significant portion of the landscape, constituting approximately 32.33% of the land use (Lam et al., 2023).

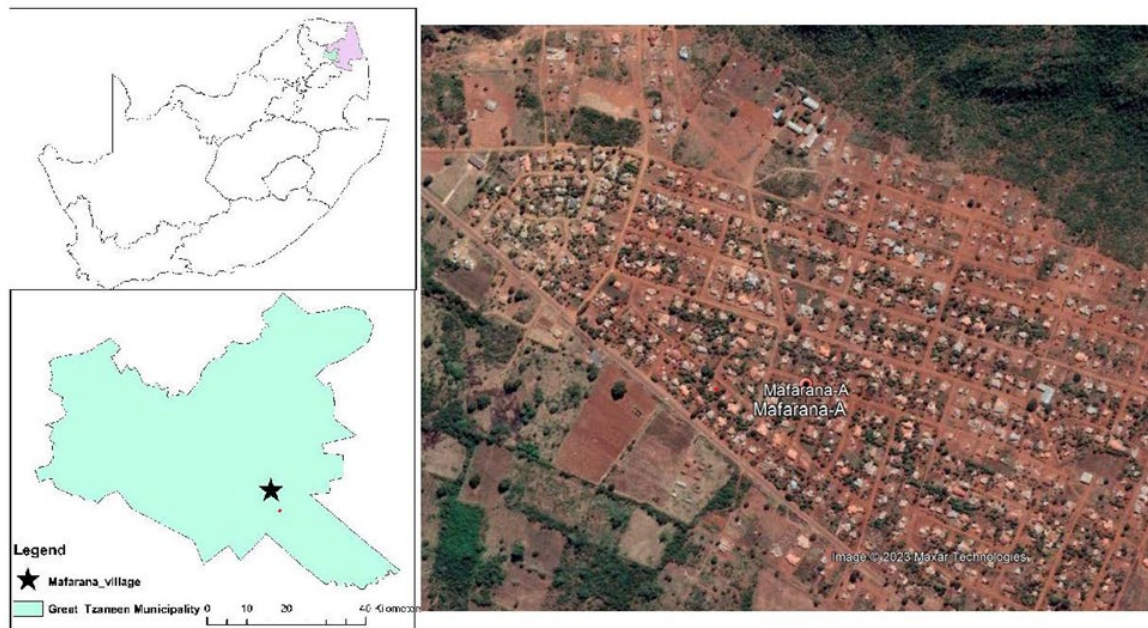


Figure 3.1: Study area map of Mafarana village in the Great Tzaneen local Municipality

### 3.2.2 Data collection method

#### 3.2.2.1 Sampling method

Case studies enable researchers to understand, interpret, observe, and study complex phenomena in their natural contexts; thus, this exploratory study employed a qualitative case study methodology. In qualitative methods, it is common to collect data from a small number of study objects (Bryman & Bell, 2007). The researcher's perspective on the data was distinctive (Kumar & Ormiston, 2012). This study made use of three different kinds of non-probability sampling techniques namely, purposive, snowball, and convenience sampling methods. These techniques were employed to collect data from all the participants (tribal leaders, community members, community partners and farmers). The purposive sampling method (non-probability) were used to interview participants that were assumed to have an understanding regarding the study and might have had the necessary answers. This assumption was based on the belief that tribal leaders and community partners, as key stakeholders within the community, would have intimate knowledge and insights relevant to the research topic. Their roles and positions within the community suggest a level of expertise, experience, and familiarity with the subject matter, making them suitable candidates for providing valuable and comprehensive information for the study. On the other hand, the snowball method was used to locate participants such as community



leaders which are also key respondents for this study. The convenience sampling technique was targeted at public places near the village and where willing participants/residents were identified and interviewed.

### **3.2.2.2 Sampling size**

The sample size for data collection was determined using Slovin's formula, which is used to calculate the sample size (n) given the population size (N) and a margin of error (e). It is computed as,  $n = \frac{N}{1+Ne^2}$  with a 95% confidence interval, therefore the margin of error is 0.05%.

The formula helped determine how many people must be sampled from the original population size of 2554. The selected sample size of 350 was cost-effective and required less time than the actual sample size.

### **3.2.2.3 Data collection procedure**

The research was conducted using qualitative and quantitative research technique approach, which was in a form of questionnaires, structured interviews as well as observational methods which was employed as an instrument for data collection. The questionnaires were used on communities around the Mafarana village to gather information about ways and strategies that the community use to manage *Dichrostachys cinerea* as the main encroacher species. The questionnaires consisted of open-ended and closed-ended questions. Interviews with the tribal authority were in a form of open discussions relating to awareness as well as relationships with the surrounding communities. Additionally, the observational assessment method was used to monitor people's behavioural patterns as well as their interaction with the natural environment.

### **3.2.2.4 Validity and reliability**

During data collection the structured interviews and questioners administered to the participants were guided by the study objective. These structured interviews and questionnaires were reviewed and approved by the experts in the field of bush encroachment management prior to going to the field. Furthermore, before heading to the field (pre-tests) the questionnaires and interviews were administered to individuals to assess how participants will respond to questionnaires and interact with

the structured interviews. In this instance, the feedback from the pilot study assisted the researcher to adjust accordingly the questionnaires as well as the structured interviews. Subsequently the pilot study outcome yielded an acceptable and satisfactory Cronbach's Alpha of 0.76.

### **3.2.2.5 Data Analysis**

The current study used the mixed methods analysis technique to analyse qualitative and quantitative data collected from Mafarana village in Tzaneen. To this end numerous scholars' postulate that the application of a mixed analysis techniques for various data type is a prevalent practice in research (Onwuegbuzie et al., 2007; Combs & Onwuegbuzie, 2010). Given the dynamic nature of the research data that was collected from Mafarana village, the current study used qualitative coding to analyse the qualitative data and questionnaires to analyse quantitative data. The researcher assessed all the administered questionnaires, and the recordings of the interviews were transcribed to get a general sense of the whole data presented and the content to be analysed. This practice followed Combs and Onwuegbuzie (2010) mixed analysis framework, which suggests that in an instance where the study design is quantitative and qualitative, the first part of the data to be analysed is qualitative data. This is important as it allows the qualitative data to be translated into a quantitative format. It is for this reason that it is only at a later stage when data has been transformed into numerical codes that can be analysed statistically (Tashakkori et al., 1998; Leavy, 2022). To uncover the significant findings regarding communal farmers' perceptions of bush encroachment management, a thematic and exploratory data analysis was conducted initially. The collected data in the form of texts from the Mafarana community was systematically categorised into excerpts. That is the qualitative data was firstly transcribed in Microsoft Excel 2019. Subsequently, the data was grouped according to themes. In this regard, inductive logics were used in the interpretation of the study results as previously suggested by Creswell et al. (2007) as well as Tavallaei and Talib (2010). This was useful in discovering the themes and patterns of the data. As it is suggested that thematic analysis is essential in identifying, organizing, and presenting the patterns of the themes across the data set (Tate, et al., 2015). Moreover, at a later stage the simple descriptive statistics analysis was integrated in the current study. Subsequently, demographic information from the questionnaires was analyzed using IBM SPSS version 26, software known for editing and analyzing data (Kremelberg, 2010), ensuring meaningful interpretation

of both qualitative and quantitative data (Creswell, 2007). This includes all questions from demographic information community perceptions and farmers section/management practices. Furthermore, data from questionnaires that could not be analysed using SPSS were then analysed through thematic analysis, which is a method for identifying, analysing, and interpreting patterns (themes) within qualitative data (Clarke & Braun, 2017).

## **CHAPTER FOUR: INDIGENOUS COMMUNAL-BASED STRATEGIES AND PERCEPTIONS FOR BUSH ENCROACHMENT MANAGEMENT IN RURAL AREAS OF SOUTH AFRICA'S SEMI-ARID SAVANNAH RANGELANDS.**



This chapter is based on the following publication:

**Tshidi Mokgatsane Baloyi**, Thabang Maphanga, Benett Siyabonga  
Madonsela, Qolani Golden Mongwe, Karabo Concelia Malakane. African Journal of  
Ecology (manuscript # AFJE-24-045)

### **4.1 Abstract**

The integration of indigenous knowledge systems into the discussion of bush encroachment management is of paramount importance. Indigenous knowledge and formal monitoring may be mutually beneficial, and using both approaches can improve natural resource management. Savannah landscapes hold deep cultural and spiritual significance for indigenous communities, and their perceptions can provide valuable insights into creating more effective, community-driven conservation initiatives. This study seeks to address this research and knowledge gap by focusing on the incorporation of indigenous knowledge systems into the discourse on bush encroachment management. These approaches not only offer effective strategies for bush encroachment management, but also make substantial contributions to the ecological sustainability of these semi-arid rangelands, particularly within the South African context. Understanding the perceptions of communal farmers regarding bush

encroachment management is also essential. This research employed three distinct non-probability sampling strategies, including purposive, snowball, and convenience sampling methods. In addition, the data obtained from questionnaires that were not suitable for analysis using SPSS were then subjected to thematic analysis, a technique used to detect, analyse, and interpret patterns (themes) within qualitative data. The majority 64,66 % of the respondents perceived bush encroachment as a phenomenon of having a lot of trees in one place (thick bush), that prevents and restricts other plants from growing. The data reveals that a higher percentage of females, specifically 60%, advocated for the incorporation of communal-based approaches and indigenous knowledge systems in the management of Sickle bush. A total of 85% farmer respondents indicated that they cut the encroacher plant down, uproot all root systems then burn the remaining roots. This is reported to be a more effective way of managing Sickle bush as an encroacher plant. The findings of this study underscore the significance of integrating indigenous knowledge systems and communal-based approaches into bush encroachment management initiatives. The high percentage of respondents advocating for these methods, particularly among female participants, highlights the importance of incorporating diverse perspectives and traditional practices into conservation efforts. The widespread adoption of techniques such as cutting down encroacher plants and uprooting their root systems, followed by burning, suggests a practical and effective approach to managing bush encroachment within semi-arid rangelands.

**Keywords:** *Dichrostachys cinerea*, Rural communities; Indigenous knowledge; Contemporary control, Management practices.

## 4.2 Introduction

Southern Africa's semi-arid savannah rangelands are ecologically diverse landscapes of immense importance, balancing a rich array of biodiversity and the livelihoods of the communities residing within them (Fisher, 2013; Ole-Saitabau, 2014). In recent years, the Southern Africa region has faced a growing ecological challenge caused by soil erosion, bush encroachment, and land degradation among other environmental issues. Bush encroachment, which refers to the expansion of woody vegetation into grasslands and savannahs, is a notable ecological problem in the semi-arid savannah rangelands of Southern Africa (Eldridge et al., 2011; Kgosikoma & Mogotsi, 2013; Belayneh & Tessema, 2017). It is estimated that in

South Africa alone approximately 13 million hectares of savannah have experienced encroachment by thorn bushes (Roques et al., 2001; Zwane, 2021). This encroachment has far-reaching impacts on the environment and the livelihoods of the communities residing within these landscapes (Eldridge et al., 2011; Angassa et al., 2012). Research has also shown that factors such as fire, overgrazing, rainfall variability and soil property can influence the dynamics of shrub encroachment in African savannas (Roques et al., 2001; Belayneh & Tessema, 2017). Additionally, the expansion of range enclosures, crop farming, and ranching, as well as the absence of fire, contribute to the expansion of bush cover in rangelands (Angassa & Oba, 2008; Bolo et al., 2019; Yassin, 2019). Nevertheless, despite the widespread occurrence and significant scale of this phenomenon in unprotected regions, including community rangelands, there is a lack of published information about various management approaches aimed at controlling and managing bush encroachment.

Communal rangelands constitute 13% of the agricultural land in South Africa and function as a feed source for cattle (Kgosikoma & Mogotsi, 2013; O'Connor et al., 2020; Sebitloane et al., 2020). Insufficient management of rangelands poses a threat to these areas due to the invasion of bushes. Thorny, woody plants dominate over grasses in degraded savannas, leading to a decrease in the occurrence and coverage of grass species and a rise in the density of woody species (Hare et al., 2020). Various methods for managing bush encroachment are available, including mechanical, biological, chemical, or combined approaches (Reed et al., 2007, Eldridge et al., 2011; Hare et al., 2021). Nevertheless, to implement these measures effectively, it is essential to enhance public knowledge and adopt a participatory approach in managing invasive woody species in regions where they jeopardize the sustainability of rangeland management. Research has been conducted throughout the African continent to assess the impact of community management on encroachment in communal rangelands. In Eastern Africa, one example of rangelands in Ethiopia is the Borana region. Pastoral groups in the Borana area have been seeking remedies to mitigate the extensive repercussions of overgrazing. One technique to provide more food for certain types of cattle is to clear areas where bushes have grown and stimulate the development of grass (Forrest et al., 2015).

