RURAL HOUSEHOLDS' PERCEPTIONS OF AN INVASIVE ALIEN SPECIES *ROSA RUBIGINOSA* L. (ROSEHIP) AND THE ROLE IT PLAYS IN RURAL LIVELIHOODS IN LESOTHO

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ABSTRACT

Despite the vast research on the negative impacts of invasive alien species on the environment, these species remain part of the rural communities due to their numerous livelihood uses. Thus, more research is required, focusing mainly on the impacts of invasive alien species on the livelihoods of rural communities. This study investigated the community perceptions of rosehip (*Rosa rubiginosa*) and its contribution to rural communities as an invasive alien species. Four community councils, Pitseng, Matlameng, Limamarela and Mphorosane in the Leribe District Lesotho, were assessed. The study followed the pragmatism paradigm. The contribution of rosehip to rural livelihoods was analysed by comparing income from rosehip with other income sources. The study used simple random sampling and snowball sampling to select a representative of 160 respondents. The primary data was collected using semi-structured questionnaires. Moreover, SPSS and Stata statistical package programs were used for statistical analyses.

The results showed that rosehip's livelihood benefits, its negative impacts, the length of time it has been available in the area, and its abundance highly influence the social, economic and environmental perception of rural communities. Furthermore, the study revealed that although the income from rosehip is extremely low and available for only three months of the year, the income plays an important part to the poorer households who have no other income sources. The study found that the main reason for engagement in rosehip harvesting despite its challenging nature was unemployment. The study also revealed that rosehip is part of the risk-reducing strategy or income diversification. Some households used it to complement other sources of income, such as agricultural production. Rosehip trade, if well-controlled, has the potential to alleviate rural poverty by creating job opportunities, providing a source of household income, and acting as a safety net in the face of shocks such as limited job opportunities and food shortages. In conclusion, households' perceptions of rosehip have proven that rosehip is a valuable resource that provides a supplementary income that contributes towards alleviating poverty in Lesotho's rural communities. The study recommends the private sector to establish and manages small agro-processing industries focusing on products used daily. The study also encourages environmental education and indigenous knowledge among community members, which would include knowledge and recognition of invasive alien species and their potential benefits and threats

DECLARATION

I, Thato Makhorole, hereby declare that this is my own original work and has not been submitted to a university other than Rhodes University, Makhanda, South Africa. The work of other authors in thesis is fully acknowledged with a complete reference list.

Signature:  **……**

Date: **……23/12/2021……**

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CHAPTER 1
INTRODUCTION

1.1. Research Context

Internationally, there has been a lot of research on invasive alien species (IAS). Perrings *et al.* (2000) argued that this results from an increase in recognising the severity of consequences related to invasive alien species globally. According to the Convention on Biological Diversity (2002: 2), invasive alien species can be generally defined as "an alien species whose introduction and spread threaten ecosystems, habitats or species with socio-cultural, economic and/or environmental harm, and/or harm to human health". Plant species have been introduced into different countries around the world, either intentionally or accidentally, for a variety of reasons, including forestry, ornamental purposes, and agriculture (Mack, 2003; Zengeya *et al*., 2017).

The growth in human population and the global trade expansion has led to the widespread distribution of species beyond their native ranges (De Lange & Van Wilgen, 2010; Westphal *et al.*, 2008; Carbutt, 2012). Westphal *et al.* (2008) showed that the rapid increase in global trade over the past few centuries is associated with the rise in the transportation of IAS. Carbutt (2012) agreed, stating that the consequences of increased trade, travel and tourism are that humans move plants across geographic barriers far beyond their natural dispersal range. According to Blackburn *et al*. (2011), IAS are introduced outside their native scope by human action that has severe negative impacts on the recipient environment

The spread of invasive alien species within their new ranges frequently has negative impacts on rural communities and the environment around them (Shackleton *et al*., 2017). Invasive alien species threaten development and worsen poverty by adversely affecting fisheries, agriculture, forestry, and natural systems, which provide critical support to people's livelihoods in developing countries (CBD, 2008). Many studies now focused on the impacts invasive plants have on local communities and their livelihood due to their recognised negative impacts on biodiversity (Shackleton et al., 2017). Invasive species result in a loss of biodiversity, retard economic development, and reduce the goods and services provided by ecosystems (Pimentel, 2002; Simberloff *et al*., 2013; Witt *et al*., 2018). A loss in biodiversity may potentially lead to

a loss in ecosystem functioning, as certain species are fundamental to certain ecosystem functions (Perrings *et al.,* 2000).

According to Perrings *et al.* (2000), invasive alien species are the most damaging species with the greatest environmental and economic impacts. Pimentel *et al.* (2001) estimated the total damages caused by IAS in the United Kingdom, United States, Australia, India, Brazil and South Africa to be more than $ 314 billion per year. Globally, invasive alien species have resulted in the loss of ecosystem goods and services estimated to be around $1,3 trillion per year. According to Admasu (2008), the negative effects are more severe in areas where households depend primarily on agriculture for food and income. The invasion by alien plants can have precise impacts on agricultural land productivity, such as reducing its grazing potential and competing for land space that could be used for crop production (Admasu, 2008; Pratt *et al.*, 2017). Due to their ability to spread rapidly, forming dense stands, invasive alien plants are also known to replace valuable native plant species used locally for commercial and non-market purposes (Eviner *et al.,* 2012; Ntsonge & Fraser, 2021). The negative impacts of *Rosa rubiginosa* include its ability to form dense shrublands in areas where it invades, which hinders livestock access to pastures and water resources (Carbutt, 2012).

While there have been more studies on invasive alien species, the majority of these studies have focused more on the negative impacts with less knowledge on their role in rural livelihoods (Shackleton *et al.*, 2011; Shackleton *et al.*, 2019). The relationship between IAS and livelihoods is very complicated because some invasive species can benefit some people and negatively affect others (Shackleton *et al.*, 2019). Despite the broadly known impacts of IAS, Shackleton *et al*. (2007) noted that many of these species are universally recognised and accepted due to their ability to provide a wide range of commercial and non-commercial uses. Kull *et al.* (2011) found that Australian *acacias* have plenty of benefits used by rural communities in Ethiopia, Brazil, Congo, France, Niger and South Africa. These livelihood uses include firewood, wind protection, sold for income, poles and tool handles, and their leaves used for soil fertility.

Shackleton *et al.* (2011) also discovered that in South Africa, prickly pear plays a significant role in the livelihoods of trading households. The contribution varied since poorer families benefited more because they had no other sources of income. Shackleton *et al*. (2007) attempted to clarify the cultural, economic and social factors, which may have motivated the use of IAS by local communities. It was discovered that IAS are of significant benefit to rural

livelihoods due to the scarcity of livelihood opportunities rural in communities (Kannan *et al.,* 2016). Kannan *et al*. (2016) noted that communities in Southern India have been using *Lantana* for over 30 years. *Lantana* is used as a raw material for craftwork by many people in southern India, providing income to enhance their livelihoods (Kannan *et al*., 2016). Similarly, in the Baringo and Garissa villages, *Prosopis* have invaded since 1973, rural communities in Kenya revealed that life without it would be difficult because they have grown dependent on it (Maundu *et al.,* 2009). People earn money from the sale of *Prosopis* products such as trade from *Prosolis* charcoal, a pole of *Prosopis* sold for US$ 1.1 40 kg and a bag of *Prosopis* pods for US$ 2.7 in Kenya (Maundu *et al.,* 2009).

R. rubiginosa, as an invasive alien plant in Lesotho, is found throughout the country but mainly in mountainous areas where temperatures are low (Kobisi *et al.*, 2019). *R. rubiginosa* is declared a 1b invasive species in South Africa under the National Environmental Management: Biodiversity Act (NEMBA, 2004). As a category 1b invader, *R. rubiginosa* cannot be cultivated, but only its fruits from the wild can be traded. However, in the case of Lesotho, there is no national list of invasive alien species or their categorisation based on their level of impact (Kobisi *et al.*, 2019). Therefore, its cultivation and sale takes place without any restrictions.

The economic benefits of *R. rubiginosa* are associated with the use and sale of its fruits, known as rosehips. Rosehips were initially used to make rosehip tea and jam due to their sweet taste and high vitamin C content (Smulders *et al*., 2011; Aguirre *et al.,* 2016). Rosehips have been known to acquire significant properties and uses by several companies worldwide. This has resulted in high demand for rosehips around the world in both the food and cosmetic industries (Ramos *et al*., 2016). According to Letšela *et al.* (2003), rural people in most southern African countries depend more on biological resources, including *R. rubiginosa,* for a living. Rosehip provides a source of household income for many people in rural communities in Lesotho. Thus, both men and women in rural areas of Lesotho are seen moving across the country, collecting rosehip to earn money to meet their financial needs (Kobisi *et al*., 2019). The prices paid for rosehips vary according to demand and season of purchase, ranging from M40 to M80 per 20 litre bucket (1Lesotho Loti = 0.068 United States Dollar).

Poverty-stricken and isolated households characterise the areas where rosehips are mostly harvested with very few income sources. Therefore, by harvesting rosehips, collectors can earn household income to meet their basic needs without requiring specific skills, as most are

uneducated (Rosehip Company, 2020). Poor rural communities in developing countries pursue a range of livelihoods strategies, including the consumption and trade of natural resources to improve their standard of living (Shackleton & Shackleton, 2004; Babulo *et al*., 2008; Mudigo, 2016). Even though there is a lack of national statistics on the total number of sellers and households participating in the trade, Pheko (2019) stated that more than 20 000 people are involved. Although rosehips from Lesotho have made their way into international trade where they are exported to manufacture products in the pharmaceutical and cosmetic industries (Kobisi *et al*., 2019), there is little or no consideration of benefits derived by local people. None of the few studies conducted in southern Africa on R. rubiginosa (Walt & Christene, 2016: Mokhobo *et al*., 2017) focused on the benefits derived by rural communities from trading in rosehip. As a result, the information on the contribution of rosehips to the livelihoods of rural communities is scarce.

Some IAS are identified and recognised as applicable, while others are labelled as problematic despite their long history of existence (Coates, 2007)). The capability of IAS in contributing to rural livelihoods may determine if it is to be viewed as a necessary resource or weed (Shackleton *et al.,* 2007; Low, 2012). However, as knowledge and understanding of the IAS improve, perceptions may change (Van Wilgen *et al.,* 2012). Robin and Carruthers (2012) demonstrated that perceptions regarding IAS might be temporary and change when the community's interests and values change, thereby allowing previously undetected negative consequences to be considered. Shackleton *et al*. (2019) argued that the perceptions of IAS are regarded as held by individuals but result from a combination of several influencing factors (Kull *et al*., 2011). Thus, more research is needed to determine the factors influencing people's perceptions, behaviour and knowledge towards biological invasions (Shackleton *et al.*, 2019; Vaz *et al*., 2020).

The decision for an individual or a group of people to regard IAS as beneficial or problematic is influenced by several factors that determine their perceptions of the species and its impacts (Kueffer, 2013; Shackleton *et al.*, 2019). In this study, the main target is human perceptions defined as "processes wherein people select, organise, interpret, retrieve and respond to the information from the world around them, producing mental impressions and constructions which will ultimately help shape behaviours and actions" (Schermerhorn & Osborn, 2000 as cited in Shackleton *et al.*, 2019:2). The perceptions of IAS is regarded as controlled by individuals (Shackleton *et al.*, 2019) but result from a combination of several influencing

factors (Kull *et al*., 2011). Thus, more research on factors influencing perceptions, knowledge and practices towards biological invasions is required (Coates, 2007).

The Sustainable Livelihood framework has been used as the framework of analysis for this study. The livelihood approach shows various elements that shape the household's livelihood, the factors that control them and how they relate to each other (Babulo *et al.*, 2008; Serrat, 2017). Thus, the framework shows how sustainable livelihoods are obtained based on the households' ability to access several types of assets linked together in pursuit of various livelihood strategies (Martinez, 2004). The approach focuses on the key factors that shape livelihoods and assesses households' livelihoods in terms of the capital assets they have at their disposal and the various livelihood strategies they employ to gain a clear understanding of the role played by rosehip. Therefore, it is a useful tool for this study on the role of invasive alien plants in rural livelihoods. It reviews the livelihood strategies that people pursue, allowing policymakers and development practitioners to understand how people establish their livelihoods in a particular context.