Studies on indigenous environmental knowledge and monitoring are very limited in industrialized nations, despite their potential importance in natural resource

management (Higgs, 2003; Shetler, 2007; Deur & Bloom, 2021). Despite the fact that local communities globally possess a significant amount of information about monitoring and management of savanna rangelands, there is a lack of documentation or evaluation about its implementation, uses, and benefits (Woods & Ruyle, 2015; Jamsranjav et al., 2019). Indigenous knowledge and formal monitoring may be mutually beneficial, and using both approaches can improve natural resource management (Reed et al., 2013). Extensive studies have been done to understand the causes and impact of bush encroachment by ecologists worldwide. But indigenous communal-based strategies and the perceptions of communal farmers regarding bush encroachment management have been neglected in most studies (Reed et al., 2007; Lohmann, 2014; Wiseman & Bardsley, 2016). In order to effectively integrate indigenous knowledge and formal methods, it is necessary to provide a clear definition of indigenous knowledge approaches and assess their validity and compatibility with formal methods (Raymond et al., 2010; Sillitoe et al., 2004). The credibility of traditional environmental knowledge is sometimes linked to its level of conformity with formal science (Ellis, 2005; German, 2010).

Recently many researchers have used scientific methods, such as Geographic Information Systems (GIS) and remote sensing, to better understand the dynamics of bush encroachment and develop strategies to address its impacts on ecosystems, biodiversity, and land use patterns (Fuhlendorf & Engle, 2004; Eldridge et al., 2011; Almalki et al., 2022; Maphanga et al., 2022; Kgaphola et al., 2023; ÖZDEŞ & Southworth, 2023). However, these methods often overlook the application of indigenous knowledge systems cultivated by local communities (Eldridge et al., 2011). The integration of indigenous knowledge systems into the discussion of bush encroachment management is of paramount importance. This integration serves to bridge the gap that exists between conventional scientific methods and the invaluable indigenous wisdom that has been cultivated by these communities over centuries. This indigenous knowledge has proven to be highly effective in managing bush encroachment and plays a significant role in ensuring the ecological sustainability of semi-arid rangelands (Kgosikoma & Mogotsi, 2013; Selemani, 2020). It provides a distinct and valuable perspective on the harmonious coexistence of human activities with nature, a core principle deeply rooted in the indigenous cultures of the region. This study seeks to address this research and knowledge gap by focusing on the incorporation of indigenous knowledge systems into the discourse on bush

encroachment management. The primary aim is to evaluate the communal-based approaches that have evolved and been conserved by indigenous communities for generations. These approaches not only offer effective strategies for bush encroachment management but also make substantial contributions to the ecological sustainability of these semi-arid rangelands particularly within the South African context. They present a unique viewpoint on the synergy between human activities and the natural world, a fundamental tenet of indigenous cultures in this region (Cajete, 1994; Díaz et al., 2015).

Furthermore, the objective of this research is to investigate the perceptions of communal farmers regarding bush encroachment management. Understanding the perceptions of communal farmers regarding bush encroachment management is also essential (Angassa & Oba, 2008; Ravhuhali et al, 2020). These landscapes hold deep cultural and spiritual significance for indigenous communities, and their perceptions can provide valuable insights into creating more effective, community-driven conservation initiatives (Angassa & Oba, 2008; McLean et al., 2023). By incorporating indigenous knowledge and honouring the cultural heritage and values of these communities, a more holistic and sustainable approach to bush encroachment management can be achieved (Angassa & Oba, 2008; Eldridge et al., 2011; McLean et al., 2023). This not only addresses the ecological challenges posed by bush encroachment but also honour the cultural heritage and values of those who have thrived in these landscapes for centuries.

## **4.3 Methodology**

### **4.3.1 Results and discussion**

#### **4.3.1.1 Demographics**

The provided data for the five tables below consists of four different demographic variables: Gender, Age Range, Occupation, Level of Education and how long has the respondent been living in the community. Each variable is tabulated with its corresponding frequencies, percentages, valid percentages, and cumulative percentages.



Table 4.1: Gender Specification in Mafarana Community Research.

		Gender Specification			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Female	233	66,6	66,6	66,6
	Male	117	33,4	33,4	100,0
	Total	350	100,0	100,0	

The above table reveals that a significant portion of the individuals interviewed in Mafarana village were female (66.6%), while a smaller portion (33.4%) consisted of males. This data suggests a gender imbalance in the current sample, reflecting a female-dominated composition, which aligns with the findings of the 2011 Statistics indicating that 55% of the community is comprised of females while 45% comprises of males. Moreover, their age range was further quantified as presented in Table 4.2 low.

Table 4.2: Age Range of Mafarana Village Respondents.

		Age Range			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	<18	1	0,3	0,3	0,3
	18-24	52	14,9	14,9	15,1
	25-34	70	20,0	20,0	35,1
	35-44	60	17,1	17,1	52,3
	45-54	44	12,6	12,6	64,9
	55 and above	123	35,1	35,1	100
	Total	350	100,0	100,0	

The data from Table 4.2 reveals a diverse age distribution among the respondents. The largest segment of participants falls within the "55 and above" age bracket, making up 35,1% of the total respondents. On the other hand, the "<18" age category represents the smallest group, comprising only 0,3% of the respondents. It is noteworthy that the majority of respondents are adults over the age of 35, constituting more than half of the total sample. This demographic profile contrasts

with the findings from Stats SA 2011 regarding Mafarana village, which showed that most of the population there is composed of youth, accounting for 65,8 of the total population. This discrepancy can be attributed to the fact that the research samples only included 1 individual below the age of 18 years. Therefore, given that elderly people dominate the demographic profile it was important to comprehend the status of employment as represented in Table 4.3.

Table 4.3: Occupations in Mafarana Community.

		Occupation Specification			Cumulative
		Frequency	Percent	Valid Percent	Percent
Valid	Student	28	8,0	8,0	8,0
	Unemployed	144	41,1	41,1	49,1
	Employed	54	15,4	15,4	64,6
	Pensioner	89	25,4	25,4	90,0
	Farmer	16	4,6	4,6	94,6
	Other	19	5,4	5,4	100,0
	Total	350	100,0	100,0	

Most respondents are either unemployed (41,1%) or pensioners (25,4%). Students and employed individuals are smaller categories, with 8% and 15,4% of respondents, respectively (*see table 4.3 above*). The "Other" category makes up 5,4% of the respondents, which might include various miscellaneous occupations. The data suggests that the employment status of the community is characterized by a significant proportion of respondents who are not actively employed, with the majority falling into the categories of Unemployed (41,1%) and Pensioner (25,4%).

Table 4.4: Education Levels in Mafarana Community.

		Level of Education			Cumulative
		Frequency	Percent	Valid Percent	Percent
Valid	No formal education	37	10,6	10,6	10,6
	Primary education	63	18,0	18,0	28,6
	Secondary education	166	47,4	47,4	76,0
	Post-secondary education	84	24,0	24,0	100,0
	Total	350	100,0	100,0	

Most respondents have secondary education (47.4%), followed by post-secondary education (24%). Primary education and no formal education represent 18% and 10.6% of the respondents, respectively. The data indicates a relatively high level of education among the community members, with most having at least a secondary education background.

Table 4.5: Years of Residency in Mafarana Community.

		How long have you been living in this community?			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	5 years	18	5,1	5,1	5,1
	10 years	11	3,1	3,1	8,3
	15 years	27	7,7	7,7	16,0
	20 years and above	293	83,7	83,7	99,7
	5,00	1	0,3	0,3	100,0
	Total	350	100,0	100,0	

Most respondents (83.7%) have been living in the community for 20 years and above. 5 years, 10 years, and 15 years categories represent a smaller proportion of the respondents. This data illustrates that a considerable number of community members have deep-rooted connections to the community, with many of them having resided there for an extended period.

#### 4.3.1. 2 **Community perceptions towards bush encroachment**

The knowledge of the Sickle bush in Mafarana villagers is reflected in Table 4.5. Consequently, Table 7, dataset indicates that most of the respondents (90.3%) are aware of what Sickle bush is, while a small percentage (9.7%) indicated that they do not know what Sickle bush is. The indigenous names for the Sickle bush are

recognized as Morêtsê in Northern Sotho and Ndzenga in the Xitsonga language, as acknowledged by the local communities. These findings imply that Sickle bush is widely recognized within both the surveyed population and the broader community. Given the education level/ literacy level indicated in table 5, this does not come as a surprise because most of the participants have a formal qualification. This coincides with a study conducted by Chepane et al. (2014), which focused on verifying the local use and knowledge of fodder trees and shrubs that livestock graze upon in the Bushbuckridge area of South Africa. The study's findings highlighted that Sickle bush was the most known shrub species, as confirmed by both genders and individuals of all age groups involved in the research.

Table 4.6: Community's Awareness/ Knowledge Regarding Sickle Bush.

		<b>Do you know what Sickle bush is?</b>			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	316	90,3	90,3	90,3
	No	32	9,1	9,1	99,4
	I do not know	2	0,6	0,6	100,0
	Total	350	100,0	100,0	

### **Perceptions on the presence of Sickle bush in the environment**

General patterns from the above theme revealed that approximately 70 % of the respondents reviewed Sickle bush as a problem. This co-relates with data from table 4.5 above which indicated that 90,3% of the respondents are familiar with Sickle bush. Majority of those that viewed it as a problem indicated that the plant destroys natural environment while competing with grass and tree species and easily spreads or invades and is difficult to control:

*“Yes, it destroys grass and leaves the ground bare. The plant is invasive and destroys indigenous plants. It also prevents livestock from browsing and grazing”.*

*“Because the plant grows fast and is uncontrollable.”*

*“Livestock like to feed on the plants flowers and seeds then spread it through the dung”.*

Contrary to this perception, those that hold different view mentioned that the plant is not a problem because it is a beneficial plant that is used for firewood, medicinal purposes, shade, and fencing. Moreover, contextualizing the indigenous knowledge of the Mafarana villagers, a study by Bussa and Shibru (2020) which looked at the effects of Sickle bush encroachment on floristic and vegetation structure in semi-arid Savannah also clearly indicated that the native plant species of the savannah plains were under pressure due to Sickle bush encroachment. Equally, as echoed by the villagers in Mafarana plant has detrimental effects to the environment, grasses, and other surrounding plants it has proven to also have beneficial uses i.e., medicinal, animal feed and firewood as scientifically corroborated by numerous scholars (Cock et al., 2019; Bussa & Shibru, 2020; Subramaniam & Jaganathan, 2021). This observation validates the space and need for co-existence of these knowledge systems within society.

### **The understanding of bush encroachment by Mafarana residents**

The respondents provided a varying range of perceptions to their understanding of bush encroachment such as its invasive nature, ability to block access, potential danger to humans and animals, and a possible association with snakes and criminal activities. However, the majority (approximately) 64.66 % of the respondents perceived bush encroachment as a phenomenon of having a lot of trees in one place (thick bush), that prevents and restricts other plants from growing. Once more, these plants are perceived to be invasive and difficult to control:

*“Bush encroachment is an area covered by thick bushes. It is also difficult to access encroached areas.”*

*“Bush encroachment is thick and inaccessible area due to large number of trees and shrubs.”*

*“It is overgrown plants that take up space”.*

Approximately 6.67% of respondents expressed uncertainty or a lack of information regarding bush encroachment. Similarly, 9% of participants provided equal feedback about bush encroachment, citing concerns about it being a plant group that harbours snakes, posing safety risks due to its thorns, and potentially attracting criminal activities. These discoveries correspond with research conducted by Sebitloane et al. (2020), which highlights and explains bush encroachment as a widespread increase

and abundance of woody vegetation in grassland and savanna biomes. The study further explains that this phenomenon has direct impact on the socio-economic well-being of rural communities and affects livestock owners and those who utilise the land for various other purposes. These findings have been affirmed through the research, as it has been demonstrated that the presence of the plant directly affects both agricultural activities and the socio-economic well-being of the Mafarana community.

### **The impact of Sickle bush presence on Mafarana community**

Data from the questionnaires indicates that the respondents have varying or rather contracting perceptions on the impact of the Sickle bush in the community. According to the data represented both negative aspects (thorn hazard, invades quickly and destroys other plants, blocks visibility, consumes ground water, and dries the soil. Negative aspects from the answers mentioned, Positive aspects indicate that that the plant is useful for firewood and medicine and beneficial for livestock feed. Majority (38%) of the respondents felt that Sickle bush invades quickly and causes loss of grazing land by destroying grasses and other plants that animals graze and browse. Contrary, 20% of the respondents provided equal feedback about Sickle bush, citing that it is both beneficial for livestock that feed on it, firewood and for shade and that it is a hazard due to presence of thorns. Only 8.7 % indicated that it consumes a lot of ground water.