1.2. Problem Statement

Invasive alien species negatively impact biodiversity by competing with native species and hinder the ecosystem's ability to supply goods and services to rural communities (Pimentel, 2002; Simberloff *et al*., 2013). On the other hand, these species are widely used by poor communities that have adapted to biodiversity change to the point where they have become incorporated into their livelihoods. (Pfeiffer & Voeks, 2008). In Lesotho *Rosa rubiginosa* fruits are largely harvested in the wild by both men and women, who sell them to local companies that then export them to South Africa and Germany. This implies that not all IAS have harmful impacts on people and the landscapes but may have important roles beyond their environmental consequences (Shackleton *et al.*, 2011).

According to Kobisi *et al*. (2019), there is a lack of information on invasive alien species in Lesotho. Therefore, the effects of IAS on livelihoods are not well understood (Nunez & Pauchard, 2010; Shackleton *et al*., 2011; Shackleton *et al*., 2019). In Lesotho, research on IAS has only focused on their ethnobotanical uses, distribution and safety, as well as policies aimed at regulating them (Fitchett *et al*., 2016; Kobisi *et al*., 2019), but no work has been done on the IAS's contribution to rural communities' livelihoods. Therefore, this study aims to contribute literature on the economic impacts of *Rosa rubiginosa* (rosehip) on livelihoods. Understanding households' perceptions of rosehip and its role in sustaining rural livelihoods are essential for

guiding policy and development strategies that respond to local people's needs. Aside from that, comparing rosehip harvesting income to other household income sources will aid in determining the rosehip's potential as a livelihood strategy.

1.3. Aim and Research Questions of the Study

This study aims to investigate rural households' perceptions of rosehip and the role it plays in rural livelihoods in Lesotho. To achieve this goal, the research questions the study seeks to answer are:

1. What are the community's social, economic and environmental perceptions towards rosehip?
2. How significant is the income from rosehip trade to the livelihoods of rural communities?
3. Which factors influence the individual's decision to participate in rosehip harvesting as a livelihood strategy?

1.4. Justification of the Study

Most studies on IAS and livelihoods with a few exceptional cases (Kannan *et al*., 2016; Shackleton *et al*., 2011) have grouped all stakeholders together or only studied one group without comparing the contribution of IAS to different groups (Shackleton *et al.*, 2019). As a result, there is insufficient data on the role played by IAS on the livelihoods of rural communities (Shackleton *et al.*, 2007). This necessitates more research on various groups to determine who benefits the most and incurs the most costs from invasive alien species in order to guide policy formulation and management (Pfeiffer & Voeks, 2008; Shackleton *et al.*, 2019).

There is increasing trade of rosehip in Lesotho as most of the rosehip harvested is sold to companies in South Africa and Germany. Rosehips are gaining popularity in the cosmetic and pharmaceutical industries around the world, and as a result, Lesotho could benefit economically from rosehip. Even though Lesotho has been involved in the trade of rosehips for several years, the communities where rosehip is primarily harvested are poverty-stricken and isolated, with limited employment opportunities for making a decent living (Rosehip Company, 2020). There is little or no information on the rosehip informal market in Lesotho. However, the sector may be very significant to the poor people's livelihoods by providing them with an income that the formal sector may not.

1.5. Structure of the Study

This study is organised into five chapters. Chapter 1 introduces the study, contextualises it within the existing literature, discusses the study's goals and objectives, and summarises the overall structure of the thesis. Chapter 2 provides a general literature review of IAS, with a specific focus on South Africa and Lesotho, how people perceive them, the contribution of IAS to rural livelihoods, and the introduction and uses of rosehip in Lesotho. Chapter 3 discusses the study's methodological approaches and a description of the study area, including a map of the areas within the Leribe community councils where this study was conducted. Chapter 4 presents the study results and discussion. Chapter 5 provides a summary of the previous chapters, the study's findings, and policy recommendations.

CHAPTER 2

LITERATURE REVIEW

2.1. Introduction

According to Zengeya *et al.* (2017), some of the reasons for alien species introductions were providing food and raw materials, soil erosion control, and pets. Biological invasions cause biodiversity loss as global human travel and trade continue to move thousands of species between and across continents (Brunel *et al*., 2013). The spread and dominance of invasive species within their new ranges often negatively impact rural communities and the environment (Shackleton *et al*., 2017).

The number of studies dealing with plant invasions is increasing rapidly (*et al*., 2019). Invasive plants can also be defined "as naturalised plants that produce reproductive offspring, often in large numbers, at considerable distances from the parent plants, and thus have a potential to spread over a large area" (Pyšek *et al*., 2004 as cited in Kobisi *et al.*, 2019:1). According to the Working for Water Programme (WfW, 2019), invasive alien species cause billions of rands of damage to South Africa's economy every year. They are the largest threat to the country's biodiversity and the ecological functioning of natural systems, the productive use of land and water security. As a result, the local indigenous fauna and flora face extinction and a reduction in essential regulating and provisioning services (Shackleton *et al.,* 2011). IAS can also change massive amounts of water from more productive uses such as agriculture, fisheries, transport, recreation and water supply (WfW, 2019).

Not all non-native species are harmful; according to Shackleton *et al*. (2017), some species naturalise, and a smaller proportion becomes invasive. Blackburn *et al*. (2011) defined naturalised species as species that have established self-sustaining populations but do not spread. In contrast, invasive species are those that have spread, often over substantial distances from where they have become naturalised and cause ecological or economic harm and have negative health impacts. Invasive species management is fundamental since they impact the communities (Shackleton *et al*., 2017). If IAS are not managed, the risk they pose to the environment, and people would undoubtedly worsen (Shackleton *et al*., 2017). CBD (2008) stated that the issue of invasive alien species needs to be taken care of immediately as their threat is increasing rapidly, and the environmental and economic impacts are intolerable.

Despite the current negative impacts associated with invasive alien species, many of these species have multiple commercial and non-market uses (Shackleton *et al*., 2007). In most cases, rural people make extensive use of IAS, and they regard them as a benefit to their livelihoods, but this will depend upon which phase of the invasion cycle they are currently in (Shackleton *et al.,* 2007). According to Zengeya *et al.* (2017), an IAS that impacts the environment and economy positively and negatively creates a conflict of interest as to whether to eradicate the species or use it for its beneficial qualities.

Although this research will be conducted in Lesotho, it will be looking at invasive alien species in general rather than Lesotho specifically. Most of the literature reviewed is from South Africa. Except for Kobisi *et al.* (2019), there are limited published studies on invasive alien species in Lesotho. According to Kobisi *et al*. (2019), the only published information on Lesotho's invasive exotic plants in 2019 came from research conducted as part of regional studies, specifically South African projects such as Kotze *et al*. (2010), which focused on the national invasive alien plant survey. Despite the fact that the literature focuses on South Africa, IAS are common in these two countries because Lesotho is landlocked in South Africa. Moreover, no laws govern IAS in Lesotho; however, they exist in South Africa. For instance, *Rosa rubiginosa* is classified as 1b category in South Africa, whereas in Lesotho, no laws govern the sale and cultivation of *Rosa rubiginosa.*

2.2. Globalisation and distribution of Invasive Alien Species

The rate of biological invasions has rapidly risen, mainly due to globalisation trends: intensified travelling, population growth, liberalisation of regulatory trade regimes and a consequent increase of global trade (Perrings *et al*., 2005; Kettunen *et al*., 2008). Invasive alien species are the outcome of the continuing and increasing human distribution of species to support horticulture, forestry, recreation and agriculture, as well as a result of accidental introductions (van Wilgen *et al*., 2007). Trade and, most generally, economic development resulted in more IAS since global trade has allowed modern societies to benefit from the unusual movement and establishment of species worldwide (McNeely, 2001). According to Meyerson and Mooney (2007), globalisation facilitates the spread of invasive alien species as international commerce develops new trade routes, markets, and products. In South Africa, alien invasive plants started in the 1600s and have been a continuing process (Moran *et al*., 2013). Biological invasions have constantly increased over the last 200 years, increasing significantly in the last 25 years (Hulme, 2009).

2.3. Negative Impacts of Invasive Alien Species

Invasive alien species have a significant effect on ecosystem services (Richardson & Rejma'nek, 2011). Ecosystem services are the gains people get from natural ecosystems such as food, water, timber and cultural values (Wallace, 2007; Katsanevakis *et al*., 2014). IAS also exposes severe impacts on the ecosystem processes fundamental to human well-being (Mooney, 2005). Wallace (2007) defined ecosystem processes as the complicated interrelationships between biotic and abiotic elements of ecosystems that result in a distinct outcome.

Even though the effects of invasive alien species on native species are well reported, different ways in which such species impact ecosystem services are still emerging (Pejchar & Mooney, 2010). Gorgens and van Wilgen (2004) stated that many invasive woody plants in South Africa influence ecosystem services. According to Charles and Dukes (2007), invasive species can alter ecosystem services by affecting populations, community interactions, ecosystem processes, and abiotic variables. Ecosystem services are challenging to measure directly due to challenges preventing researchers from boldly judging those processes as alternatives for services (Eviner *et al.,* 2012). Charles and Dukes (2007) suggested that one reason is that the links between these mechanisms and ecosystem services are primarily lacking in the literature. It was also found that there is a general lack of work in invasive species and their alteration of ecosystem services (Charles & Dukes, 2007).

Invasive alien plants impose significant environmental problems in South Africa's terrestrial and freshwater ecosystems (Richardson *et al*., 1997; Le Maitre *et al*., 2000). Exotic trees and shrubs increase above-ground biomass and evapotranspiration, decreasing surface water runoff and groundwater recharge (Gorgens &Van Wilgen, 2004). Calder and Dye (2001) suggested that invasive alien species, especially tree species, often have much-increased water usage due to the species invasion characteristics such as greater height, root depth and senescence, compared to the native species they replace. Dye and Jarmain (2004), in their study on the impact of black wattle (*Acacia mearnsii*) and De Wild (*Fabaceae*) on streamflow, found that the IAP reduced the amount of streamflow and increased evapotranspiration rates within water catchment areas compared to the natural indigenous vegetation. IAS can also change an ecosystem's water balance and water retention capacity by increasing evapotranspiration, for example, black cherry, *Prunus serotina* (Kettunen *et al.*, 2008). Le Maitre *et al*. (2000) found that the main invading species are the wattles, especially Acacia cyclops, which are probably

exploiting groundwater and fog, thereby utilising more water than is directly available as surface runoff.

The introduction of IAS has the potential to change many components of the carbon (C), nitrogen (N), water, and other cycles of an ecosystem (Ehrenfeld, 2003; Humphrey *et al*., 2019; Jo & Frank., 2017). According to Ehrenfeld (2003), IAS significantly change soil nutrient trends by varying from native species in plant morphology, productivity and biomass, plant morphology, phenology, and tissue chemistry. They commonly modify nitrogen fixation rates, increase biomass and net production, and produce waste with faster decay rates than native species. (Ehrenfeld, 2003).

IAS can affect native ecosystems by changing fuel properties, which can, in turn, affect fire behaviour, thereby altering fire regime characteristics such as frequency, intensity, extent, type, and seasonality of fire (Brooks *et al*., 2004; Pejchar & Mooney, 2010). IAS can restrict local species and increase the dangers to neighbouring individuals and communities by increasing the frequency or occurrence of floods and wildfires (Humphrey *et al*., 2019). According to van Wilgen (2015), IAS alters the type and quantity of fuel available to assist fires, thus introducing fires into locations where they did not originally occur. They also intensify the volume of plant material in fire-prone ecosystems, thereby increasing fires.

IAS can influence erosion through a range of techniques, including soil-stabilisation capacity, changes in soil properties, and vertebrate IAS consume plant roots and biomass, causing erosion (Pejchar & Mooney, 2010). Although some IAS have been intentionally introduced to limit soil erosion (Zengeya *et al*., 2017), such introductions frequently have unexpected effects for other natural ecosystems (Pejchar & Mooney, 2010). Forseth and Innis (2004) investigated Kudzu (*Pueraria lobata*), an invasive plant introduced into the south-eastern United States in 1876 to aid in erosion control. However, lately, it covers approximately 3 million ha and is continuing to spread swiftly by 50 000 ha per year. Kudzu impacts air quality, fix atmospheric nitrogen poses a serious economic liability and overpower some native trees by shading and overtopping them. Increased soil erosion caused by IAS decreases pH, increases nutrient loads, elevates water temperature, increases turbidity and salinity, and increases the composition of pollutants, including heavy metals and the number of micro-organisms causing diseases (Smith *et al*., 2011; Chamier *et al*., 2012).

The social and economic effects of invasive alien species are attributed to both costs associated with species control efforts as well as the direct impact of the species on agricultural

productivity, property values, tourism, and outdoor recreation, native fisheries and public utility operations (Pimentel *et al*., 2000; NISIC, 2021; Crystal-Ornelas *et al*., 2021). Invasive alien species severely damage productive agricultural land, reducing its productivity (Pimentel *et al.*, 2000; *et al*., 2021). According to Eschen *et al*. (2021), the estimated overall cost of IAS to agriculture in Africa is USD 65.58 billion, with management costs, a decrease in livestock deduced income and crop yield losses accounting for the most significant part of the estimated costs. Therefore, this has a substantial impact on the livelihoods of people dependent on crop and livestock production (Mugasi *et al.,* 2000; Eschen *et al*., 2021).

IAS may also negatively impact cultural ecosystem services by eliminating culturally significant species (Pfeiffer & Voeks, 2008; Pejchar & Mooney, 2010; Dube, 2016). According to Charles and Dukes (2007), cultural services encompass aesthetic values, recreation and tourism, religious values, educational values, and cultural heritage value systems. Recreation and tourism are said to be the most hindered cultural services by aquatic and terrestrial IAS since IAS make natural areas less accessible, potentially reducing wildlife and rare-plant viewing (Charles & Dukes, 2007). Ditomaso *et al*. (2006) noted that yellow star-thistle (*Centaurea solstitialis*) in some areas restricts access to recreational spaces due to its sharp thorns, resulting in an economic impact on such sites.

According to Bartz and Kowarik (2019), not all negative impacts of IAS constitute significant damage because communities frequently accept the minimal effect of invasive alien species. Thus, this suggests that IAS can also benefit a community's social life and provide habitat for native wildlife species with cultural significance (Dickie *et al*., 2014). Eucalyptus, for example, is known to provide ideal habitat for culturally significant and iconic African fish eagles in South Africa (Dickie *et al*., 2014).

2.4. Invasive Alien Species Perceptions

The plant usually gets the attention of society after it has naturalised and become invasive in its foreign ecosystem (Dube, 2016). The society comprises many individuals with different attitudes, perceptions, and value systems (Dube, 2016). Nonetheless, according to Fischer *et al.* (2011), when it comes to invasive alien species, society entails two groups of people being scientists, those who play a vital role in the discussion of IAS and the general public as those who are most affected by the IAS. Schermerhorn and Osborn (2000, as cited in Shackleton *et al.*, 2019:2) define human perceptions as "processes wherein people select, organise, interpret,

retrieve and respond to the information from the world around them, producing mental impressions and constructions which will ultimately help shape behaviours and actions".

Most scholars have argued that there is a growing emphasis on the human dimension of invasive alien species, although socio-ecological perspectives remain unaddressed. (Kull *et al.,* 2011; Vaz *et al*., 2020; Shackleton *et al.*, 2019). Humans play an essential role in biological invasions by driving the introduction of non-native species, enduring the impacts of their uncontrolled expansion, and acting on their management (Shackleton *et al.*, 2019; Vaz *et al*., 2020). Thus, perceptions and social awareness are critical when making decisions about IAS to achieve practical management actions such as their control or eradication (Shackleton *et al.*, 2019). According to Vaz *et al.* (2020), the importance of understanding local knowledge and perceptions has been highlighted in initiatives on invasive alien species.

The attitudes and behaviours of stakeholders toward the environment can determine the success or failure of a natural environment conservation initiative (Kim *et al*., 2006). Shackleton *et al*. (2019) argued that individuals' perceptions of the natural environment are progressively accepted as crucial as conservation and management. People's interaction with the environment makes it vital to examine the link between their perceptions of the environment and environmental issues (Gray *et al*., 2010). In this regard, understanding people's perceptions and attitudes is crucial for the development of sound management strategies to protect and upgrade ecosystem services, biodiversity and human well-being (Milfont & Duckitt, 2010; Fischer *et al.*, 2011; Dube, 2016; Shackleton *et al*., 2019; Vaz *et al*., 2020). Investigating public perceptions of IAS provides intelligent rather than objective solutions (Coates, 2007).

Coates (2007) further noted that some IAS are identified and recognised as applicable, while others are labelled as problematic despite their long history of existence ()). The capability of IAS in contributing to rural livelihoods may determine if it is to be viewed as a necessary resource or weed (Shackleton et al., 2007; Low, 2012). However, as knowledge and understanding of the IAS improve, perceptions may change (Van Wilgen et al., 2012). Robin and Carruthers (2012) demonstrated that perceptions regarding IAS might be temporary and change when the community's interests and values change, thereby allowing previously undetected negative consequences to be considered. Shackleton et al. (2019) argued that the perceptions of IAS are regarded as held by individuals but result from a combination of several influencing factors (Kull et al., 2011). Thus, more research is needed to determine the factors

influencing people's perceptions, behaviour and knowledge towards biological invasions (Shackleton et al., 2019; Vaz et al., 2020).

In their study of uses and perceptions of Australian acacias, Kull et al. (2011) identified three factors that may influence perceptions: biophysical characteristics, familiarity with the species, and social context. The public's use and perceptions may be shaped by the IAS species, the surrounding environment, and whether a tree develops and spreads independently (Kull et al., 2011; Shackleton et al., 2019). Moreover, the initial purpose of introduction, whether direct or indirect and the period a species has been established, its accessibility and its abundance to communities may influence how IAS is used and perceived (Kull et al., 2011).

Pfeiffer and Voeks (2008) noted that perceptions towards IAS might be positive when people are impacted positively and negative when they are affected negatively by it. For example, people's perceptions of prickly pear were negative because it reduced grazing land, but some people saw it as beneficial because it supplemented household income (Shackleton et al., 2007). Shackleton et al. (2019) argued that many people have positive or negative perceptions of species with beneficial economic and livelihood benefits, such as Australian acacias that generate wood and tannins or prickly pears that grow edible fruit and provide fodder. Moreover, perceptions may also be influenced by individuals' characteristics, including demographics, experience, knowledge of species, and social, ecological, environmental, and economic effects. (Latkin et al., 2009; Kull et al., 2011; Jones & Dione, 2013; Shackleton et al., 2019).

2.5. Benefits of Invasive Alien Species to rural livelihoods

Most research on the invasive alien species reveals their negative economic and ecological impacts. Although the effects on the IAS have been assessed, there is still a lack of knowledge regarding their role in rural livelihoods (Shackleton *et* al., 2007; Shackleton *et al*., 2011). Kull *et al.* (2011) agreed, demonstrating that studies on preference, drivers of use and adoption are scarce. As a result, IAS control programs are being implemented without regard for their value to local communities (Shackleton *et al*., 2007; Kull *et al.*, 2011). The relationship between IAS and livelihoods is complicated as some invasive species can benefit some people and negatively affect others (Shackleton *et al.*, 2019).

Numerous IASs are widely recognised and accepted because of their ability to positively impact rural livelihoods (Shackleton *et al*., 2007; Dos Santos *et al.,* 2014). Kull *et al*. (2011)

proved that Australian *Acacias* provide a wide range of benefits to rural livelihoods across the globe. Most rural communities have neglected the negative impacts of IAS in favour of their positive effects and have incorporated them into their livelihoods (de Neergaard *et al.*, 2005). Many other communities continued to use them to better their lives, and then, as time passed, some were identified as culturally significant (Shackleton *et al*., 2007).

Pfeiffer and Voeks (2008) argue that local people are unable to differentiate between local species and IAS on several occasions but instead regard them as an essential part of their livelihoods. According to Shackleton *et al.* (2008), some IAS play an equal or even more significant role in livelihoods than local species. Dos Santos *et al.* (2014) agree, stating that in Brazil, 97% of IAS are viewed as valuable by local communities, with services and direct use of IAS being more important than those provided by local species. Shackleton *et al*. (2007) found that people preferred prickly pear over other species, and most were unaware of its alien status. As a result, rural communities that gain more benefits may welcome IAS in greater numbers because of their contribution to their livelihoods (Shackleton *et al*., 2007).

IAS can be integrated into local livelihoods in two ways. Firstly, potentially beneficial IAS may be introduced due to their perceived benefits (Shackleton *et al*., 2007). The first introduction is usually done in a controlled environment such as farming, where people plant them in their gardens (Shackleton *et al*., 2007). For instance, in Lesotho, *Rosa rubiginosa* was introduced to Lesotho to help with the significant soil erosion problem by planting in dongas and erosion valleys (Mokhobo *et al*., 2017). Due to their characteristics, such as rapid growth and ability to adapt to different environmental and climatic conditions (Eviner *et al.,* 2012), these species may escape their original locations and invade larger environments and landscapes, threatening livelihoods non-users (Shackleton *et al*., 2007). Secondly, as the abundance of IAS increases, resulting in a decline in indigenous species, local communities may switch to using previously unutilised IAS, making it more visible as a potential resource (Shackleton *et al*., 2007; Dos Santos *et al.,* 2014). As a result, the importance of some IAS may necessitate changes to regular routines to incorporate them into local livelihoods (Ngorima & Shackleton, 2018).

Numerous studies have noted that rural communities use IAS as part of their livelihood strategies (de Neergaard *et al*., 2005; Shackleton *et al*., 2007; Shackleton *et al*., 2011). Shackleton *et al.* (2007) elaborate that rural communities make widespread use of IAS and, in most cases, prefers them in more densities. For instance, in Tidbury, South Africa, 92% of the

households interviewed wanted *Opuntia ficus-indica* (Prickly Pear) in large densities because they valued it as a source of food and fodder (Shackleton *et al*., 2007). Most IAS are preferred over local species by rural communities because of their livelihood value due to abundance or changes in tastes and simplicity of harvest (Shackleton & Shackleton, 2004; Shackleton *et al*., 2007). As a result, changes in preference may lead to intense cultivation in IAS (Shackleton *et al*., 2007), such as the cultivation of *Ajuga sericifera* in Transkei Wild Coast home gardens (Keirungi & Fabricius, 2005).

Invasive alien species are also used for medicinal purposes in many countries around the world. Maema *et al*. (2016) noted that local people harvest some IAS for their alleged medicinal properties. The use of IAS for medicinal purposes is also the case in Lesotho, where a few studies revealed that rural communities use IAS to treat different diseases (Kobisi *et al*., 2019; Maema *et al*., 2016). For instance, species such as *Datura stramonium, S. halepense, Agave Americana and Tagetes minuta* are commonly used for a variety of skin problems such as swelling sores, boils, bruises, sore feet and blisters (Moteetee & Van Wyk, 2011; Seleteng-Kose *et al.*, 2015; Kobisi *et al.*, 2019). In South Africa, *Bidens pilosa* have been revealed to have antimicrobial, anti-helminthic, anti-malaria, protozoicide and anti-ulcerogenic properties (Lewu & Afolayan, 2009). According to Mander *et al*. (2007), the South African medicinal plant trade is estimated to be worth R2.9 billion per year, making it the major industry in rural areas because it employs a significant number of people, approximately 133 000, with rural women constituting the majority (Mander *et al*., 2007).

Shackleton *et al*. (2007) argued that some people use an IAS because they have accepted its presence and make the best of it. The literature on IAS contribution to livelihoods also found that most rural communities rely on IAS for food, firewood, and building materials. (Saenz *et al.,* 2003; Shackleton *et al*., 2007; Shackleton *et al*., 2011; Kannan *et al*., 2016). In Lesotho, for instance, *Acacia dealbata* and *Populus* x *canescens* are commonly used for firewood and valuable biomass sources. In contrast, *Opuntia ficus-indica*, *Rosa rubiginosa* and *Rubus cuneifolius* are consumed for their edible fruits and used in jam making (Kobisi *et al.*, 2019). Saenz *et al*. (2003) also described the use of the prickly pear as a food source in Mexico, focusing on the agro-processing of prickly pear fruits and leaves to create different products sold commercially.

Many studies have shown that some IAS are essential in meeting the subsistence needs of many households. For instance, Kannan *et al*. (2016) noted that communities in Southern India have

been using *Lantana* for over 30 years. *Lantana* is used as a raw material for craftwork by many people in southern India, providing income to enhance their livelihoods (Kannan *et al*., 2016). Similarly, in the Baringo and Garissa villages that Prosopis have invaded since 1973, rural communities in Kenya revealed that life without it would be difficult because they have grown dependent on it (Maundu *et al.,* 2009). This could be because people earn money from the sale of *Prosopis* products such as a 40 kg bag of *Prosopis* pods for US$ 2.7, a pole from *Prosopis* in Garissa for US$ 1.1 and trade charcoal made from *Prosopis* (Maundu *et al.,* 2009).