*“It kills all the grass around and increases crime in the community.”*

*“There is no grass growing, the soil does not produce food.”*

*“Although we use it for firewood and medicine, it remains a serious hazard to us (people). Children are being pricked by the thorn and it can cause permanent damage to the skin and health”.*

*“It will prick kids and old people as well when they enter an encroached area.”*

From the data, it is crucial to emphasize the dual nature of the plant, with both positive and negative aspects, indicating a complex relationship with the environment and human interactions. This suggests a complicated link with the environment and human relationships. Although the Sickle bush has many advantages, such as being useful for firewood, medicine, and some cattle, it also has negative consequences.

These include injuries caused by its thorns, loss of grazing area, damage of flora, decreased visibility, and depletion of groundwater. The link between the community, the environment, and the existence of the Sickle bush is characterized by intricate dynamics. Studies have investigated the possibility of using Sickle bush as a source of energy due to its significant biomass content and favourable wood characteristics (Fernández 2015). Furthermore, it has been scrutinized as a viable option for nutritious animal feed (Mupangwa et al., 2023) and for its potential medical applications (Sáez & Alfayate, 2020). However, the proliferation of Sickle bush in semi-arid savannahs has been reported to negatively impact the native flora, leading to a decrease in species richness and variety (Bussa & Shibrú, 2020).

#### **4.3.1.3 Correlation between the different age groups and knowledge of Sickle bush (common encroaching species)**

As per figure 4.1 provided below, it is evident that a considerable number of respondents across various age groups lack awareness about community-based projects aimed at addressing the issue of Sickle bush in the community. Notably, around 65% of respondents aged 55 and above firmly stated that they have no knowledge of any projects related to Sickle bush. Respondents in the age group of 25 to 44 seem to share a similar level of awareness or lack thereof regarding the existence of community-based projects targeting Sickle bush. Furthermore, some respondents mentioned their general lack of knowledge about any community projects. The data from the graph strongly indicates a lack of significant activity when it comes to community-based projects for Sickle bush control. It also suggests that community members, regardless of their age, are not well-informed about such initiatives/ projects. These results align with a study by Guta (2013) which raised critical questions about the limits of community engagement in community-based projects in communities.

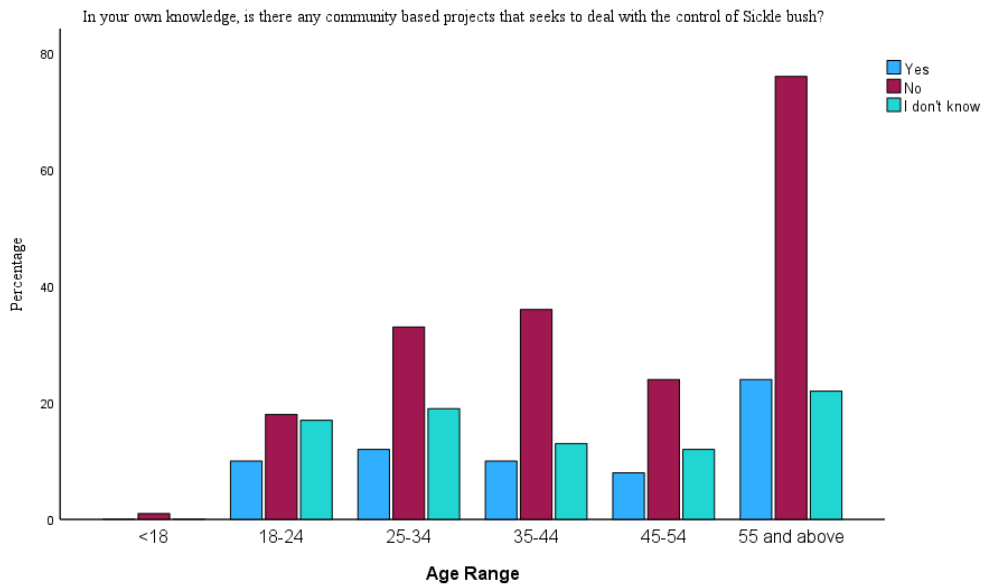


Figure 4.1: Knowledge Of Community Based Projects Targeting Sickle Bush, Per Age Groups.

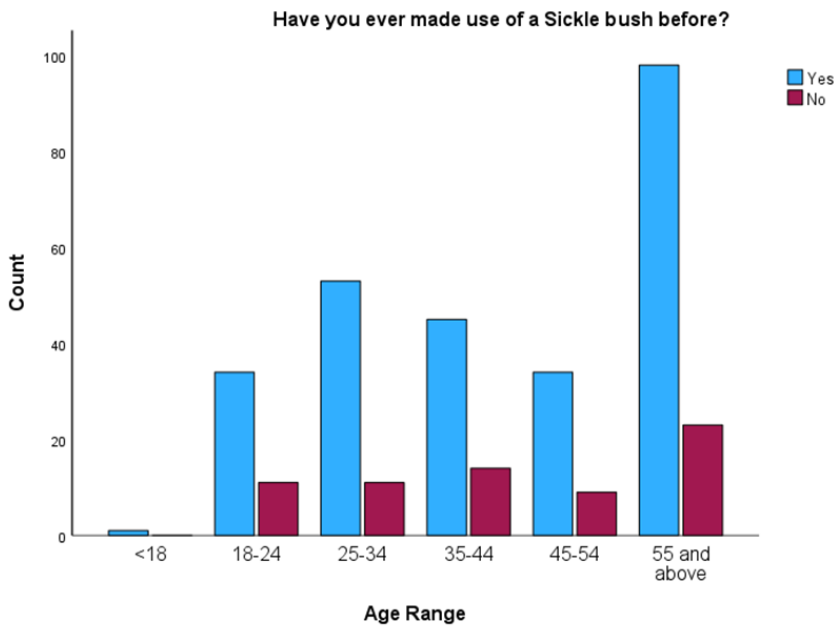


Figure 4.2: Sickle Bush Usage Per Age Group.

The data presented in figure 4.2 above shows that most respondents have used the plant across all age groups. However, it is noteworthy that among the 123 respondents in the 55 and above age group, approximately 92 of them have prior experience with the plant. This suggests that this age group has the highest usage rate, possibly indicating that younger generations are less familiar with Sickle bush compared to older generations. Additionally, it is important to mention that a



significant portion of the participants interviewed were 55 years and above as indicated in table 4.2. There are numerous studies that support this finding by indicating that Sickle bush has been used in communities for several uses ranging from medicinal, livestock forage, fencing poles and to fuel wood (Dingaan, 2018; Sáez & Alfayate, 2020; Nghikembua et al., 2023)

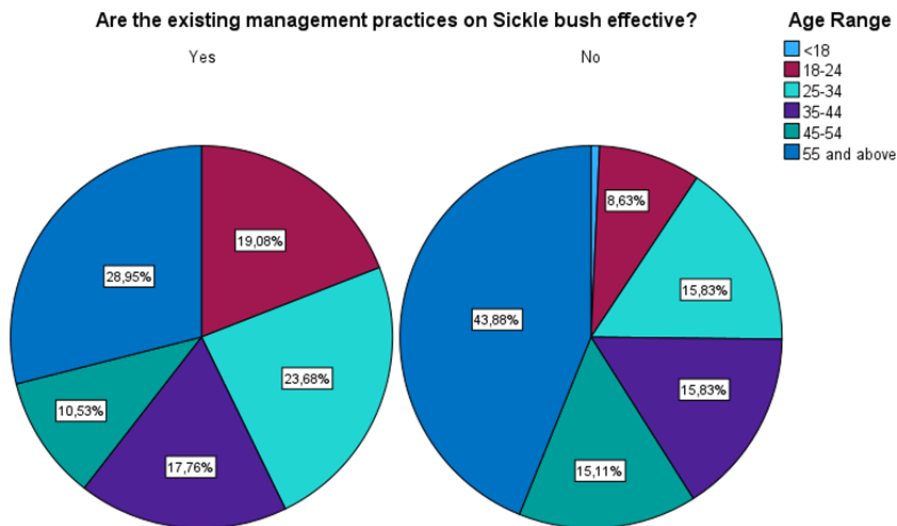


Figure 4.3: Community Perception of Sickle Bush Management Practices.

The data presented in the above graph reveals the perception of the effectiveness of current management practices for handling Sickle bush. Among the respondents who answered "yes" to this question, a significant proportion of individuals aged 55 and above expressed agreement with the current management practices' effectiveness. This discovery aligns with a study by Tenagyei (2021) which found that farmers in semi-arid Ghana perceive indigenous techniques to be effective for managing farmlands. In contrast, a smaller percentage of respondents in the 45-54 age bracket concurred with these practices. Interestingly, most respondents in the 55 and above age group disagreed with the existing management practices for Sickle bush, accounting for 43% of this group, which also happens to be the largest age group surveyed, as shown in Table 4.2. This data from the 55 and above age group clearly suggests that a substantial portion of the respondents have reservations about the effectiveness of the current management practices for Sickle bush.

#### **4.3.3.4 Perception and management practices on Sickle bush as an encroacher plant**

##### **Perceptions of the main factors contributing to bush encroachment**

Out of the surveyed participants, 20 individuals were identified as farmers. The purpose of singling out this group was to inquire about their firsthand experiences and specific management practices regarding Sickle bush in their respective farming areas daily. Around 70% of farmers, as indicated, verified that bush encroachment is caused by livestock consuming the plants and subsequently spreading them through dung in arable lands. Equally, three farmer groups, each accounting for 10%, agreed that the factors contributing to bush encroachment include inadequate control and management of woody plants, encroaching plants producing fruits and flowers that rapidly germinate, and the influence of wind and rain.

*“Cattle graze on the seeds/ fruit of the plant and then scatter it around grazing areas through defaecation”.*

*“Livestock also feeds on the plants and when they release faeces, they in a way also spread the seeds.”*

*“Livestock (cattle and goats) are the main carriers of spreading the Sickle bush as they feed on the seeds.”*

This finding is not isolated rather in congruent with a study by Belaynah (2017) which indicated that in semi-arid African ecosystems, bush encroachment is not only linked to /contributed by overgrazing, soil nutrient and moisture availability, elevated CO<sub>2</sub> levels, fire frequency only but also to the spread of woody species seeds by animals. According to Twine (2013), impoverished people often depend on a wider variety of advantages derived from their animals, including income for purchasing food and other goods. The proliferation of woody plants, however, was attributed to a multitude of circumstances. Varying degrees of education might contribute to divergent perspectives among those who use property. Everyone had advanced degrees in subjects directly connected to conservation. A study was conducted in a different region of South Africa where a rural community held unfavourable views towards woody encroachment. Their concerns stemmed from the potential damage to their crops, destruction of arable land, and alteration of the landscape identity by wild animals (Shackleton et al., 2013).

## **Perceptions on bush encroachment management in the Mafarana village**

There are diverse opinions on the management of bush encroachment within the village. However, it is important to note that majority (40%) of the respondents have indicated that the community, including farmers, is not actively engaged in managing bush encroachment. The only observed activities involve the collection of firewood, and some farmers only remove the encroaching vegetation in the specific areas where they cultivate. This was followed by approximately 35% of respondents who only viewed encroacher plants as being dangerous to animals as well as humans and as such they should be removed. A few respondents, approximately 5 % believed that the encroacher plants such as Sickle bush should not be removed because they are beneficial.

*“Nothing has been done at the moment for the management of bush encroachment in the village, only farmers remove it where they farm.”*

*“The encroaching plants are only controlled through the use of firewood and uprooting of the plant by farmers so that it does not grow again.”*

*“The plant should not be removed because it is important.”*

The statements provided by respondents emphasize that, currently, there is little initiative-taking management of bush encroachment in the village. Actions taken are mainly reactive, with farmers removing encroaching vegetation only in areas where they cultivate. Additionally, this data correlates precisely with findings from a study conducted in South Africa, revealing that most smallholder farmers in the region have abandoned their croplands due to rapid change in landcover that was accelerated by bush encroachment that was not effectively managed (Blair et al., 2018). Hence, comprehending the factors behind bush encroachment necessitates an inclusive methodology that incorporates the use of both ecological and indigenous ecological knowledge (Sop & Oldeland, 2011). The views and demands of the rural poor are crucial to address due to their reliance on ecosystem services, which may lead to different objectives compared to tourist and conservation groups (McNally et al., 2016). Perceptions of ecosystem services vary across land users, and their responses to changes in ecosystem services are expected to differ due to variations in their land use and resources (Carpenter et al., 2009; Ellis et al., 2019).