Kull *et al*. (2011) showed that more impoverished communities in rural and marginalised areas rely on IAS for household livelihood needs and income generation. Kobisi *et al.* (2019) claimed that both men and women harvest Rosa rubiginosa fruits and sell them for a living in Lesotho. This is in line with Shackleton *et al*. (2011), who found that most people in the Eastern Cape Province who traded in prickly pear were from low-income households looking for extra money to meet their daily needs. The income from sales of prickly pear contributed to household income. Participants used it to primarily cover household needs such as purchasing groceries, paying school fees, and purchasing school stationery (Shackleton *et al*., 2007; Shackleton *et al*., 2011; Ntsonge & Fraser, 2021). Shackleton *et al*. (2011) further showed that the importance of IAS on the household's livelihood as being indicated by the household expenses that were financed with the income from its sale. Traders in the Kat River Valley also engaged in barter system with their neighbours and exchanged prickly pear for staple food (Shackleton *et al*., 2007).

Several studies have demonstrated the significance of invasive alien species as safety nets (Paumgarten, 2005; Shackleton *et al*., 2007; Shackleton *et al*., 2011). Shackleton *et al.* (2011) and Ntsonge and Fraser (2021) noted that the safety net is commonly identified during periods of shock or stress. It is used to keep those directly impacted from falling deeper into poverty. Shackleton and Shackleton (2004) noted several occasions when a species can act as a safety net. The first case may be when a household may increase its utilisation of a resource that it did not previously use in place of purchased commodities or other resources that it can no longer access due to economic shocks or stress. For instance, in Britain, *Rosa rubiginosa* fruits (rosehips) were used as a source of vitamin C during World War 2, where imports of citrus fruits were limited (Perry, n.d.). It can also occur when a household temporarily trades in natural resources during periods of economic stress, such as job loss. For example, in Grahamstown, Eastern Cape, unemployed individuals sold prickly pear fruits to generate income (Shackleton *et al.,* 2011).

2.6. Control of Invasive Alien Species

The need for effective control programmes has been recognised worldwide to counter the impacts of IAS (van Wilgen, 2001). Many countries have developed strategies for dealing with biological invasions (De Lange & Van Wilgen, 2010) and the global strategy on invasive alien species was proposed (McNeely *et al*., 2001). Brunel *et al*. (2013) showed that since IAS have a high probability of uncontrollable growth, which lead to environmental and economic damages, preventing or tackling the spread of IAS is most effective and cost-effective in their early stages of establishment.

According to van Wilgen *et al.* (2011), effective management needs to be implemented to control the spread of IAS into new areas, reducing their negative impacts where they are already widespread and abundant. Shackleton *et al.* (2017) further showed that the threat caused by invasive species to people and the environment would be significantly worse without proper management. There are three principal techniques used to control IAS: mechanical, chemical, and biological control.

2.6.1. Mechanical Control

Mechanical control is the physical felling or uprooting of plants and is combined with fire (Van Wilgen *et al*., 2001). It involves the use of handheld tools such as saws, slashers and axes as well as power-driven tools such as chainsaws and brush cutters. This method is time-consuming; therefore, it is only suitable for areas with low infestations. Mechanical control is costly and requires a large labour force, especially in dense infestations (Van Wilgen *et al*., 2001; Auld & Johnson, 2014; Hill & Coetzee, 2017). Hill & Coetzee (2017) stated that this method is better used in controlling terrestrial weeds in South Africa since it is ineffective for water weeds.

2.6.2. Chemical Control

Chemical control involves using herbicides to kill invasive plants (Auld & Johnson, 2014). This method consists of applying herbicides to prevent the sprouting of cut stumps and kill seedlings after felling or burning (Van Wilgen *et al*., 2001). It is the most common method used lately to eliminate invasive plants, even though it may negatively impact non-targeted wildlife (Curtis & Bidart, 2017). Van Wilgen *et al.* (2001) stated that the use of chemical control is often administered by government legislation and requires a high level of training to avoid any negative impacts herbicides may cause.

Chemical control is less labour-intensive as compared to manual physical control, except for the treatment of individual woody plants (Auld & Johnson, 2014). Herbicides are acknowledged as the most effective method for directly reducing invasive plant biomass and density (Blossey, 1999). The most significant advantage of the herbicidal control method is that it can achieve results over a short period (Van Wyk & van Wilgen, 2002; Hoare, 2016). However, this method should be used as the last resort since it can severely damage the native species (Hoare, 2016).

2.6.3. Biological Control

Biological control is the method of reducing the damage caused by IAS by deliberately introducing host-specific plant-feeding insects, mites or pathogens from the specific region of origin into the invaded environment (Zimmermann *et al*., 2004; Van Wilgen *et al*., 2004; CBD, 2018). The biological control method aims to achieve the situation where the once known invasive alien species become non-invasive naturalised aliens (Van Wilgen *et al*., 2001). It is not a simple task to perform as some procedures must be followed. Effective safety tests that may take several years are conducted before releasing any natural enemies to ensure that it is adequately host-specific (Zimmermann *et al*., 2004; "Biological Control", 2019; Coetzee *et al.*, 2020).

The use of biological control methods to suppress weeds has a long history. According to Winston *et al*. (2014), since 1836, 551 biological agents have been used in over 130 countries worldwide, targeting 224 weeds. About 66% of the weeds targeted were controlled in at least one country where the various biological control agents have been released (Schwarzländer *et al*., 2018).

Biological control is the most environmentally friendly, cost-effective in the long run and self-sustaining method used to suppress IAS because it does not require reapplying chemicals or poison (Zimmermann *et al*., 2004; Culliney, 2005; Zachariades *et al.,* 2017; Maluleke *et al.*, 2021). It can, therefore, be concluded that the biological control method results in efficient and permanent control of IAS, leading to the mitigation of their economic impacts.

In South Africa, the first use of a biological control agent was in 1913. The cochineal insect was released to control drooping prickly pear, resulting in a permanent reduction of the extensive infestations (Moran *et al*., 2013; Hoare, 2016). As a result, biological control agents were released for the control of other IAS. Zachariades *et al.* (2017) showed that biological control contributes naturally to the management of 34 of the 59 IAS species on which biological

control agents are established in South Africa. The most apparent successes have been against cacti, Australian *Acacia* species, and floating aquatics (Klein, 2011).

According to Culliney (2005), the benefits of biological weed control are unusually noticeable where fiscal budgets are tightly constrained. Van Wyk and Van Wilgen (2002) calculated the cost of biological control of water hyacinth to be less than that of herbicidal control when excluding the costs of monitoring the progress of natural enemies in the program. Biological control was found to be at least 400 times more cost-effective than chemical control. Zimmermann *et al*. (2004) stated that biological control over other methods was estimated to result in 19.8 percent savings in the overall budget for the management of problem plants in South Africa. Biological control has shown to be more beneficial in economic terms when comparing its cost of research and implementation to the benefits of restored ecosystem services or avoided costs and avoided ongoing control costs (van Wilgen *et al*., 2011). Most studies on biological control of invasive species have estimated high returns on investment. As biological controls become more effective and widespread, more impressive savings are expected in the future (Zimmermann *et al*., 2004).

A recent literature review on two control methods (Maluleke *et al*., 2021) found the overall total cost for four aquatic weeds (Pista stratiotes, Salvinia molesta, Azolla, *filiculoides and Myriophyllum aquaticum*) using biological control is more cost-effective as compared to chemical control. The cost of biological control for all four aquatic weeds was estimated to be approximately R7.8 million, while the cost of chemical control to achieve the same degree of control ranged from R150 million to R1 billion, which depended on the type of application and the number of follow-up operations. Therefore, the programme has avoided potential expenses of R90 to R631 on every R1 spent using a biocontrol agent by using biological control instead of chemical control on the four weeds.

2.6.4. Integrated Control

Integrated weed control involves combining at least two primary control elements: mechanical, chemical, and biological (Van Wilgen *et al*., 2001; Culver *et al*., 2019). These control methods are commonly integrated to effectively reduce the amount of IAS (Van Wilgen *et al*., 2001). IAS such as the Yellow star-thistle (*Centaurea solstitialis*), Black wattle (*Acacia mearnsii*) and Triffid weed (*Chromolaena odorata*) has been managed using integrated control (Van Wilgen *et al*., 2001). Van Wilgen *et al*. (2012) estimated that a combination of mechanical, chemical and biological control reduced the lantana invasion in South Africa by 50%.

The control of the prickly pear using mechanical control was ineffective as the species was spread widely (Van Wilgen *et al.,* 2001). The use of biological control agents (*Cactoblastis* caterpillar and a cochineal insect) (Hoffmann *et al.,* 1999; Moran *et al*., 2013) has improved the situation substantially. Lotter & Hoffmann (1998) stated that an approach of combining herbicide control on scattered populations with the release of biological control agents onto larger infestations shows a more promising method for bringing the weed under control. The Broad-leaved paperbark (*Melaleuca quinquinervia*) in the United States of America was also controlled using a combination of all three control methods. Mechanical control is generally used in more accessible sites, while in less accessible sites, a foliar herbicidal spray may be used. Wetland seedlings are also killed using prescribed burning (Hammer, 1996). The use of biological control agents, such as the snout weevil (*Oxyopsvitiosa),* has been applied since 1997, and several other potential insects have been identified (Van Wilgen *et al*., 2001).

2.7. *Rosa Rubiginosa* L. and its Introduction in Lesotho

Rosa rubiginosa L., widely known as Sweet Briar and as eglantine in most regions of the world, is a Rosaceae family deciduous shrub native to Europe and Asia (Hunter, 2014; Flores *et al*., 2019). It is part of invasive alien species in South Africa, Australia, New Zealand, and North and South America (Hunter, 2014). It was introduced primarily for ornamental and hedging purposes in most invaded countries (Henderson, 2001). The shrub grows about 1–2 meters tall, with little arching branches and hooked thorns. It blooms in early summer with pink to white roses. The presence of sticky glands on the underside of the leaflets that secrete a strong, sweet smell is one of the distinguishing features of *R. rubiginosa* (Zimmermann, 2012).

R. rubiginosa invades high altitude grassland, exceptionally moist valleys, rocky outcrops, waterways, sides of roads, and overgrazed land (Henderson, 2001; Carbutt, 2012). However, the shrub can also infiltrate dryland environments (Carbutt, 2012). It can rapidly invade open areas due to its increasingly rapid growth rate and seed production, efficient seed dispersal aided by animals, and ability to form dense shrubland, changing the appearance of vegetation (Carbutt, 2012). Its infestations are primarily in lightly shaded and sunny areas (Hunter, 2014).

R. rubiginosa has numerous reproductive techniques, which include self-pollination (Zimmermann *et al*., 2011). *R. rubiginosa* does not depend solely on pollinators for seed production because its seeds are distributed by many animals, including birds, allowing them to spread in different surroundings rapidly (Werlemark, 2000). (Carbutt, 2012). It is also dispersed by root suckers and crown fragments leftover from disturbances (Zimmermann *et*

al., 2011; Carbutt, 2012). *R. rubiginosa*, as with all Rosa species, produces rosehips, which are fleshy achenes fruits that range in colour from orange to scarlet (Hunter, 2014). As a result, *R. rubiginosa* is deemed a valuable shrub due to the numerous economic advantages affiliated with rosehips (Franco *et al*., 2007; Barry *et al*., 2008; Ramos *et al*., 2016).

In Lesotho, *R. rubiginosa* was introduced by English missionaries who used rosehips to feed their horses (Mokhobo *et al*., 2017). It requires low winter temperatures, as is found with many other members of the family *Rosaceae*, to terminate seed dormancy (Henderson, 2001). The areas invaded by *R. rubiginosa,* including Lesotho, experience the highest frequencies of below freezing minimum temperatures in southern Africa (Henderson, 2001).

There is no national list of invasive aliens species or their categorisation based on their level of impact (Kobisi *et al.*, 2019), as in the case of South Africa, where *R. rubiginosa* is categorised as category 1b invasive. This means its cultivation and sale are allowed. However, in South Africa, *R. rubiginosa* has been classified as a 1b invasive species under the National Environmental Management Biodiversity Act (2004). *R. rubiginosa* is categorised as a 1b because it is thought to cause severe environmental and economic damage. It also implies that the shrub has spread almost to a significant degree that its removal is nearly impossible; thus, the goal is to control these species rather than eradication. Similarly, *R. rubiginosa* is categorised as a group 2 invasive species in Australia under the Natural Resources Management Act (NRM), 2004 (Hunter, 2014). This implies that the plant or its products cannot be sold or transported. Its movement or sale is only allowed by law with a permit, and the Chief Officer can only grant that per Section 188 (Hunter, 2014). Plants growing on road reserves must be controlled by NRM authorities, whereas plants growing on private property must be controlled by landowners. Likewise, New Zealand, under the New Zealand Department of Conservation, classifies it as an environmental weed and is prohibited from sale, propagation, and distribution (Howell, 2008).

Rosehips from Lesotho are organic since they grow in the wild without any interference from chemicals; as a result, they are categorised under the organic wild collected products (Censkowsky *et al.*, 2007). Censkowsky *et al.* (2007) estimated the total global quantities of organic wild collected products, and it was found that rosehip was the 5th most significant organic wild collected product globally. The reported collected area amounted to 11,8 million hectares with a global total of 7,782 tons of rosehip harvested. Of the worldwide capacity of 7,782 tons, 1000 tons of rosehips were harvested in the Lesotho area (Censkowsky *et al.*, 2007).

Burkina Faso is the country in Africa for which the largest organic wild-harvested quantities were reported (Shea butter). Lesotho has the second largest level of production of rosehips.

2.7.1. Uses of *Rosa rubiginosa* L.

The economic benefits of *R. rubiginosa* are associated with the use and sale of its fruits, known as rosehips. *R. rubiginosa* may be beneficial to rural communities because it provides a variety of services and goods. *R. rubiginosa* can restore degraded native forests as a nurse plant, creating a protective microenvironment (De Pietri, 1992). This is attributable to the shrubs' thorns preventing cattle grazing and contributing to soil structure recovery, permitting native woody species to grow within the microenvironment eventually and thus become bigger than *R. rubiginosa shrubs* (De Pietri, 1992; Carbutt, 2012). *R. rubiginosa* is also known as a useful fodder plant because goats can eat fully grown plants while new shoots and seedlings are eaten by sheep and cattle (Grundy *et al*., 1989).

According to Letšela *et al*. (2003), several shrubs, including R. rubiginosa, are used for fuelwood in rural Lesotho. R. rubiginosa is used as a wild fruit in some areas, primarily by men while caring for their livestock during the day (Letšela *et al*., 2003; Kobisi *et a*l., 2019). Furthermore, Ladio (2005) stated that R. rubiginosa has been used by rural communities in Argentina and is regarded as the most useful alien plant by families with dietary restrictions and limited access to medicines. Rosehips were used as rosehip tea and jam because of their taste and high vitamin C content (Smulders *et al*., 2011; Aguirre *et al.,* 2016). Edible *R. rubiginosa* rosehips contain between 500-2200 mg/100g of vitamin C within the fresh fruits (Pirone *et al.,* 2007). Vitamin C content in rosehips is greater than the vitamin C content in citrus fruits (Barry *et al*., 2008; Aguirre *et al.,* 2016). Rosehips also contain other beneficial minerals such as phosphorus, magnesium, iron, sodium, and calcium (Barry *et al.*, 2008).

Hundreds of Basotho men and women, especially in rural areas, collect rosehip to earn money to meet their financial needs. Kobisi *et al.* (2019) claimed that both men and women collect loads of rosehips to supply the export market in exchange for money. According to Rosehip Company (2020), the communities in Lesotho, where they buy material, are very poor and isolated, with little potential for generating income. However, by participating in the rosehip market, the harvesters have the potential for earning an income without needing specific skills, as most are uneducated. Angelsen *et al.* (2014) stated that about a quarter of the income of rural households in developing countries comes from natural resources. Rural people in most

southern Africa depend more on biological resources, including *R. rubiginosa,* for their livelihoods (Letšela *et al.*, 2003).

In the cosmetic industry, rosehips have a growing market (Ramos *et al*., 2016). The seeds of rosehips are used to make rosehip oil which has a variety of applications, including accelerating skin regeneration and healing of damaged tissues. (Jasminka, 2019). The oil is widely known for its valuable unsaturated fatty acids and natural antioxidants (Prescha *et al.*, 2014). In the study conducted by Nowak (2005), *R. rubiginosa* was among the top six rosa species in terms of the amount of oil. *R. rubiginosa* rosehips have contain about 8% oil while *Rosa canina* var. *dumalis* contain about 11% oil. The results also indicated that rosehips are high in unsaturated fatty acids. *R. rubiginosa* has about 78% of unsaturated fatty acids extracted per rosehip, while *Rosa dumalis* var. *besseriana* was the highest, with approximately 79% of unsaturated fatty acids extracted per rosehip.

2.7.2. The Negative Impacts of *Rosa rubiginosa* L.

Pavek (2012) and Hunter (2014) discovered that *R.rubiginosa's* dense thickets affect pasture productivity since they lead to significant pasture production loss, increasing competition with productive pasture species. The shrubs may also inhibit livestock from accessing water and grazing land (Grundy *et al*., 1989; Carbutt, 2012). Moreover, areas invaded by the shrub may become occupied by the plant, decreasing desirable vegetation. *R. rubiginosa* proliferates disturbed native vegetation in environments with heavy rainfall, lowering its ecological benefits (Hunter, 2014). Grundy *et al*. (1989) also speculated that the negative effects of *R. rubiginosa* on farmland could significantly impact agricultural sectors in invaded countries. Le Maitre *et al*. (2016) evaluated the effect of several invasive alien plants, including *R. rubiginosa*, on South African water supply. *R. rubiginosa* was discovered to have an annual estimated flow reduction factor of 72% of mean annual runoff. The study also discovered that *R. rubiginosa* used water reasonably (Le Maitre *et al*., 2016).

2.7.3. Control of *Rosa Rubiginosa* L.

R. rubiginosa is hard to manage due to the large infestations and sprout regeneration. Control frequently necessitates using multiple techniques, such as mechanical control, herbicide application, and grazing management (Pavek, 2012; Hunter, 2014). Several methods have been used in the past to control *R. rubiginosa*, including mechanical control through hand pulling and the use of horses to pull out dense thickets (Grundy *et al*., 1989). *Rosa rubiginosa* control is most effective when the plants are young. Young plants in well-managed pastures are

conveniently destroyed by grazing and competitive pressure from pasture plants, preventing seedlings from establishing (Natural Resources South Australia, 2017). Furthermore, large shrubs are more resistant to grazing than young plants, so they can be foliar sprayed and treated with basal bark (Hunter, 2014). Only herbicides certified for use in grassland and non-cropping situations are used, and they are applied with extreme caution to avoid harming non-target plants. Metsulfuron methyl, triclopyr, and glyphosate are among the herbicides approved for use (Tamar Valley Weed Strategy, 2015). Grundy *et al*. (1989) also reported that the chemical control method, which included picloram spray, was successful on mature R. rubiginosa shrubs.

2.8. Sustainable Livelihoods

Rural households in developing countries engage in different livelihood strategies for poverty reduction (Babulo *et al.*, 2008). The number of livelihood strategies pursued by each household is determined by the assets available to them. (Babulo *et al*., 2008; Walter & Armstrong, 2014; Zhong *et al*., 2015). As a result, identifying the assets that form the basis of various livelihood strategies is essential for development-focused policies that aid in designing opportunities that promote sustainable livelihoods (Scoones, 1998; Babulo *et al.*, 2008). The assets can be natural resources in the form of ecosystem goods and services, physical capital such as land, knowledge and capacity, people's health, financial assets such as savings and credit (DFID, 1999; Zhong *et al*., 2015). According to DFID (1999), human capital is the basis for developing sustainable livelihoods because it influences the types of livelihood options available to households and their access level.

Chambers and Conway (1991:6) define a livelihood as comprising of "the capabilities, assets (stores, resources, claims and access) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base". Scoones (1998) demonstrated that access to various livelihood resources linked in search of numerous livelihood strategies could lead to sustainable livelihoods. Scoones (1998) further discussed five main components of livelihood sustainability: poverty reduction, the creation of working days, livelihood adaptation, well-being and capability, and natural resource base sustainability. Households that cannot adapt or survive in the face of short-term or long-term changes are undoubtedly vulnerable and not likely to obtain a sustainable livelihood (Scoones, 1998; Niehof, 2004).

2.8.1. Sustainable Livelihood Framework

The sustainable livelihood approach is characterised as a better way of thinking about the development's objective, scope and priorities to intensify poverty reduction (DFID, 1999; Majale, 2002; Serrat, 2017). It outlines different factors that shape the household's livelihood, the elements that control or strengthen them, and the relation between those factors (Babulo *et al.*, 2008; Serrat, 2017). As a people-centred approach to sustainability, it weighs the progress that the already available activities have made in sustaining livelihoods and aids in formulating development activities (Serrat, 2017). The sustainable livelihood framework comprises five key components: livelihood assets, vulnerability context, transforming structures, livelihood strategies, and livelihood outcomes (Mdee, 2002; Serrat, 2017; Zhao *et al.*, 2019). This framework examines how capital assets as a central feature are affected by the vulnerability context components in which they are derived and the institutions and policy changes to develop livelihoods strategies that lead to numerous livelihood outcomes (Mdee, 2002). Therefore, the study employed the sustainable livelihood approach as a framework that describe the assets and livelihood strategies of the people in the study area.

2.8.2. Capital Assets

The sustainable livelihood approach aims to increase the variety of livelihood assets available to different households (Serrat, 2017). Livelihood assets pentagon comprises five forms of capital assets used by households to develop livelihood: natural capital, human capital, physical capital, social capital, and financial capital (Mahdi *et al*., 2009; Serrat, 2017; Zhao *et al.*, 2019).

- **Natural Capital:** Natural capital comprises the natural resources base, ecosystem and environmental services, providing essential resources and services to households (Scoones, 1998; Mahdi *et al.*, 2009). For example, land, water, wildlife, wild foods and trees (Sati & Vangchhia, 2017; Serrat, 2017). According to DFID (1999), natural capital is critical to people who rely on natural resource-based activities for all or part of their income, such as harvesting wild plants, fisheries and farming. However, nobody would survive without the aid of essential environmental services and food produced from natural capital (DFID, 1999).

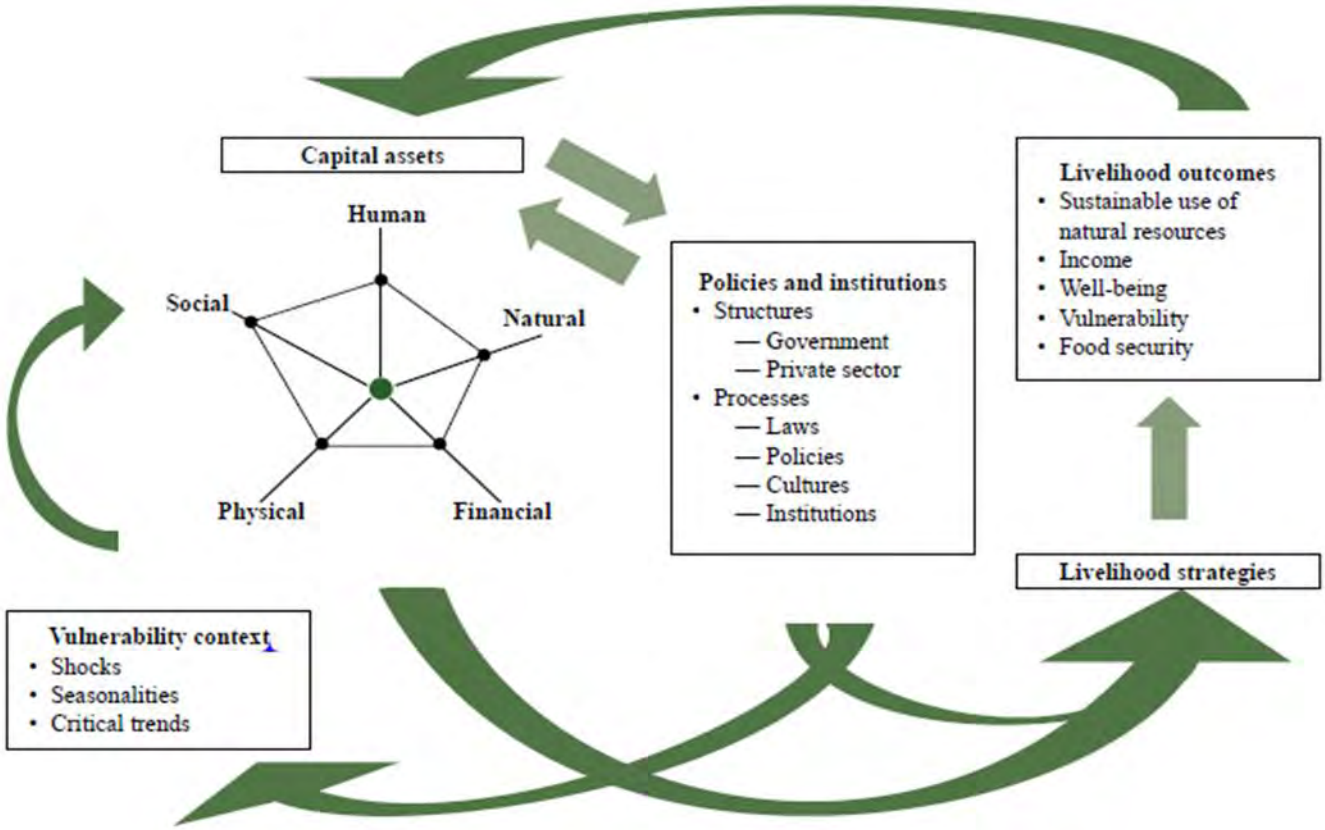

Figure 2.1: The Sustainable Livelihoods Framework

Source: Serrat, 2008

- **Human Capital:** Consists of individual aspects such as the knowledge, skills, good health, education, and capacity to work, enabling people to pursue various livelihood strategies and attain desired livelihood outcomes (Scoones, 1998; DFID, 1999; Serrat, 2017). At a household level, the human capital is determined by the quality and amount of available labour, which differs according to the work experience from a particular field, household size, level of education, health status, age and gender (DFID, 1999; Serrat, 2017). Although it is not sufficient on its own to attain positive livelihood outcomes, human capital is needed in making use of each of the four other types of assets (DFID, 1999). The households involved in rosehip harvesting have low education levels that limit their chances of obtaining formal employment. This implies that human capital is lacking among rosehip harvesters.