## **Farmers management skills of Sickle bush as an encroacher plant**

A total of 85% farmer respondents indicated that they cut the encroacher plant down, uproot all root systems then burn the remaining roots. This is reported to be a more effective way of managing Sickle bush as an encroacher plant. Equally, two farmer groups, each accounting for 5%, indicated that they manage the plant through the following ways: harvest it for firewood and fencing and through cutting the stem only. Interestingly, another 5% of respondents indicated that there is no need for management of Sickle bush as an encroachment plant. Although majority of the respondents indicated a set indigenous management style for Sickle bush, this data suggests a range of opinions among farmers regarding the necessity of addressing the Sickle bush as a potential threat.

*“As a farmer, I cut the plant and uproot it, that’s the best way of controlling it where I am farming.”*

*“By uprooting the plants roots completely, this method ensures that the plant does not grow back. The seedlings that grow are also uprooted.”*

*“There is nothing I can do; I just observe as it encroaches.”*

Based on the survey responses, it appears that a considerable number (35%) of respondents have acquired knowledge in managing Sickle bush as an encroacher plant through self-teaching. Their proficiency in these methods seems to stem from past failures and hands-on experience. An additional 30% of respondents gained knowledge about managing Sickle bush as an encroacher plant by observing successful outcomes on neighbouring farms, which served as a visible and effective learning source. The remaining group of respondents either learned this method from their parents and grand-parents or from the local extension officer. The remaining set of participants acquired this approach either through family teachings passed down from their parents and grandparents or from guidance provided by the local extension officer.

*“It was a decision I came up with because there was no other alternative.”*

*“No one has. I realised that if I do not uproot it, it does not die.”*

*“I was not taught any management practices, but I have seen others uprooting the tree.”*

*“My grandparents and father.”*

This in a way aligns with a study by Angassa and Oba (2008) on herder perceptions regarding the effects of range enclosures, crop farming, fire bans, and bush encroachment on communal rangelands. The research underscored the significance of indigenous knowledge, particularly in relation to bush encroachment on these shared grazing areas. The study revealed that farmers' perceptions of managing highly encroached rangelands played a beneficial role in the decision-making processes for rangeland management. It appeared that these farmers had acquired such management strategies from the practices of previous generations.

### **Indigenous knowledge system and the management of bush encroaching species.**

The graph illustrates divergent perspectives between male and female participants aged 55 and above about the use of indigenous knowledge in controlling Sickle bush and other encroacher species. Among individuals in this demographic, males have a greater understanding of indigenous knowledge systems and the management of Sickle bush, as compared to females. However, overall, this age group exhibited more participation in responding to this question compared to other age groups. The other age groups exhibited little engagement with the indigenous knowledge system, resulting in a conspicuous absence of responses to these inquiries. These findings indicate that individuals aged 55 and above had a greater understanding of the indigenous knowledge system and management of Sickle bush. These findings are consistent with the results of two studies, which indicate that older participants, particularly those aged 55, had a greater understanding of the indigenous knowledge system and the management of Sickle bush (Ayaa, 2016; Maringa, 2021).

Indigenous knowledge system and the management of Sickle bush and other encroacher species

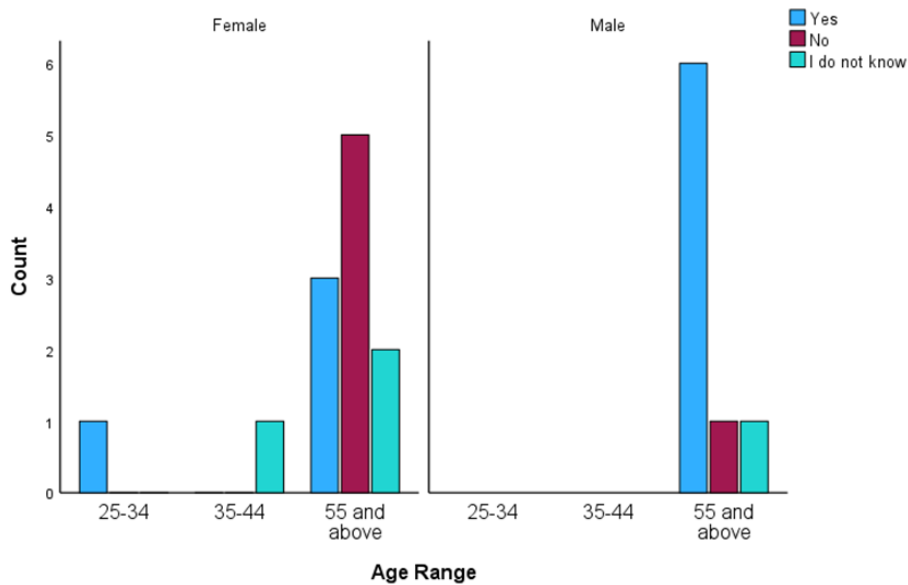


Figure 4.4: Indigenous Knowledge of Sickle Bush Management by Age.

**4.3.3.5 The efficacy of indigenous knowledge systems and methodologies in the management of Sickle bush.**

In Figure 4.5, it is evident that indigenous knowledge system methods have a history of success in managing Sickle bush. When looking at the responses from female participants, a significant 80% expressed confidence in the effectiveness of these indigenous methods, while only 20% disagreed. On the other hand, the responses from male participants were slightly different. Among the male respondents, 75% believed in the success of these indigenous knowledge methods, while 10% disagreed with this notion. Interestingly, 15% of male respondents were uncertain or did not have a clear opinion on the matter. The data demonstrates that a majority of both female and male respondents perceive the previous success of indigenous knowledge methods in managing Sickle bush, though there is a notable difference in the levels of agreement and uncertainty between the two genders. The results are in alignment with a study from Tanyanyiwa (2011) which indicated that indigenous knowledge systems have been found to play a crucial role in the management of forest resources, including the control of invasive species like Sickle bush. In the specific case of Sickle bush, the use of indigenous knowledge systems could potentially offer sustainable and effective management strategies.

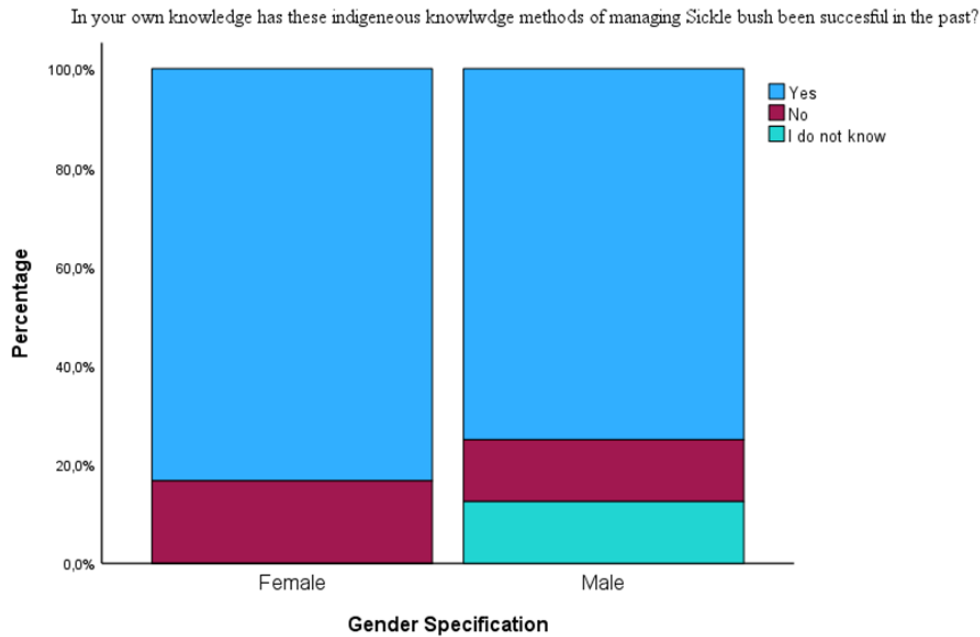


Figure 4.5: Success of Indigenous Sickle Bush Management by Gender.

In Figure 4.6, the data reveals that a higher percentage of females, specifically 60%, advocated for the incorporation of communal-based approaches and indigenous knowledge systems in the management of Sickle bush. In contrast, only 40% of males were in agreement with this approach. When looking at those who responded negatively, approximately 83.33% of the negative responses came from females, while males accounted for 16.16% of the negative responses. Additionally, there was a group of respondents who either did not know or chose not to respond to this question. Among this group, females constituted 75% of the respondents, while males made up 25% of the group. This data suggests a notable gender disparity in opinions and awareness regarding the inclusion of communal-based approaches and indigenous knowledge systems in Sickle bush management. In contrary, Brodt (1999) and Lake (2018) both emphasize the mixed nature of knowledge use, with information from multiple sources being integrated into local bodies of knowledge. This suggests that the management of Sickle bush should not be approached from a singular perspective, but rather through a combination of formal and informal knowledge systems.

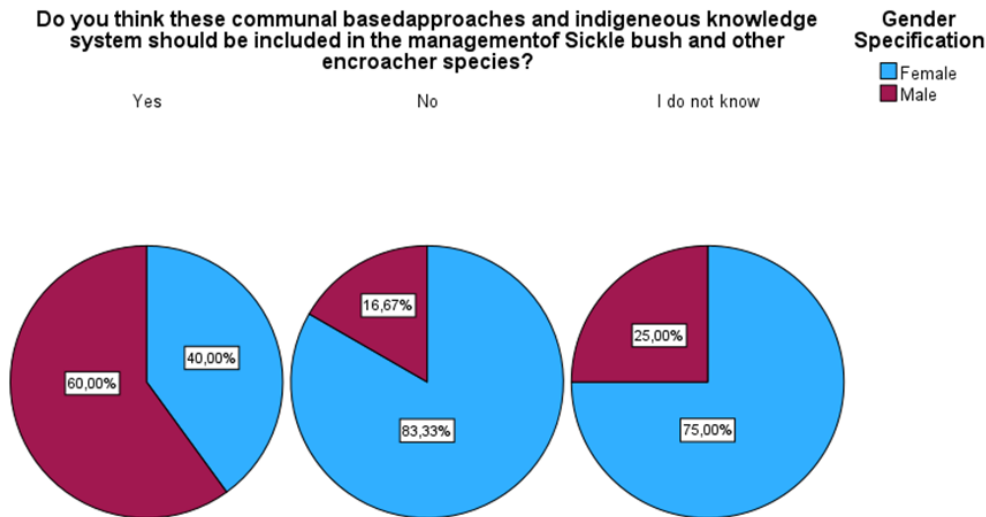


Figure 4.6: Gender Inclusion in Sickie Bush Management Approaches.

The respondents were also questioned on the weaknesses of the current methods employed for managing Sickie bush. Seemingly, majority of the respondents (45%) indicated that the methods have no weakness as it kills the encroacher plant completely. The approach involving cutting, uprooting, and burning has been widely recognized as a successful and efficient method by the farmers. Nonetheless, 35% of respondents argued that the technique is labour-intensive, time-consuming, and entails a substantial amount of effort, deeming it very challenging.

*“Uprooting is the only way we can be successful in clearing the tree”.*

*“If we do not burn the underground small roots, it grows again. It is also time consuming”.*

*“It is strenuous and time consuming. When you are old it is difficult to dig”.*

*“It is difficult and takes time”.*

This discovery aligns with finding in a study by Sinha et al. (2022) that measured the efficacy of different methods to manage invasive plants. According to this study methods of managing problematic plants through cutting uprooting and burning are highly effective and successful but the challenge is that invasive and encroacher plant species tend to invade freshly cleared or burnt areas easily due to exposure of the dormant seed to direct sunlight, water and veld fires that stimulate the



germination of seeds (Snyman, 2004; Tokozwayo, 2022). Moreover, the method has been proven to have detrimental long-term environmental implications to the soil as it causes soil erosion and environmental degradation (Matayaya et al., 2017).

### **Government based project on controlling bush encroachment**

The graph provides valuable insights into the respondents' awareness of government-based projects targeting the control of Sickle bush. Notably, it shows that 80% of those who answered negatively to the question fell within the age range of 55 and above, while the remaining 20% were aged between 35 and 44. In contrast, when considering those who did express knowledge of government initiatives aimed at managing Sickle bush, only about 10% were in the 35 to 44 age brackets. The majority, constituting 90% of respondents who displayed awareness of such projects, were aged 55 and above. It is interesting to note that there is no available data pertaining to the responses from respondents in the other age groups, which is a limitation in this analysis. These age groups did not offer responses to the question, resulting in a gap in the available data. In summary, the data from the graph indicates varying levels of awareness of government efforts to combat Sickle bush across different age groups. The results of this study are consistent with those of Itholeng (2007), revealing that local communities generally lack information about government projects within their vicinity. The study suggests that these communities are not well-informed about government-sponsored initiatives and are not actively participating in them.