- **Physical Capital:** Refers to the transport, roads, vehicles, secure shelter, adequate access water supply, access to information and tools and technology required to form livelihoods (DFID, 1999; Mahdi *et al*., 2009; Serrat, 2017). According to DFID (1999),

a lack of specific forms of infrastructure is considered an essential aspect of poverty. For example, without adequate transport infrastructure, required fertiliser cannot be adequately transported, resulting in low agricultural yields. As a result, transporting the limited product to market becomes difficult and costly (DFID, 1999). Therefore, a lack of physical capital limits productivity and people's capacity to achieve their livelihood goals. Rosehip harvesters need proper tools for harvesting and adequate transport to transport their rosehip to the market easily.

- **Social Capital:** Refers to the social networks, associations and relationships that exist among communities in pursuit of livelihood strategies (Scoones, 1998; DFID, 1999; Serrat, 2017). Social relationships are typically marked by trust and mutual support. They serve as the foundation for safety nets among the poor as they work together to achieve their diverse livelihood outcomes (DFID, 1999; Serrat, 2008). Social capital is available among rosehip harvesters as they form rosehip harvesters associations where they share information on other poverty-reduction strategies.

- **Financial Capital:** Refers to financial resources such as savings, cash, wages, pensions, credit and remittances that people use to achieve their livelihood outcomes (DFID, 1999; Mahdi *et al*., 2009; Serrat, 2017). Financial capital is possibly the most adjustable of the five asset categories. For instance, it can achieve direct livelihood outcomes, such as purchasing food to reduce food insecurity (DFID, 1999). However, financial capital appears to be the least available livelihood asset among the poor (DFID, 1999; Serrat, 2017). Rosehip provides harvesting households with financial capital, as the primary reason for rosehip harvesting is income generation.

2.8.3. Vulnerability Context

According to Serrat (2008), vulnerability is the uncertainty in the welfare of communities, households, and individuals due to changes in their external environment. Households with vulnerable livelihood systems lack assets and the ability to access them, making it challenging to meet the needs of their families (Serrat, 2017). Critical trends and shocks, and seasonality significantly impact people's livelihoods and the wide choice of assets since they have minimal or no choice over them (DFID, 1999). DFID (1999) argued that the vulnerability context factors are significant because they significantly affect people's asset status and the options available to them in quest of valuable and effective livelihood outcomes. Thus, a better understanding of the concept of vulnerability could provide measures to enhance livelihoods by managing risk

(Adger, 2006). Significant parameters to vulnerability may be either external or internal. External aspects include the stress and shocks individuals are subjected to, whereas internal elements can cope with shocks and stresses (Adger, 2006; Serrat, 2017). The vulnerability includes:

- **Shocks** (e.g., conflict, illnesses, floods, storms, droughts, pests, diseases): Shocks can result in the permanent destruction of assets, forcing people to dispose of their assets and even abandon their homes as a way of coping. (DFID, 1999; Butt & Hussan, 2015; Serrat, 2017). In the context of this study, shocks include loss of a job or death of a member of the household who was the provider for the family, forcing one to harvest rosehip.

- **Seasonality** (e.g., prices, food availability and employment opportunities): They are amongst the most significant and long-lasting causes of struggles for low-income families (DFID, 1999; Serrat, 2017). Rosehip is only available for three months, so rosehip's income is available for a limited time.

- **Critical trends** (e.g., economic, demographic, governance, technological and environmental trends.): They may be more or less harmless, but they are more observable and have a significant impact on the rates of return on various livelihood options, whether economic or non-economic (DFID, 1999; Serrat, 2017). Trends among rosehip harvesters in Lesotho include unemployment. The high abundance of *Rosa rubiginosa* may increase the community's vulnerability by invading some of the land used for farming. As a result, people may incur higher costs to clearing them.

2.8.4. Policies and Institutions

Serrat (2008) argues that livelihood strategies and outcomes are shaped by the environment of structures and processes, not merely by accessibility to capital assets or the vulnerability context. Structures comprise public and private sector organizations that formulate and enforce policy and legislation, provide services, purchase, sell, and do various other issues that affect people's livelihoods (DFID, 1999; Serrat, 2008). DFID (1999) claimed that structures are critical in supporting processes to function, as there is no legislation without legislative bodies. Processes include the regulations, laws, agreements, practices, societal norms, policies, and operational arrangements that govern how structures operate (Serrat, 2008).

Policies and institutions influence livelihoods in all sectors, from the household to the international level (DFID, 1999; Majale, 2002). Policies, institutions, and processes substantially impact the conditions that influence multiple livelihood strategies and sustainable livelihoods because they function at all stages and in public and private domains (Bingen, 2000; Majale, 2002). They influence access to a wide range of capital (natural, physical, financial, social, and human) assets and capital substitutability (DFID, 1999; Bingen, 2000; Majale, 2002). Moreover, policies and institutions also determine the extent to which a facilitating environment for livelihoods exists, as opposed to one that is hindering or limiting (DFID, 1999; Hobley, 2001).

2.8.5. Livelihood Strategies and Livelihood Outcomes

The goal of livelihood strategies is to achieve livelihood outcomes (Serrat, 2008). The sequence of choices and activities that people engage in to earn their livelihood goals is a livelihood strategy (DFID, 1999; Zhao *et al*., 2019). Households' decisions on livelihood strategies may involve off-farm activities, intensification versus diversification, pensions, and grants, natural resource-based activities, migration, and remittances, as well as short-term versus long-term outcomes (Serrat, 2008). Livelihood outcomes are the outputs or accomplishments or outputs of livelihood Strategies (DFID, 1999). This may include improved food security, restored human dignity, more income, more sustainable use of the natural resource base, reduced vulnerability, and enhanced well-being, although there may also be conflict (DFID, 1999; Serrat, 2008). To mitigate the effects of the vulnerability context, households in Lesotho engage in multiple income-generating activities such as rosehip harvesting in order to achieve favorable outcomes that benefit the household. This livelihood outcome includes decreased vulnerability and increased rosehip income, which leads to improved food security.

2.9. Chapter Summary

This chapter reviewed the literature on invasive alien spices and their contribution to rural livelihoods, with the majority of the evidence emerging from South Africa and other African countries because there is very little information on IAS in Lesotho, where the study is based. The sustainable livelihood framework was discussed as the analytical framework for this study, explaining the factors that comprise a livelihood. Poor rural communities use several invasive alien species to support their livelihoods in various ways, including food, income generation, medicine, hedging, soil erosion control, and social and cultural purposes. In emphasising the significance of these species to livelihoods, it is evident that some knowledge on the positive

effects exists. However, few studies have examined the degree of their contribution to rural communities, particularly in Lesotho. As a result, this study will use rosehip harvesting in the Leribe District as a case study. The following chapter discusses the study area and provides details on data collection and analysis methods.

CHAPTER 3

STUDY AREA AND METHODOLOGY

3.1. Introduction

This chapter describes the methods used to conduct this study on rural households' perceptions of rosehip and the role it plays on livelihoods in Lesotho. The chapter also provides a description of the research area and a discussion of the various steps of the study, such as study participant selection, data collecting, and data analysis.

3.2. Study Area

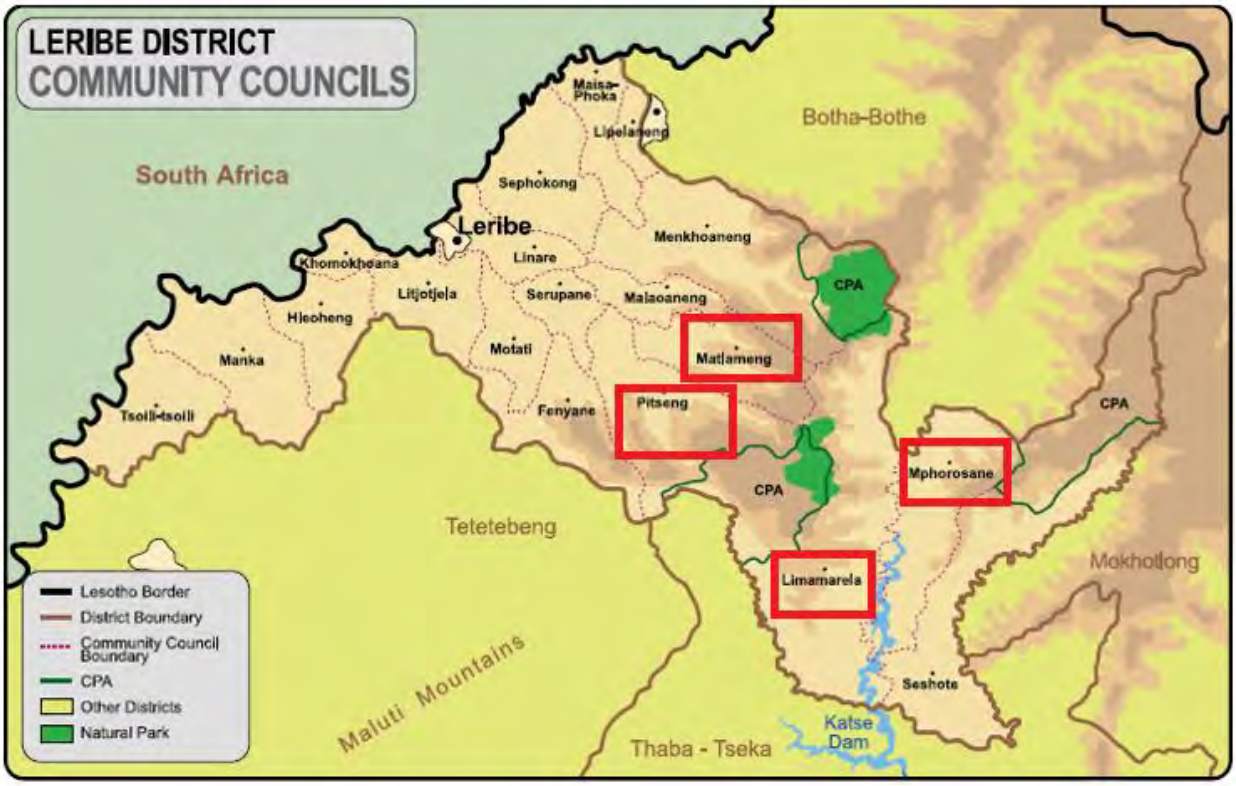

Figure 3.1: Map of Leribe District Lesotho, red rectangles show sampled areas

Source: Trillo-Figueroa, 2009

Lesotho is a small landlocked country bordered by South Africa, with an area of 30 355 km² (On The World Map, 2021). The country is divided into ten administrative districts. Leribe is one of the ten districts located in the country's northern part. The population of Leribe is estimated to be 337 500 people, in an area of 2828 km², resulting in a population density of

119 people per square kilometre (Trillo-Figueroa, 2009; Lesotho Bureau of Statistics, 2016). Arable land accounts for 17% of the district's total land area and is rapidly declining due to significant soil erosion and land degradation (Trillo-Figueroa, 2009; Makhata *et al*., 2021). The district is divided into thirteen constituencies and eighteen community councils (Trillo-Figueroa, 2009).