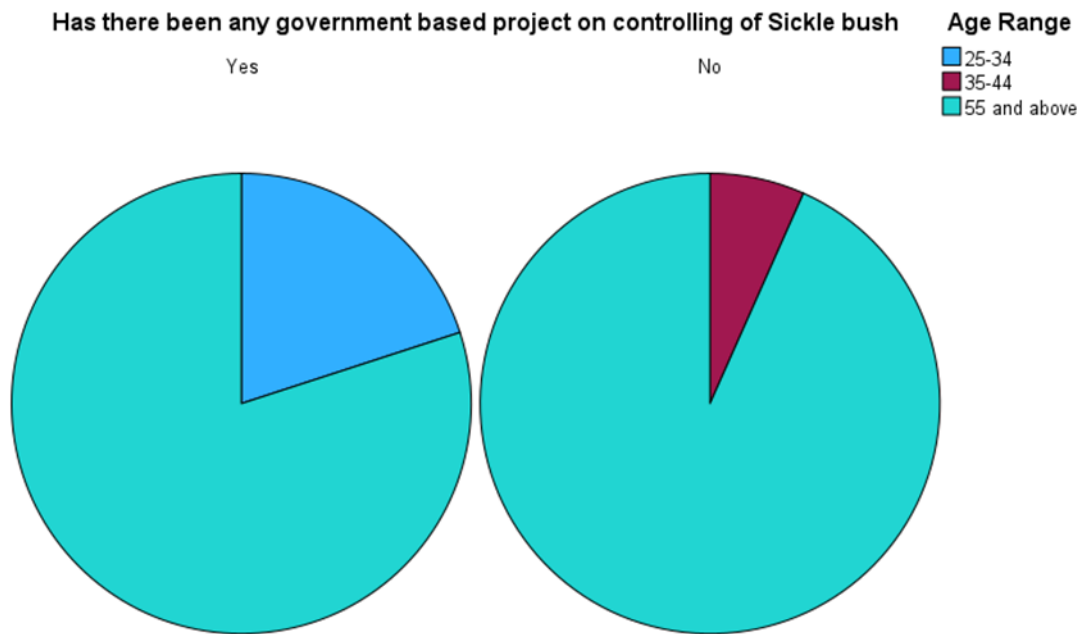


Figure 4.7: Knowledge Of Government-Based Projects for Controlling Sickle Bush Per Age Range.

Table 4.7: Table illustrating communities' sense of belonging to projects.

		Do communities feel a sense of belonging to such projects?			
		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Yes	7	2,0	35,0	35,0
	No	5	1,4	25,0	60,0
	I do not know	8	2,3	40,0	100,0
	Total	20	5,7	100,0	
Missing	System	330	94,3		
<b>Total</b>		<b>350</b>	<b>100,0</b>		

Based on table 4.7 above, 2.0% of the total respondents answered "Yes," 1.4% answered "No," and 2.3% responded with "I do not know." It is essential to note that a sizeable portion of respondents (94.3%) did not answer the question, resulting in missing data. Excluding the missing data, the valid percentages indicate that 35% of the respondents feel a sense of belonging to the projects, 25% do not feel a sense of belonging, and 40% are uncertain about their sense of belonging. This is no surprise because majority (approximately 90%) of the respondents did mention that they do not know of any community-based project that deals with Sickle bush as indicated in

figure 4.1 and 4.7 above and the discussions thereof. These results correspond with a study by Mangani et al (2020) which indicated that local communities do not feel a sense of belonging in such projects because they are not often involved and sometimes do not directly benefit.

#### **4.3.4 Conclusion**

In conclusion, the provided data offers a comprehensive insight into the demographic characteristics, awareness, perceptions, and management practices related to Sickle bush within the surveyed community of Mafarana village in the Greater Tzaneen Municipality of Limpopo province. Here are key points derived from the data: The sample exhibits a gender imbalance, with a higher proportion of females (66.6%) compared to males (33.4%). This aligns with the 2011 Statistics for the community, which also showed a higher percentage of females in the overall population. The respondents show a diverse age distribution, with the majority falling within the "55 and above" age group (35.1%). A sizeable portion of the respondents has secondary education (47.4%), followed by post-secondary education (24%). The high education level aligns with the community's awareness of Sickle bush, with 90.3% recognizing it. Respondents hold varied perceptions of Sickle bush, with some viewing it as a problem due to its negative impact on the environment, while others see it as beneficial for firewood, medicine, and livestock feed. The complex relationship with Sickle bush is reflected in both positive and negative aspects. The data indicates a lack of awareness and involvement in community-based projects addressing Sickle bush, particularly among older respondents (55 and above). This aligns with existing literature questioning the effectiveness of community engagement in such projects (Brooks et al., 2013; Cabrera et al., 2020; Mangani et al., 2020).

Indigenous knowledge systems, especially among older respondents, are perceived as effective in managing Sickle bush. There is a notable gender inconsistency in opinions about incorporating communal-based approaches and indigenous knowledge systems for Sickle bush management. However, a sizeable portion of respondents, especially those aged 55 and above, lack awareness of government projects targeting Sickle bush control. These echoes broader findings suggesting a lack of community involvement and information regarding government initiatives. Also, considerable percentage of respondents expressed uncertainty about their sense of belonging to community-based projects dealing with Sickle bush. This

unclearness may be attributed to the overall lack of awareness and involvement in such initiatives. While there is not a formalized strategy for addressing the encroachment of Sickle bush in the community, many farmers have adopted what appears to be a successful approach passed down through generations. Despite the apparent effectiveness of these methods, they come with weaknesses such as being labour-intensive, time-consuming, and requiring considerable effort. In summary, the data highlights the subtle relationship between the community and Sickle bush, reflecting a need for more targeted and inclusive efforts in community engagement, education, and project implementation to address the challenges posed by Sickle bush effectively. The study also emphasizes the importance of considering indigenous knowledge systems and implementing interventions related to Sickle bush management.

## CHAPTER FIVE: CONCLUSION AND RECOMMENDATION

This chapter aims at providing an overall conclusion of the research study and provide recommendations to the community of Mafarana village in Limpopo province as well as the local and provincial government. The study investigated communal-based approach strategies for bush encroachment management in a savannah rangeland of Mafarana village. The study was successful in achieving all its listed objectives and highlighted the following findings:

- Sickle bush is well known in the community, and it is considered a problem. This knowledge of the woody or shrubby plant can be as a result of the elevated levels of education within the community. The data on the high usage of Sickle bush also suggests that the community has had some type of indigenous knowledge on Sickle bush which was transferred from one generation to another.
- The community also understands the phenomenon of bush encroachment and it is understood that it has detrimental impacts towards the environment, and humans.
- Besides limited interventions by government to assist with controlling the available Sickle bush, the community believes that the plant is easily spread by livestock through the availability of seeds in their dung.
- Farmers in the community have adopted a distinct way of managing encroachment by cutting, uprooting, and burning Sickle bush, which is effective and successful for them while waiting for government intervention. However, this method is also said to be time consuming.
- There seem to be no government based nor community-based projects aimed at controlling nor managing the problem of bush encroachment within the community. Even if they were there, community members feel that they would not be directly involved in such projects.

### 5.1. Conclusion

The issue of bush encroachment on savannah ecosystems has been increasing globally and communal farming areas in poor and rural communities are no exception to this form of environmental degradation. Within the community of Mafarana village in the Greater Tzaneen Municipality of Limpopo province, the comprehensive insights

gained from the data indicate the complex and dynamic patterns of bush encroachment, with Sickle bush being the main encroacher plant. The gender imbalance, diverse age distribution, and varying educational backgrounds of the respondents contribute to the complexity of perceptions and management practices related to bush encroachment.

The findings of the current study reveal a diverse relationship with Sickle bush, where community members perceive it both as a challenge and a resource. The perspectives regarding its environmental impact and utility for firewood, medicine, and livestock feed, highlight the need for context-specific strategies in addressing the issue. Additionally, the data indicates a lack of awareness and participation in community-based projects, particularly among older respondents, reflecting potential challenges in engaging diverse age groups in such initiatives. Moreover, indigenous knowledge systems emerge as a valuable resource, especially among the elderly community members, suggesting the potential of integrating traditional practices into communal-based approaches for Sickle bush management. However, there are challenges as the data also highlights gender inconsistency in opinions, emphasizing the importance of considering diverse perspectives and experiences within the community. This study sheds light on limited awareness of any government initiatives and the uncertainty among respondents about their involvement in community projects targeting Sickle bush. This underlines the necessity for improved communication and community engagement strategies to bridge the gap between governmental efforts and local communities. Despite the absence of a formalized strategy to manage and control Sickle bush, the data reveals that most farmers have adopted successful approaches passed down through generations. However, these methods come with weaknesses, such as being labour-intensive and time-consuming. This highlights the importance of striking a balance between traditional practices / indigenous knowledge systems and innovative, sustainable interventions for effective Sickle bush management with modern land management strategies.

This study therefore underlines the need for targeting an inclusive effort in community engagement, education, and project implementation to effectively address the challenges posed by Sickle bush encroachment. Ultimately, emphasizing the integration of indigenous knowledge systems and acknowledging the diversity of perspectives within the community will be crucial in developing communal-based strategies that are both sustainable and culturally sensitive. Overall, the findings

advocate for a holistic and collaborative approach involving the community, government, and other stakeholders to achieve long-term success in mitigating the impact of Sickle bush on the community of Mafarana village.

## **5.2 Recommendations**

Recommendations for communal-based strategies for bush encroachment management in a savannah rangeland, specifically in Mafarana village, have been tailored to the local context, considering the community's resources, traditional practices, and ecological conditions. The following are recommendations for the community including farmers and local and/or provincial government:

- The local and provincial governments should initiate community workshops and awareness programs to educate residents about the negative impacts of bush encroachment on grazing lands, biodiversity, and water resources. This will foster a sense of ownership and responsibility among community members by highlighting the long-term benefits of sustainable land management.
- Local and provincial governments should also conduct a participatory mapping exercise to identify areas affected by bush encroachment. This can be done in collaboration with local experts and environmental agencies such as the Conservation South Africa (CSA) and the Kruger to Canyon Biosphere Region (K2C) to assess the severity of encroachment and its impact on the ecosystem.
- The local communities and government departments should promote and integrate traditional grazing practices that prevent bush encroachment, such as controlled burning or rotational grazing, into modern land management strategies. Therefore, encourage the sharing of indigenous knowledge among community members to enhance the effectiveness of these practices.
- There is a need to establish a community-based monitoring system to regularly assess changes in vegetation cover and identify areas where bush encroachment is intensifying.
- The community must collaborate with local agricultural extension services, research institutions, and NGOs to provide technical support and guidance for sustainable land management practices.

- Develop incentive programs that reward communities for successful bush encroachment management, such as access to additional resources, improved infrastructure, or participation in eco-tourism initiatives.
- Implementation of controlled burning practices under community supervision to reduce encroaching woody vegetation.
- Farmers to establish firebreaks and conduct controlled burns during appropriate seasons to prevent uncontrolled wildfires.
- Lastly, local, and provincial governments must involve the community throughout the planning and implementation process of any land management plans to ensure the success and sustainability of these strategies. This could be conducted through regular communication, capacity building, and adaptive management approaches, which will contribute to the effectiveness of communal-based bush encroachment management in Mafarana village.