The Leribe District encompasses three ecological zones: lowlands, foothills, and mountains (Trillo-Figueroa, 2009; Moeletsi & Walker, 2013; Hlalele, 2019). Trillo-Figueroa (2009) noted that temperatures range from -2°C in winter to 32°C or higher in the summer in the lowlands. The climatic conditions are harsh in the mountains, with colder and longer winters and a typically cooler summer. Snow falls between April and October in the mountains. Contrarily, the lowland climate is constantly chilly and dry in the winter and exceptionally hot in summer (Trillo-Figueroa, 2009). The average annual precipitation in Leribe ranges between 500 mm and 800 mm, with the mountain areas receiving a higher percentage of total rainfall than the lowlands (Trillo-Figueroa, 2009). Therefore, due to its good soils and high rainfall, the Leribe District is regarded as one of the country's major agricultural production zones (Trillo-Figueroa, 2009; Maseatile, 2011; Hlalele, 2019). The most common crops across the community councils are maize, sorghum, and beans. Hence a significant proportion of the communities throughout this district rely on subsistence agriculture and livestock for a living (Hlalele, 2019; Makhata *et al*., 2021).

The lowland zone has major urban settlements, industrial establishments and adequate infrastructure (Trillo-Figueroa, 2009; Hlalele, 2019). However, due to poor road conditions, the majority of the mountain region is inaccessible. Trillo-Figueroa (2009) confirms that the primary natural resource in this area is water, Lesotho's most valuable resource due to the numerous rivers and streams that run through the district. Leribe, on the other hand, is challenged with problems such as low-income levels, high unemployment rate, land degradation, and severe soil erosion, all of which limit sustainable agricultural productivity (Hlalele, 2019). Trillo-Figueroa (2009) also indicates that the entire district has 81,382 households, most of which are headed by females. The majority of families in the community rely on income from agriculture, remittances and manufacturing industries.

For this study, four community councils (CCs) were purposely selected to understand social, economic and environmental perceptions of *Rosa rubiginosa* (rosehip) and its role in rural livelihoods. One village was chosen for sampling from each community council. The first was

the Pitseng community council comprising Voka-Zenzela village, followed by Matlameng community council with Ha letele village, then Limamarela community council with Ha lejone village, and lastly, Mphorosane community council with Tiping village. These areas were chosen because of the abundance of *Rosa rubiginosa* near the villages.

3.3. Research Design

This study followed a pragmatism paradigm, which promotes the development of understanding through practical applications as well as the acquisition of solid knowledge through thought and experiences (Kaushik & Walsh, 2019). Pragmatism also allows for the mixing of approaches and methods for data collection and analysis (Tuyet Tran, 2017; Kaushik & Walsh, 2019). According to Caracelli (as cited in Johnson *et al.*, 2007), a mixed-method approach is "one that planfully juxtaposes or combines qualitative and quantitative methods to provide a more elaborated understanding of the phenomenon of interest, including its context, to gain greater confidence in the conclusions generated by the evaluation study." Moreover, the study made use of the cross-sectional study approach to collect data across a sample population at a single point in time. This approach allows the researcher to collect data quickly and easily as they do not require any follow with subjects and can be done with self- report surveys (Cherry, 2019). A comparative study of Rosehip harvesters and non-harvesters was used.

3.4. Sampling approach and Sample Size

To identify research participants, simple random sampling was used. Probability sampling also known as random sampling, is one where each participant has a known non-zero chance of being selected (Battaglia, 2011; Taherdoost, 2016; Etikan & Bala, 2017; Showkat & Parveen, 2017). Thus, in probability sampling, each participant has the same chance of being selected. Simple random sampling is regarded as the best, most straightforward, and the fairest method of selecting participants as everyone has the same chance of being selected (Taherdoost, 2016; Showkat & Parveen, 2017). The lists of harvesters and non-harvesters obtained from the village chief was used to select participants randomly. Every household was assigned a specific number, which was then placed in a bowl from which participants were drawn at random.

The sample population comprised of people from four villages in Lesotho in Leribe District, namely Pitseng (Voka-Zenzela), Lejone, Matlameng (Ha letele), and Mphosong (Tiping). These villages were specifically chosen due to their abundance of rosehips. In each village, 40 households were selected, with 20 harvesters and 20 non-harvesters. Thus, 160 respondents

participated in the study and were divided into two groups: harvesters and non-harvesters. Hutcheson and Sofroniou (1999) recommended sample size of at least 150 or more for PCA. As a result, this sample size was sufficient to generate unbiased results. All of the respondents were over the age of 18.

Table 3.1: Sample size in the surveyed villages

Number	Community Council	Village	Sample Size
1.	Pitseng	Voka-Zenzela	40
2.	Matlameng	Letele	40
3.	Limamarela	Lejone	40
4.	Mphorosane	Tiping	40
Total	4 CCs	4 Villages	160

3.5. Data Collection

Primary data was used to acquire detailed information regarding *Rosa rubiginosa* (rosehips) and its role in rural livelihoods in Lesotho. The study used questionnaire-based interviews. Thus, a semi-structured questionnaire was used to collect both qualitative and quantitative data for the study. The semi-structured questionnaire combined predefined questions with several possible answers and open-ended questions that allowed respondents to provide more thorough responses. Face-to-face interviews were chosen because they can be used with illiterate respondents, and they enable the researcher to give explanations for unclear or more complex questions (Mathers *et al.*, 2007).

The questionnaire was administered face to face with the sampled household in all four villages. The household head was interviewed if available; if absent, the most senior family member available and had knowledge on rosehip was interviewed. The interviews took place from the 7th June 2021 to the 11th June 2021 and were conducted at the participants' homes. Household interviews lasted between 30-45 minutes. All interviews were done using the local home language in Lesotho, which is Sesotho. The questionnaire included sections on household characteristics, knowledge of rosehip, rosehip harvesting and income, crop production costs and income, livestock production costs and income, other sources of income for one year, and household capital assets.

The researcher collected the data for this study with the help of two enumerators who spoke the local language (Sesotho). Permission was requested from the respondents before the

interviews were recorded. The importance of recording interviews was to allow respondents to answer open-ended questions without interruption, as some would stop for a moment and wait for the researcher to finish writing before continuing their story. Then at times, they might lose their line of thought. As a result, recording the interviews contributed to the accuracy of the information, especially given almost all of the interviews were conducted in the native language, ensuring that they could later be appropriately translated back into English.

3.6. Empirical Analysis

The study employed both descriptive and empirical models for data analysis. Descriptive statistics included the frequency, percentages, standard deviation, means, and bar charts. The independent t-test was the appropriate parametric test to determine whether the two groups were statistically different. To perform an independent t-test, the dependent variable had to be continuous, and the data be normally distributed as well as the adequacy of the sample size. However, the assumption of normality did not hold while using the Kolmogorov-Smirnov test for normality as the p-value was greater than 0.05. Therefore, a non-parametric test Mann-Whitney U test, was used to compare whether the statistical difference existed in the dependent variable household income for two groups of harvesters and non- harvesters. A Chi-square ($\chi 2$) test mainly used for categorical variables was used to identify whether the harvesting of rosehip is specific to any particular demographic characteristic and variables.

Microsoft Excel, STATA v17 and Statistical Package for Social Studies (SPSS) v22 statistical package programs were used in the statistical analyses and diagrammatic representations. The empirical models employed the Probit regression model to evaluate the factors influencing households' participation in rosehip harvesting. Households' perceptions of rosehip were collected using a 5-point Likert scale where 1 means strong disagreement and 5 means strong agreement, implying that the household head perceives rosehip to have positive impacts.

3.6.1. Principal Component Analysis

Principal components analysis (PCA) was used to generate the perception indexes, which were then used as explanatory variables in the probit model. Principal component analysis, which is a technique for reducing the dimensionality of large datasets by increasing interpretability while minimizing information loss, has been widely used to generate indexes (Muchara *et al*., 2014; Jolliffe & Cadima, 2016). Shaukat *et al.* (2016) noted that one advantage of PCA is that it enables variables measured in different units. PCA extracts the meaningful information from

the data set and expresses it as a set of new orthogonal variables known as principal that are arranged so that the first few retain the majority of the variation present in all the original variables (Joliffe 2002; Shaukat et al., 2016). It divides a data matrix's total variance build-in variables into a new set of derived variables (Yi), a linear combination of the initial variables (Shaukat *et al.*, 2016; De Silva, 2017). Thus, according to (Mendes, 2011), the PCA equation in matrix notation can be expressed:

$$Y=W'X \quad (1)$$

where X is the matrix that contains p original variables and W is the matrix of weights which contains standardized weights (wij) of each variable in PCs. The magnitudes of the coefficients indicate how much each variable contributes to that component. The units of the variables may have an impact on PCA (De Silva, 2017). Based on differences in the units of variables used in PCA, the correlation matrix of variables (C) is used to obtain eigenvalues and variable weights. Furthermore, Bartlett's sphericity test is used to test the null hypothesis that the correlation matrix is an identity matrix or that all correlations are zero. This means that the suitability of PCA is determined by Bartlett's sphericity test result. As a result, Bartlett's sphericity test was used in this study to assess the appropriateness of PCA. The formula for this test is as follows:

$$X^2 = \frac{11+2p-6n}{6} \log_e |C| \quad (2)$$

Where p is the number of components, n is the number of observations in the sample, and C is the correlation matrix.

The study used factor extraction, which determines the smallest number of factors that can be used best to describe the interrelationships among the set of variables. Only PCs with eigenvalues greater than one were used (Kaiser 1960). Therefore, only the score values of the first two selected PCs were considered. For each perception (social, economic and environmental), two perception indexes were generated and used in the probit model as determinants of participation.

3.6.2. Probit Model

The Probit model is a popular statistical model for analysing data with binomial distributions (Alabi *et al*., 2012). The dependent variable takes the values of zero and one. The probit model assumes that while the values of zero and one were observed for the dependent variable(Y),

there is a latent, unobserved continuous variable, Y*, determining the value of Y. Thus, Y* can be specified as follows (Ndakaza *et al*., 2016):

$$Y^* = \beta o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k \beta_{ki} + \varepsilon i \quad (3)$$

$$y = \{1 \text{ if } y^* > 0, 0 \text{ otherwise}\}$$

where represent vectors of random variables and represents a random disturbance term. Then from equation (1),

$$\text{Prob}(Y = 1) = \text{Prob}(\beta o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k \beta_{ki} + \varepsilon i > 0) \quad (4)$$

$$= 1 - \text{Prob}(\varepsilon i > -(\beta o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k \beta_{ki}))$$

$$= 1 - \phi(-(\beta o + \beta 1 X 1 i + \beta 2 X 2 i + \ldots + \beta k \beta k i)) \quad (5)$$

where Φ is the cumulative distribution function of Ɛ (Morgan *et al*., 2004; Ndakaza *et al*., 2016).

The probit model assumed that the data came from a random sample of size N, with each sample observation denoted by I, i = 1,..., N. To rule out serial correlation, the observations of y must be statistically independent of one another (Morgan *et al*., 2004). Furthermore, the literature informed the independent variables on factors influencing participation in natural resources harvesting.

The probit model parameters were estimated using the Maximum Likelihood Estimation (MLE) technique. MLE prioritized parameter estimates that provided the greatest probability of achieving the observed sample y. Therefore, according to Morgan *et al*. (2004), the probit regression model was then specified as follows,

$$Y = \beta o + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_{14} X_{14} + \varepsilon i \quad (6)$$

Where Y is a dichotomous dependent variable which can be explained as;

Y = 1, if a household participate in rosehip harvesting, Y = 0, otherwise,

βo = the intercept

$\beta_1, \ldots \beta_9$ = regression coefficients that explain the probability of a household's participation in rosehip

Ɛi = the error term.

Xi = Vectors of parameters to be estimated, i.e. independent variables (i =1, 2, 3…14).

Table 3.2 presents the explanatory variables included in the Probit model to determine factors that influence households' decision to participate in rosehip or not as a harvester. According to Suleiman *et al*. (2017), as the household head's age increases, their chances of participating in forest product collection decrease due to a lack of energy, as collection requires more active and stronger people. On the other hand, elder household heads are more likely to participate in natural resource collection because it improves their livelihood opportunities (Kazungu *et al.*, 2021). Age was measured in this study by the actual number of years of the household head and is expected to either have a positive or negative effect on participation in rosehip harvesting.

Table 3.2: Variables hypothesized to influence households' decision to participate in Rosehip or not as a harvester

Variable definition	Variable measurement unit	Expected sign
Dependent Variable		
Participation in the harvesting of rosehip	1= household harvested rosehip 0= otherwise	
Independent Variables		
Age	Number of years	+ or -
Education level	Numbers of years spent at school	-
Household size	Total members in the households	+
Gender	1= Male 0= Female	-
Occupation	1= Salaried job 0= Otherwise	-
Group membership	1= Yes 0= No	+
Social grants	1= Yes 0= No	+ or -
Wage income	Household income in Maloti (M)	-
Economic perception index	Continuous	+ or -
Social perception index	Continuous	+ or -
Environmental perception index	Continuous	+ or -

A household with educated members is expected to have a negative correlation with participation in rosehip harvesting. The years of formal education of household members

influence the nature and decisions of their economic activities (Mulenga *et al*., 2011; Adongo *et al*., 2019). Household size is expected to positively affect participation in rosehip harvesting. According to Suleiman *et al*. (2017), large families have limited land holdings and high food dependency ratios, so they rely on natural resource collection due to the availability of family labour. Other previous studies (Aung *et al*., 2014; Moe & Liu, 2016; Adongo *et al*., 2019) also found a positive and significant relationship between household size and forest resources dependency.