## References

- Adedibu, P.A., Opeyemi, A.A., Lawrence, A.J., Paul, J.I., and Oguntoy, E., 2001. Savanna Biomes in Nigeria: Indicator Species and Plant Adaptation Strategies, 4.
- Adger, W.N. and Vincent, K., 2005. Uncertainty in adaptive capacity. *Comptes Rendus Geoscience*, 337(4), 399-410.
- Admasu, T., Abule, E. and Tessema, Z.K., 2010. Livestock-rangeland management practices and community perceptions towards rangeland degradation in South Omo zone of Southern Ethiopia. *Livestock Research for Rural Development*, 22(1).
- Agyen-Brefo, R., 2012. The effects of encroachment on sustainable Public Land Management: a case study of the Owabi catchment area in Kumasi. (Doctoral dissertation, Kwame Nkrumah University of Science and Technology).
- Almalki, R., Khaki, M., Saco, P.M., and Rodriguez, J.F., 2022. Monitoring and Mapping Vegetation Cover Changes in Arid and Semi-Arid Areas Using Remote Sensing Technology: A Review. *Remote Sensing*, 14(20), p.5143.
- Anderies, J.M., Janssen, M.A., & Walker, B., 2002. Grazing Management, Resilience, and the Dynamics of a Fire-driven Rangeland System. *Ecosystems*, 5, 23-44.
- Angassa, A., 2005. The ecological impact of bush encroachment on the yield of grasses in Borana rangeland ecosystem. *African Journal of Ecology*, 43(1), 14-20.
- Angassa, A. and Oba, G., 2008. Herder perceptions on impacts of range enclosures, crop farming, fire ban and bush encroachment on the rangelands of Borana, Southern Ethiopia. *Human ecology*, 36, 201-215.
- Angassa, A., Oba, G. and Stenseth, N.C., 2012. Community-based knowledge of indigenous vegetation in arid African landscapes. *Consilience*, (8), pp.70-85.
- Archer, S. and Stokes, C., 2000. Stress, disturbance and change in rangeland ecosystems. *Rangeland desertification*, 9, 17-38.
- Archer, S.R., Andersen, E.M., Predick, K.I., Schwinning, S., Steidl, R.J. and Woods, S.R., 2017. Woody plant encroachment causes and consequences. *Rangeland systems: Processes, management, and challenges*, 25-84.
- Archer, S.R., 2010. Rangeland conservation and shrub encroachment: new perspectives on an old problem. *Wild rangelands: conserving wildlife while maintaining livestock in semi-arid ecosystems*, 53-97.
- Asner, G.P., Elmore, A.J., Olander, L.P., Martin, R.E. and Harris, A.T., 2004. Grazing systems, ecosystem responses, and global change. *Annu. Rev. Environ. Resour.*, 29, 261-299.
- Avorny, F.K., Zougmore, R.B., Partey, S.T. and Tengan, K., 2018. Candidate fodder trees and shrubs for sustainable ruminant production in northern Ghana. *Livestock Research for Rural Development*, 30(9), 1-8.

- Ayaa, D.D. and Waswa, F., 2016. Role of indigenous knowledge systems in the conservation of the bio-physical environment among the Teso community in Busia County-Kenya. *African Journal of Environmental Science and Technology*, 10(12), 467-475.
- Ayelew, S. and Muluaalem, G., 2018. A review on bush encroachment effect on cattle rearing in rangelands. *Journal of Rangeland Science*, 8(4), 403-415.
- Bacci, L., Díaz-Balteiro, L., & Fernández-Landa, A., 2018. Community-based management of bush encroachment in southern Africa: a review of successes, failures, and prospects. *Land Use Policy*, 72, 576-584.
- Belayneh, A., & Tessema, Z.K., 2017. Mechanisms of bush encroachment and its inter-connection with rangeland degradation in semi-arid African ecosystems: a review. *Journal of Arid Land*, 9, 299-312.
- Bell, E. and Bryman, A., 2007. The ethics of management research: an exploratory content analysis. *British journal of management*, 18(1), pp.63-77.
- Beyene, F., 2009. Exploring incentives for rangeland enclosures among pastoral and agropastoral households in eastern Ethiopia. *Global Environmental Change*, 19(4), pp.494-502.
- Bolo, P.O., Sommer, R., Kihara, J.M., Kinyua, M., Nyawira, S. and Notenbaert, A.M.O., 2019. Rangeland degradation: Causes, consequences, monitoring techniques and remedies. CIAT Publication. Cajete, G., 1994. *Look to the mountain: An ecology of indigenous education*. Kivaki Press, 585 E. 31st St., Durango, CO 81301.
- Bussa, B. and Shibru, S., 2020. Effects of Sicklebush (*Dichrostachys cinerea* (L.) wight and arn. shrub) Encroachment on Floristic and Vegetation Structure in Semi-arid Savannah of Southern Ethiopia. *J. Environ. Earth Sci.*, 10, 1-11.
- Brodts, S.B., 1999. Interactions of formal and informal knowledge systems in village-based tree management in central India. *Agriculture and Human Values*, 16(4), pp.355-363.
- Cabrera, J.F., Harrison, R. and Tsui, J., 2020. Method to Improve the Effectiveness of Community-Based Participatory Research Projects: A Social Network Approach. *Progress in Community Health Partnerships: Research, Education, and Action*, 14(3), pp.393-406.
- Canavan, K., Paterson, I.D., Ivey, P., Sutton, G.F. and Hill, M.P., 2021. Prioritisation of targets for weed biological control III: a tool to identify the next targets for biological control in South Africa and set priorities for resource allocation. *Biocontrol Science and Technology*, 31(6), pp.584-601.
- Cao, X., Liu, Y., Cui, X., Chen, J. and Chen, X., 2019. Mechanisms, monitoring, and modelling of shrub encroachment into grassland: a review. *International Journal of Digital Earth*, 12(6), 625-641.

- Chauke, M.A., Shai, L.J., Mogale, M.A., Tshisikhawe, M.P. and Mokgotho, M.P., 2015. Medicinal plant use of villagers in the Mopani district, Limpopo province, South Africa. *African Journal of Traditional, Complementary and Alternative Medicines*, 12(3), 9-26.
- Chepape, R.M., Mbatha, K.R. and Luseba, D., 2014. Local use and knowledge validation of fodder trees and shrubs browsed by livestock in Bushbuckridge area, South Africa. *Ghanaian Popul*, 77, pp.20-47.
- Chingono, T.T. and Mbohwa, C., 2015. Fire hazard modelling in Southern Africa. In *Proceedings of the World Congress on Engineering and Computer Science*, 1, 514-519).
- Clarke, V. and Braun, V., 2017. Thematic analysis. *The journal of positive psychology*, 12(3), 297-298.
- Cock, I.E., Selesho, M.I. and Van Vuuren, S.F., 2019. A review of the traditional use of southern African medicinal plants for the treatment of malaria. *Journal of ethnopharmacology*, 245, 112176.
- Combs, J. P., & Onwuegbuzie, A. J. (2010). Describing and illustrating data analysis in mixed research. *International Journal of Education*, 2(2).
- Conradie, B., Nandjila, R., & Isakson, S., 2018. Participatory and collaborative bush encroachment management in Namibia: Experiences from the Otjihavera community game guard program. *Land Use Policy*, 79, 462-471.
- Cornwall, A. and Brock, K., 2005. What do buzzwords do for development policy? A critical look at 'participation', 'empowerment' and 'poverty reduction.' *Third world quarterly*, 26(7), 1043-1060.
- Creswell, J.D., Way, B.M., Eisenberger, N.I. and Lieberman, M.D., 2007. Neural correlates of dispositional mindfulness during affect labeling. *Psychosomatic medicine*, 69(6), pp.560-565.
- Cronbach, L. J., 1951. Coefficient alpha and the internal structure of tests. *Psychometrika*, 16(3), 297-334.
- Czeglédi, L. and Radácsi, A., 2005. Overutilization of pastures by livestock. *Gyepgazdálkodási Közlemények*, 3(1-2), 29-35.
- Danley, K., *Letters of the Bush: A Case Study of Traditional Setswana Herbal Medicine*. 2006. Independent Study Project (ISP) Collection, Paper, 270.
- Deur, D. and Bloom, R., 2021. Fire, native ecological knowledge, and the enduring anthropogenic landscapes of Yosemite Valley. In *Routledge Handbook of Indigenous Environmental Knowledge*. Taylor & Francis.
- Dingaen, M. and du Preez, P.J., 2018. *Vachellia* (Acacia) karroo communities in South Africa: an overview. *Pure and Applied Biogeography*, 109-141.

Díaz, S., Demissew, S., Carabias, J., Joly, C., Lonsdale, M., Ash, N., Larigauderie, A., Adhikari, J.R., Arico, S., Báldi, A. and Bartuska, A., 2015. The IPBES Conceptual Framework—connecting nature and people. *Current opinion in environmental sustainability*, 14, 1-16.

Eldridge, D.J., Bowker, M.A., Maestre, F.T., Roger, E., Reynolds, J.F. and Whitford, W.G., 2011. Impacts of shrub encroachment on ecosystem structure and functioning: towards a global synthesis. *Ecology letters*, 14(7), 709-722.

Fernández, M, García-Albalá, J, Andivia, E, Alaejos, J, Tapias, R, Menéndez, J., 2015. Sickie bush (*Dichrostachys cinerea* L.) field performance and physical–chemical property assessment for energy purposes, *Biomass and Bioenergy*. 81,483-489.

Fernández, M., Alaejos, J., Andivia, E., Madejón, P., Díaz, M.J. and Tapias, R., 2020. Short rotation coppice of leguminous tree *Leucaena* spp. improves soil fertility while producing high biomass yields in Mediterranean environment. *Industrial Crops and Products*, 157, 112911.

Fisher, J.T., 2013. People, parks, and rangelands: an analysis of three-dimensional woody vegetation structure in a semi-arid savanna. Faculty of Science, University of the Witwatersrand.

Fraser, E.D., Dougill, A.J., Mabee, W.E., Reed, M. and McAlpine, P., 2006. Bottom up and top down: Analysis of participatory processes for sustainability indicator identification as a pathway to community empowerment and sustainable environmental management. *Journal of Environmental Management*, 78(2), 114-127.

Gobelle, S.K., & Gure, A., 2018. Effects of bush encroachment on plant composition, diversity, and carbon stock in Borana rangelands, Southern Ethiopia. *International Journal of Biodiversity and Conservation*, 10, 230-245.

Gouws, A., 2017. Chopped shrubs save a persevering farmer. *Stockfarm*, 7(2), 30-31.

Graw, V., Ghazaryan, G., Dall, K., Delgado Gómez, A., Abdel-Hamid, A., Jordaan, A., Pirooska, R., Post, J., Szarzynski, J., Walz, Y. and Dubovyk, O., 2017. Drought dynamics and vegetation productivity in different land management systems of Eastern Cape, South Africa—A remote sensing perspective. *Sustainability*, 9(10), .1728.

Grimble, R. and Wellard, K., 1997. Stakeholder methodologies in natural resource management: a review of principles, contexts, experiences, and opportunities. *Agricultural systems*, 55(2), 173-193.

Gustafsson, J., Cederberg, C., Sonesson, U. and Emanuelsson, A., 2013. The methodology of the FAO study: Global Food Losses and Food Waste—extent, causes and prevention”-FAO, 2011.

- Gxasheka, M., Solomon, T.B., Lesoli, M. and Mlisa, N., 2013. Euryops Floribuntus Encroachment in Eastern Cape Communal Rangelands: Indigenous and Scientific Understanding of Effects on Range Ecology, and Food Security (Doctoral dissertation, University of Fort Hare).
- Haddaway, N. R., Page, M. J., Pritchard, C. C., & McGuinness, L. A. ,2022. PRISMA2020: An R package and Shiny app for producing PRISMA 2020-compliant flow diagrams, with interactivity for optimised digital transparency and Open Synthesis Campbell Systematic Reviews, 18, e1230. <https://doi.org/10.1002/cl2.1230>
- Hardin, G., 1968. The tragedy of the commons: the population problem has no technical solution; it requires a fundamental extension in morality. *Science*, 162(3859), 1243-1248.
- Hare, M.L., Xu, X., Wang, Y. and Gedda, A.I., 2020. The effects of bush control methods on encroaching woody plants in terms of die-off and survival in Borana rangelands, southern Ethiopia. *Pastoralism*, 10(11-14).
- Hare, M.L., Wang, Y.D., Xu, X.W., Yuan, Y., Na, Z. and Gedda, A.E., 2021. Do Bush Control Techniques Have an Effect on the Density, Cover and Recruitment of Woody Plants in a Semi-Arid Savanna? The Case of a Semi-Arid Savanna, Southern Ethiopia. *Frontiers in Environmental Science*, 9, p.545.
- Hendren, K., Newcomer, K., Pandey, S.K., Smith, M. and Sumner, N., 2023. How qualitative research methods can be leveraged to strengthen mixed methods research in public policy and public administration. *Public Administration Review*, 83(3), 468-485.
- Higginbottom, T.P., Symeonakis, E., Meyer, H. and van der Linden, S., 2018. Mapping fractional woody cover in semi-arid savannahs using multi-seasonal composites from Landsat data. *ISPRS Journal of Photogrammetry and Remote Sensing*, 139, 88-102.
- Higgs, E., 2003. *Nature by design: people, natural process, and ecological restoration*. MIT Press.
- Hobbs, R.J. and Humphries, S.E., 1995. An integrated approach to the ecology and management of plant invasions. *Conservation biology*, 9(4), pp.761-770.
- Hudak, A. T., 1999. Rangeland Mismanagement in South Africa: Failure to Apply Ecological Knowledge. *Human Ecology*.27:1:55-78.
- Hutley, L.B., and Setterfield, S.A., 2008. *Encyclopedia of Ecology*, 3143-3153
- Huxman, T.E., Wilcox, B.P., Breshears, D.D., Scott, R.L., Snyder, K.A., Small, E.E., Hultine, K.R., Pockman, W.T., & Jackson, A.N., 2005. Ecohydrological implications of woody plant encroachment. *Ecology*, 86, pp. 308-319.

- Itholeng, K.B.I., 2007. The indigenous knowledge of the local community towards weeds and alien invasive plants in the Dinokana area, North-West Province, South Africa (Doctoral dissertation, North-West University).
- James, L.F., Young, J.A. and Sanders, K., 2003. A new approach to monitoring rangelands. *Arid Land Research and Management*, 17(4), 319-328.
- Jamsranjav, C., Fernández-Giménez, M.E., Reid, R.S. and Adya, B., 2019. Opportunities to integrate herders' indicators into formal rangeland monitoring: an example from Mongolia. *Ecological Applications*, 29(5), p.e01899.
- Jeltsch, F., Milton, S.J., Dean, W.R.J. and Van Rooyen, N., 1997. Analysing shrub encroachment in the southern Kalahari: a grid-based modelling approach. *Journal of Applied Ecology*, 1497-1508.
- Jucker Riva, M., Baeza, J., Bautista, S., Christoforou, M., Daliakopoulos, I.N., Hadjimitsis, D., Keizer, J.J., Liniger, H., Quaranta, G., Ribeiro, C. and Salvia, R., 2018. How does land management contribute to the resilience of Mediterranean forests and rangelands? A participatory assessment. *Land degradation & development*, 29(10), 3721-3735.
- Kellner, K., Fouché, J., Tongway, D., Boneschans, R., van Coller, H. and van Staden, N., 2022. Landscape Function Analysis: responses to bush encroachment in a semi-arid savanna in the Molopo region, South Africa. *Sustainability*, 14(14), 8616.
- Kgaphola, M.J., Ramoelo, A., Odindi, J., Mwenge Kahinda, J.M., Seetal, A.R. and Musvoto, C., 2023. Impact of land use and land cover change on land degradation in rural semi-arid South Africa: case of the Greater Sekhukhune District Municipality. *Environmental Monitoring and Assessment*, 195(6), 710.
- Kgosikoma, O. E., and Mogotsi, K., 2013. Understanding the causes of bush encroachment in Africa: The key to effective management of savanna grasslands. *Tropical Grasslands-Forrajes Tropicales*, 1(2), pp.215–219.
- Kgosikoma, K. A., Gadibolae, C. S., Mmopelwa, G., and Mosimanyana, B. M., 2018. Community participation in bush encroachment control: Experiences from Khutse, Botswana. *Journal of Arid Environments*, 157, 1-8.
- Kraaij, T. and Ward, D., 2006. Effects of rain, nitrogen, fire and grazing on tree recruitment and early survival in bush-encroached savanna, South Africa. *Plant Ecology*, 186(2), 235-246.
- Kumar, K. and Ormiston, J., 2012. Bounding research settings. *Handbook of Research Methods on Social Entrepreneurship*, pp.106-123.
- Lake, F.K., Parrotta, J., Giardina, C.P., Davidson-Hunt, I. and Uprety, Y., 2018. 12 Integration of Traditional and Western knowledge in forest landscape restoration. *Forest landscape restoration: Integrated approaches to support effective implementation*, pp.198-226.

- Lam, Q.D., Rötter, R.P., Rapholo, E., Ayisi, K., Nelson, W.C.D., Odhiambo, J. and Foord, S., 2023. Modelling maize yield impacts of improved water and fertilizer management in southern Africa using cropping system model coupled to an agro-hydrological model at field and catchment scale. *The Journal of Agricultural Science*, 161(3), pp.356-372.
- Leavy, P., 2022. *Research design: Quantitative, qualitative, mixed methods, arts-based, and community-based participatory research approaches*. Guilford Publications.
- Li, J., Ravi, S., Wang, G., Van Pelt, R.S., Gill, T.E. and Sankey, J.B., 2022. Woody plant encroachment of grassland and the reversibility of shrub dominance: Erosion, fire, and feedback processes. *Ecosphere*, 13(3), 3949.
- Liu, Y., Shi, Z., Gong, L., Cong, R., Yang, X., & Eldridge, D.J, 2019. Is the removal of aboveground shrub biomass an effective technique to restore a shrub-encroached grassland? *Restoration Ecology*, 27, 1348-1356.
- Lohmann, D., Tietjen, B., Blaum, N., Joubert, D.F. and Jeltsch, F., 2014. Prescribed fire as a tool for managing shrub encroachment in semi-arid savanna rangelands. *Journal of Arid Environments*, 107, 49-56.
- Lockwood, M., Davidson, J., Curtis, A., Stratford, E. and Griffith, R., 2010. Governance principles for natural resource management. *Society and natural resources*, 23(10), pp.986-1001.
- Londe, D., Cady, S., Elmore, R.D. and Fuhlendorf, S., 2022. Woody plant encroachment pervasive across three socially and ecologically diverse ecoregions. *Ecology and Society*, 27(3), 11.
- Lukomska, N., Quaas, M.F., & Baumgärtner, S., 2014. Bush encroachment control and risk management in semi-arid rangelands. *Journal of environmental management*, 145, 24-34.
- Luvuno, L., Biggs, R., Stevens, N. and Esler, K., 2018. Woody encroachment as a social-ecological regime shift. *Sustainability*, 10(7), 2221.
- Mairiga, N.M., & Ibrahim, M. (2021). *Assessment of Indigenous Knowledge in Managing Environmental Challenges: A Case Study of Ringim Local Government Area of Jigawa State, Nigeria*.
- Malami, I., Jagaba, N.M., Abubakar, I.B., Muhammad, A., Alhassan, A.M., Waziri, P.M., Yahaya, I.Z.Y., Mshelia, H.E. and Mathias, S.N., 2020. Integration of medicinal plants into the traditional system of medicine for the treatment of cancer in Sokoto State, Nigeria. *Heliyon*, 6(9), 04830.
- Mampholo, R.K., 2006. *To determine the extent of bush encroachment with focus on Prosopis species on selected farms in the Vryburg district of North West Province (Doctoral dissertation, North-West University)*.

- Mangani, T., Coetzee, H., Kellner, K., Chirima, G., 2020. Socio-Economic Benefits Stemming from Bush Clearing and Restoration Projects Conducted in the D’Nyala Nature Reserve and Shongoane Village, Lephalale, South Africa. *Sustainability*, 12, 5133.
- Mangena, P., Kwetepane, T., Peta, T.S.P., Shengwenyana, C., Mutele, M. and Moila, R., 2014. Survey to determine botanical composition and identification of the localities of certain plant species used for study purposes. Botany Student Forum, University of Limpopo.
- Maphanga, T., Dube, T., Shoko, C. and Sibanda, M., 2022. Advancements in the satellite sensing of the impacts of climate and variability on bush encroachment in savannah rangelands. *Remote Sensing Applications: Society and Environment*, 25, 100689.
- Mariani, M., Connor, S.E., Theuerkauf, M., Herbert, A., Kuneš, P., Bowman, D., Fletcher, M.S., Head, L., Kershaw, A.P., Haberle, S.G. and Stevenson, J., 2022. Disruption of cultural burning promotes shrub encroachment and unprecedented wildfires. *Frontiers in Ecology and the Environment*, 20(5), 292-300.
- Marius, L.N., Osafo, E.L., Mpofu, I.D., van der Merwe, P., Boys, J. and Attoh-Kotoku, V., 2017. Indigenous knowledge and identification of local woody plant species as potential feeds for goats in the communal farming areas of Namibia. *Livestock Research for Rural Development*, 29(10), p.1.
- Matayaya, G., Wuta, M. and Nyamadzawo, G., 2017. Effects of different disturbance regimes on grass and herbaceous plant diversity and biomass in Zimbabwean dambo systems. *International Journal of Biodiversity Science, Ecosystem Services & Management*, 13(1), pp.181-190.
- McLean, M., Warner, B., Markham, R., Fischer, M., Walker, J., Klein, C., Hoeberechts, M. and Dunn, D.C., 2023. Connecting conservation & culture: The importance of Indigenous Knowledge in conservation decision-making and resource management of migratory marine species. *Marine Policy*, 155, p.105582.
- Mitchard, E.T. and Flintrop, C.M., 2013. Woody encroachment and forest degradation in sub-Saharan Africa’s woodlands and savannas 1982–2006. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 368(1625), 20120406.
- Mokgotsi, R.O., 2018. Effects of bush encroachment control in a communal managed area in the Taung region, North West Province, South Africa (Doctoral dissertation, North-West University).
- Moleele, N.M., Ringrose, S., Matheson, W. and Vanderpost, C., 2002. More woody plants? The status of bush encroachment in Botswana’s grazing areas. *Journal of Environmental Management*, 64(1), 3-11.



- Mugasi, S.K., Sabiiti, E.N. and Tayebwa, B.M., 2000. The economic implications of bush encroachment on livestock farming in rangelands of Uganda. *African Journal of Range and Forage Science*, 17(1-3), 64-69.
- Mupangwa, J., Lutaaya, E., Shipandeni, M.N.T., Kahumba, A., Charamba, V. and Shiningavamwe, K.L., 2023. Utilising Encroacher Bush in Animal Feeding. In *Towards Sustainable Food Production in Africa: Best Management Practices and Technologies* (pp. 239-265). Singapore: Springer Nature Singapore.
- Musiwa, M., & Palmer, A. R., 2018. Community-led approaches to bush encroachment control: experiences from communal rangelands in Namibia. *Land*, 7(2), 58.
- Naidoo, L. 2011. Using an airborne hyperspectral and LiDAR integrated sensor approach to spectrally discriminate and map savanna bush encroaching species in the Greater Kruger National Park region. University of Cape Town.
- Nangole, E. W., & Skidmore, A. K., 2017. Community-based bush control and rangeland management in Namibia. *Land Use Policy*, 61, 237-247.
- Ndlela, S., 2022. The role of agricultural extension and landcare policy in building farmer capacity to manage natural resources: the case of landcare programmes in KwaZulu-Natal, South Africa (Doctoral dissertation, University of KwaZulu-Natal).
- Nepstad, D., Carvalho, G., Barros, A.C., Alencar, A., Capobianco, J.P., Bishop, J., Moutinho, P., Lefebvre, P., Silva Jr, U.L. and Prins, E., 2001. Road paving, fire regime feedback, and the future of Amazon forests. *Forest ecology and management*, 154(3), 395-407.
- Nghikembua, M.T., Marker, L.L., Brewer, B., Leinonen, A., Mehtätalo, L., Appiah, M. and Pappinen, A., 2023. Response of woody vegetation to bush thinning on freehold farmlands in north-central Namibia. *Scientific Reports*, 13(1), p.297.
- O'Connor, T.G. and Chamane, S.C., 2012. Bush clump succession in grassland in the Kei Road region of the Eastern Cape, South Africa. *African Journal of Range & Forage Science*, 29(3), 133-146.
- O'Connor, T.G., Puttick, J.R. and Hoffman, M.T., 2014. Bush encroachment in southern Africa: changes and causes. *African Journal of Range & Forage Science*, 31(2), 67-88.
- O'Connor, T.G. and van Wilgen, B.W., 2020. The impact of invasive alien plants on rangelands in South Africa. *Biological Invasions in South Africa*, 14, pp.459-487.
- OleSaitabau, H., 2014. Impacts of Climate Change on the Livelihoods of Loita Maasai Pastoral Community and the Related Indigenous Knowledge on Adaptation and Mitigation. National Museums of Kenya. Nairobi, Kenya. Accessed on, 11, p.2017.

- Onwuegbuzie, A.J. and Leech, N.L., 2007. Sampling designs in qualitative research: Making the sampling process more public. *Qualitative Report*, 12(2), 238-254.
- ÖZDEŞ, M. and Southworth, J., 2023. Land Change Science: Understanding the complexity of monitoring protected areas in savanna ecosystems of Sub-Saharan Africa. *Türk Coğrafya Dergisi*, (82), 63-76.
- Palmer, A.R. and Ainslie, A., 2007. Using rain-use efficiency to explore livestock production trends in rangelands in the Transkei, South Africa. *African Journal of Range and Forage Science*, 24(1), 43-49.
- Ratnam, J., Bond, W.J., Fensham, R.J., Hoffmann, W.A., Archibald, S., Lehmann, C.E., Anderson, M.T., Higgins, S.I. and Sankaran, M., 2011. When is a 'forest' a savanna, and why does it matter? *Global Ecology and Biogeography*, 20(5), 653-660.
- Ravhuhali, K.E., Mlambo, V., Beyene, T.S., Luvhengo, U. and Palamuleni, L., 2020. Socio-cultural perceptions of communal farmers towards rangeland degradation in selected localities of South Africa. *Range Management and Agroforestry*, 41(1), 147-155.
- Reed, M.S., Dougill, A.J. and Taylor, M.J., 2007. Integrating local and scientific knowledge for adaptation to land degradation: Kalahari rangeland management options. *Land Degradation & Development*, 18(3), 249-268.
- Reed, M.S., Fazey, I., Stringer, L.C., Raymond, C.M., Akhtar-Schuster, M., Begni, G., Bigas, H., Brehm, S., Briggs, J., Bryce, R. and Buckmaster, S., 2013. Knowledge management for land degradation monitoring and assessment: an analysis of contemporary thinking. *Land Degradation & Development*, 24(4), 307-322.
- Roques, K.G., O'connor, T.G. and Watkinson, A.R., 2001. Dynamics of shrub encroachment in an African savanna: relative influences of fire, herbivory, rainfall, and density dependence. *Journal of Applied Ecology*, 38(2), 268-280.
- Rose, K.C., Graves, R.A., Hansen, W.D., Harvey, B.J., Qiu, J., Wood, S.A., Ziter, C. and Turner, M.G., 2017. Historical foundations and future directions in macrosystems ecology. *Ecology Letters*, 20(2), 147-157.
- Rudolf de Groot, P.S., van de Berg, A. and Amelung, B., 2005. Cultural and amenity services. *Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group*, 1, p.455.
- Rukuni, M., and Mhanda, W. M., 2011. Community-Based Rangeland Management in Southern Africa: Some Lessons from Practice. *Society & Natural Resources*, 24(3), 285-299.
- Sáez, S.J.M. and Alfayate, J.A.E., 2020. Sicklebush (*Dichrostachys cinerea*) as a Medicinal Plant. *Journal of Animal Production*, 32 (3), 3526
- Saintilan, N. and Rogers, K., 2015. Woody plant encroachment of grasslands: a comparison of terrestrial and wetland settings. *New Phytologist*, 205(3), 1062-1070.

- Samuels, M.I., Allsopp, N., and Hoffman, M.T., 2019. Traditional mobile pastoralism in a contemporary semiarid rangeland in Namaqualand, South Africa. *Rangeland Ecology & Management*, 72(1), pp.195-203.
- Schafer, J. and Bell, R., 2002. The state and community-based natural resource management: the case of the Moribane Forest Reserve, Mozambique. *Journal of Southern African Studies*, 28(2), 401-420.
- Scholtz, R., Donovan, V.M., Strydom, T., Wonkka, C., Kreuter, U.P., Rogers, W.E., Taylor, C., Smit, I.P., Govender, N., Trollope, W. and Fogarty, D.T., 2022. High-intensity fire experiments to manage shrub encroachment: lessons learned in South Africa and the United States. *African Journal of Range & Forage Science*, 39(1), 148-159.
- Sebitloane, T., Coetzee, H., Kellner, K., & Malan, P.W., 2020. The socio-economic impacts of bush encroachment in Manthestad, Taung, South Africa. *Environmental & Socio-economic Studies*, 8, 1 - 11.
- Sedibe, M., 2011. Inequality of access to resources in previously disadvantaged South African high schools. *Journal of Social Sciences*, 28(2), pp.129-135.
- Selemani, I.S., Eik, L.O., Holand, Ø., Ådnøy, T., Mtengeti, E. and Mushi, D., 2013. The effects of a deferred grazing system on rangeland vegetation in a north-western, semi-arid region of Tanzania. *African journal of range & forage science*, 30(3), 141-148.
- Selemani I S 2014: Communal rangelands management and challenges underpinning pastoral mobility in Tanzania: a review. *Livestock Research for Rural Development*. Volume 26, Article #78. Retrieved September 21, 2023, from <http://www.lrrd.org/lrrd26/5/sele26078.html>
- Selemani, I.S., 2020. Indigenous knowledge and rangelands' biodiversity conservation in Tanzania: success and failure. *Biodiversity and conservation*, 29(14), pp.3863-3876.
- Shackleton, C. M., Shackleton, S. E., Netshiluvhi, T. R., Geach, B. S., and Balance, A., 2002. Use of plant resources in the lowveld bushveld of the Limpopo Province, South Africa. *Economic Botany*, 56(3), 301-314.
- Shetler, J.B., 2007. *Imagining Serengeti: A history of landscape memory in Tanzania from earliest times to the present*. Ohio University Press.
- Shikangalah, R. and Mapani, B., 2020. A review of bush encroachment in Namibia: From a problem to an opportunity? *Journal of Rangeland Science*, 10(3), 251-266.
- Sibanda, M., Mutanga, O. and Rouget, M., 2016. Discriminating rangeland management practices using simulated hyspIRI, landsat 8 OLI, sentinel 2 MSI, and VENµs spectral data. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, 9(9), 3957-3969.

Smit, G.N. and Rethman, N.F.G., 1992. Inter-related floristic changes associated with different long-term grazing treatments in Sourish Mixed Bushveld. *Journal of the Grassland Society of southern Africa*, 9(2), 76-82.

Smit, G.N., 2002. The maintenance of the productivity and value of farmland in savanna through the effective management of bush encroachment: ecological considerations. *Acta Structilia: Journal for the Physical and Development Sciences*, 9(2), 5-40.

Smit, G.N., 2004. An approach to tree thinning to structure southern African savannas for long-term restoration from bush encroachment. *Journal of environmental management*, 71(2), 179-191.

Smit, I.P., Asner, G.P., Govender, N., Vaughn, N.R., & Wilgen, B.W., 2016. An examination of the potential efficacy of high-intensity fires for reversing woody encroachment in savannas. *Journal of Applied Ecology*, 53, 1623-1633.

Smit, N., 2014. BECVOL 3: an expansion of the aboveground biomass quantification model for trees and shrubs to include the wood component. *African Journal of Range & Forage Science*, 31(2), 179-186.

Snyman, H.A., 2004. Short-term influence of fire on seedling establishment in a semi-arid grassland of South Africa. *South African Journal of Botany*, 70(2), 215-226.

Snyman, H.A., 2009. Germination potential of *Seriphium plumosum* (bankrupt bush, slangbos or vaalbos). *Grassroots*, 9(1), 43-48.

Snyman, H.A., 2013. Disturbances impact on longevity of grass seeds, semi-arid South African rangeland. *Rangeland Ecology & Management*, 66(2), 143-156.

Sop, T.K., Oldeland, J., Schmiedel, U., Ouedraogo, I. and Thiombiano, A., 2011. Population structure of three woody species in four ethnic domains of the sub-sahel of Burkina Faso. *Land Degradation & Development*, 22(6), 519-529.

Solomon, T.B., Snyman, H.A. and Smit, G.N., 2007. Cattle-rangeland management practices and perceptions of pastoralists towards rangeland degradation in the Borana zone of southern Ethiopia. *Journal of Environmental Management*, 82(4), pp.481-494.

Sporton, D. and Thomas, D.S., 2002. Local lessons for global problems: contributions to global debates. *Sustainable livelihoods in Kalahari environments: contributions to global debates*, pp.217-226.

Stafford, W., Birch, C., Etter, H., Blanchard, R., Mudavanhu, S., Angelstam, P., Blignaut, J., Ferreira, L. and Marais, C., 2017. The economics of landscape restoration: Benefits of controlling bush encroachment and invasive plant species in South Africa and Namibia. *Ecosystem Services*, 27, 193-202.

Statistics South Africa (StatsSA). 2011. Census Data.  
[https://www.statssa.gov.za/?page\\_id=4286&id=12203](https://www.statssa.gov.za/?page_id=4286&id=12203) [05 May 2023]

- Steenkamp, V., 2003. Traditional herbal remedies used by South African women for gynaecological complaints. *Journal of Ethnopharmacology*, 86(1), 97-108.
- Subramaniam, S. and Jaganathan, D.A., 2021. Comprehensive review on *Dichrostachys cinerea*. *J. Univ. Shanghai Sci. Technol*, 23, 1298-1312.
- Symeonakis, E. and Higginbottom, T., 2014. Bush encroachment monitoring using multi-temporal Landsat data and random forests. *The International Archives of Photogrammetry, Remote Sensing and Spatial Information Sciences*, 40(2), 29.
- Tashakkori, A. and Teddlie, C., 1998. *Mixed methodology: Combining qualitative and quantitative approaches* (Vol. 46). sage.
- Tate, W.L., Ellram, L.M. and Kirchoff, J.F., 2010. Corporate social responsibility reports: a thematic analysis related to supply chain management. *Journal of Supply Chain Management*, 46(1), 19-44.
- Tavallaei, M. and Talib, M.A., 2010. A general perspective on role of theory in qualitative research. *Journal of International Social Research*, 3(11).
- Tenagyei, L. and Kanton Osumanu, I., 2021. Farmers' perceived effectiveness of indigenous land management practices: a study in semi-arid Ghana. *Local Environment*, 26(12), pp.1532-1545.
- Thomas, D.S.G. and Twyman, C., 2004. Good or bad rangeland? Hybrid knowledge, science, and local understandings of vegetation dynamics in the Kalahari. *Land Degradation & Development*, 15(3), 215-231.
- Thondhlana, G. and Muchapondwa, E., 2014. Dependence on environmental resources and implications for household welfare: Evidence from the Kalahari drylands, South Africa. *Ecological Economics*, 108, pp.59-67.
- Tokozywayo, S., 2016. Evaluating farmers' perceptions and the impact of bush encroachment on herbaceous vegetation and soil nutrients in Sheshegu communal rangelands of the Eastern Cape, South Africa.
- Tokozywayo, S., Thubela, T., Gxasheka, M., Mthi, S., Gulwa, U., Nyangiwe, N., Kwaza, A., Jokani, N., Mgujulwa, N., Mkabile, Y. and Bozo, T.T., 2022. Short-Term Influence of Burning on Species Abundance, Biomass Production, Wood Plant Density and Browsing Unit in an Albany Thicket of the Eastern Cape, South Africa. *Agricultural Sciences*, 13(1), 74-85.
- Trollope, W.S.W., 1974. Role of fire in preventing bush encroachment in the Eastern Cape. *Proceedings of the Annual Congresses of the Grassland Society of southern Africa*, 9(1), 67-72.
- Trollope, W.S., 1980. Controlling bush encroachment with fire in the savanna areas of South Africa. *African Journal of Range & Forage Science*, 15, 173-177.

Tshisikhawe, M.P., 2012. An ecological evaluation of the sustainability of bark harvesting of medicinal plant species in the Venda region, Limpopo province, South Africa (Doctoral dissertation, University of Pretoria).

Ward, D., 2005. Do we understand the causes of bush encroachment in African savannas?. *African Journal of Range and Forage Science*, 22(2), 101-105.

Wiseman, N.D. and Bardsley, D.K., 2016. Monitoring to Learn, Learning to Monitor: A Critical Analysis of Opportunities for Indigenous Community-Based Monitoring of Environmental Change in Australian Rangelands. *Geographical Research*, 54(1), pp.52-71.

Wigley, B.J., Bond, W.J. and Hoffman, M.T., 2009. Bush encroachment under three contrasting land-use practices in a mesic South African savanna. *African Journal of Ecology*, 47, 62-70.

Woods, S.R. and Ruyle, G.B., 2015. Informal rangeland monitoring and its importance to conservation in a US ranching community. *Rangeland Ecology & Management*, 68(5), pp.390-401.

Würsig, J., and Würsig, M., 2018. The role of local communities in controlling bush encroachment in Namibia. *Journal of Arid Environments*, 155, 84-88.

Yassin, I., 2019. Bush encroachment in Borana rangeland in the case of Southern Ethiopia: Causes, impacts and management implications. *International Journal of Agriculture Innovations and Research*, 7(4), 420-428.

Zerga, B., 2015. Rangeland degradation and restoration: A global perspective. *Point Journal of Agriculture and Biotechnology Research*, 1(2), 37-54.

Zwane, T.J., 2021. Influences of bush encroachment and intensity on small mammals in a mesic savanna, Pretoria, South Africa (Doctoral Dissertation-University of KwaZulu-Natal).