Gender is expected to have a negative relationship with participation in rosehip because, in this study, more females were engaged in harvesting than males. This suggests that most men do not participate in harvesting because it is assumed that collecting forest products is the responsibility of women (Adongo *et al.*, 2019). Also, male-headed households tend to be well-off relative to female-headed households (Kamanga *et al*., 2008; Phali, 2015).

The occupation of the household members is expected to have a negative relationship with participation in rosehip harvesting. Suleiman *et al*. (2017) observed that households that earn wages are more likely to invest their time in other parts of the economy rather than relying on natural resource collection. A household whose members have a permanent job is also expected to have lower chances of participating in rosehip harvesting. Moreover, this study hypothesizes that rosehip-related associations membership is likely to influence participation in rosehip harvesting positively. Membership in forest products-related groups or any social network is critical for exchanging information between members and even the pursuit of a common goal (Suleiman *et al*., 2017; Adongo *et al.*, 2019). Social grants are expected to have either a positive or negative correlation with participation in rosehip harvesting.

Lastly, perceptions are expected to have either a positive or negative association with participation in rosehip harvesting. This suggests that people who perceive rosehip positively are expected to participate in rosehip harvesting. In contrast, people with negative perceptions of rosehip are expected to have lower chances of participating in rosehip harvesting. Previous studies (Shackleton *et al.,* 2019; Kapitza *et al.,* 2019; Sosa *et al.,* 2021) reported that increased knowledge about invasive species issues could change how the community perceives them, thus influencing their decision to take part in them.

3.7. Measuring Income and Definitions

The household interviews provided detailed information on household income sources. Household income was computed as the sum of income of all people in a particular household.

According to Suleiman *et al*. (2017), it includes income from off-farm activities (e.g., self-employment and formal employment), forest products incomes, and agricultural incomes. The total net income method (including cash and non-cash incomes) was widely employed to calculate household income (Babulo *et al*., 2008; Cavendish, 2002; Heubach *et al*., 2011). Total household income was divided into four major categories: rosehip income, livestock income, crop income, off-farm (wage) income, remittances, and social grants income (old-age pensions and child grants). The income category was computed using the methods described below, based on the approaches used in similar studies (Babulo *et al*., 2008; Heubach *et al*., 2011; Angelsen *et al.*, 2014; Moe & Liu, 2016; Mugido & Shackleton, 2019; Adongo *et al.*, 2019).

Rosehip income was calculated as the income from the sale of rosehip. Rosehips were not harvested for subsistence purposes by any of the interviewed households. Households provided the local market prices of the rosehip, and the average price was used for calculations since the prices differed in each village. Furthermore, households provided the quantity of rosehip collected monthly, quantity sold and cash amount obtained from selling the product.

Livestock income: Angelsen *et al.* (2014) defined livestock income as the value of products obtained from livestock (along with live animals' sales) and services (such as rented-out draft power) but excluded incremental stock value changes. Annual gross livestock income for each household was calculated as the income from the sale of livestock and household consumption of livestock products (milk, meat, and eggs). Annual livestock cost for each household was obtained by summing the costs of production units (e.g., veterinary services and purchased fodder). Therefore, subtracting total annual costs from annual gross livestock income resulted in net livestock income.

Net crop income was calculated as the total annual crop output (computed by multiplying quantity produced by market price) produced in a given season minus the total crop production costs (such as seed, fertilizer, and hired equipment) incurred in the same cropping season.

Wage income included wages earned from skilled and unskilled labour, either temporary or permanent (e.g., doctor, taxi driver, cleaner, and nurse). Annual wage income was calculated using the actual values provided by households for these activities in a given year.

Remittances included cash received by households from family members throughout the year. In Lesotho, it is common for rural households to receive monthly money from family members working in neighbouring countries such as South Africa.

Social grants included all the social security grants given to qualifying Lesotho citizens by the government. The social grants income included old-age pensions and child support grants.

3.8. Ethical Considerations

This research was performed in accordance with the Rhodes University Research Ethical Standards Policy's ethical guidelines. The questionnaire was approved for use by the Economics Department's Research Ethics Sub-committee. Each questionnaire had a paragraph on the front page that provided a brief introduction to the researcher, the purpose of the research, how the study's findings would be used, and the institution associated with the research study. Research participants were also briefed on the sorts of questions that would be asked in order for them to give their informed consent to participate in the study.

Respondents were also informed that their participation in the study was completely voluntary. They can somehow skip responding to questions that they did not feel comfortable answering and withdraw consent at any point during the interview if they so desired. The respondents were guaranteed that their confidentiality would be treated with respect. Once a potential research participants agreed to participate in the study, they were given consent forms to sign after reading all of the terms as evidence that they had consented to participate in the study.

3.9. Chapter Summary

The chapter provided a brief overview of the study area to establish the significance of the study. This study applied the mixed methods approach in collecting and analysing data. The sample of 160 respondents from the Leribe District was drawn using simple random sampling and snowball sampling. Data collection used semi-structured questionnaires. The following chapter presents the research results and discusses the descriptive statistics and the econometric analysis results. The research findings are discussed in the context of the sustainable livelihood framework.

CHAPTER 4
RESEARCH RESULTS AND DISCUSSION

4.1. Introduction

Rosehip harvesting is a livelihood strategy used by unemployed and marginalized communities with very few alternatives for earning a living. This chapter presents the research findings from a study of the role of rosehip in rural livelihoods in Pitseng, Matlameng, Limamarela, and Mphorosane community councils in Leribe District Lesotho, outlining the contribution of rosehip to harvesters' household incomes and the social, economic, environmental, and ecological perceptions of rosehip among households. Furthermore, it determines the contribution of rosehip harvesting income to household income by comparing it to other income sources such as agriculture, which comprises cash and non-cash income from animals and crops, remittances, social grants, and wage income the percentage share.

4.2. Socioeconomic Characteristics of the Respondents

The demographic and socioeconomic attributes of the 160 sampled respondents are presented in Table 4.1. The average age of responding members was 47 years, with a minimum of 18 years and a maximum of 90 years. This implies that the study communities were made up of older people, as 69 percent were over 35 years, meaning they were at the stage in their lives where most were supporting their families. As a result, they would be expected to engage in different income generating activities like Rosehip harvesting. Furthermore, the average household size was four members (50%), with 1-3 and 7-9 members accounting for 41 and 9 percent, respectively. The typical household had four members with a minimum of one and a maximum of nine people (Table 4.1). This implies that households with more family members would participate more in Rosehip harvesting because of the available labour. Furthermore, most interviewed respondents were female (73%). More than half of the respondents (83) were married, 43 were widowed, 22 were single, and 12 were divorced.

Educations levels were generally low, with almost two-thirds of the respondents (62%) having attended up to primary level education and only 28 percent have secondary education. Twelve respondents had no education. Of the 160 respondents, only 2 percent had tertiary education. Thus, this implies a high rate of illiteracy in the study areas because most of the respondents

are who have achieved formal education were unable to proceed to higher education institutions. As a result, participation in Rosehip harvesting would be high among the less educated because harvesting does not require any skills.

Households' attributes class		Frequency*	Minimum	Maximum	Mean	SD
Age of household head (years	≤ 25	18 (11)	18	90	47.41	17.76
	26-35	32 (20)				
	36-45	25 (16)				
	46-55	22 (14)				
	56-65	37 (23)				
	≥ 66	26 (16)				
Household size	1-3	65 (41)	1	9	4	1.89
	4-6	80 (50)				
	7-9	15 (9)				
Gender	Female	117(73)				
	Male	43 (27)				
Educational level	No Education	12(8)	0	15	6.40	3.44
	Primary	100(62)				
	Secondary	45(28)				
	Tertiary	3(2)				
Marital status	Single	22(14)				
	Married	83(52)				
	Divorced	12(8)				
	Widowed	43(27)				
Membership of a Social group	Burial Society	98(61)				
	Savings & Credit	11(7)				
	Religious group	5(3)				
	Farmers group	3(2)				
	No group	43(27)				

Table 4.1: Socioeconomic attributes of respondents

** Figures in the brackets present percentages of respondents, and outside brackets present frequencies of responses.*

Moreover, the majority of participants (73%) belonged to at least one social group. The predominant was burial society (61%) which is common among rural households. Membership to Rosehip-related associations would increase participation in rosehip harvesting as harvesters may share places where rosehip is available in abundance.

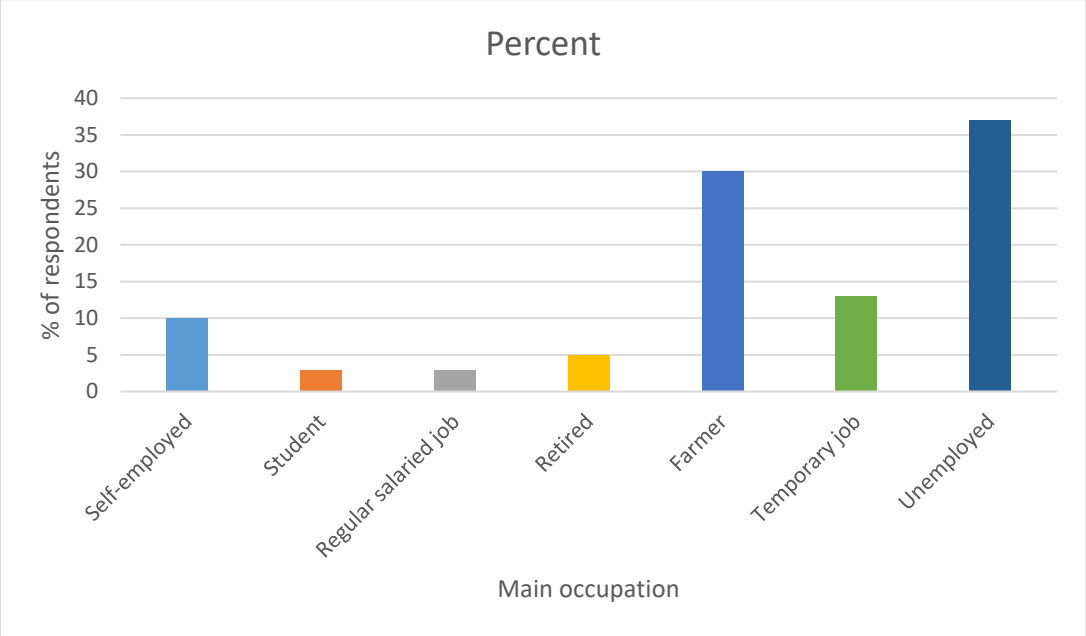

Figure 4.1: Respondents main occupation

The results in Figure 4.1 revealed that approximately 30 percent of the respondents were farmers growing both livestock and crops. The main crops grown in all four areas were maize, beans, and sorghum, while the primary livestock kept were cattle, sheep, and goats. The remaining 26 percent of employed respondents had informal or formal jobs. This indicates that the unemployment rate was high among the four areas as 37 percent were without jobs, with Matlameng having the highest unemployment rate. This implies that the more people are umployed the more their chances of parting in rosehip harvesting increases. The finding is synonymous with the literature on Lesotho's unemployment rate, which shows high levels of unemployment among the youth, who later engage in any available income generating activities (Shale, 2013).

4.3. Households' Knowledge, Uses, and Perceptions of Rosehip

4.3.1. Knowledge of Rosehip

As shown in Table 4.2, all respondents were familiar with *Rosa rubiginosa* (rosehip) and referred to it by the Sesotho name Morobei. When asked if they knew rosehip did not originate in Lesotho, almost all respondents (90%) were surprised to learn that it is an alien species. However, only a small percentage of respondents (10%) presumed rosehip was an alien species. Moreover, 91 percent of respondents believed rosehip existed before they were born (Table 4.2). The remaining 9% stated that rosehip arrived later. One of the oldest respondents, aged 90, noted that rosehip has been present for all of his life, but they only saw it as a weed because they were unaware of its importance compared to other species in their area.

Table 4.2: Knowledge of Rosehip

Variables		Frequency	Percent
Do you know *Rosa rubiginosa*	Yes	160	100
Knowledge of Rosehip invasive status	Yes	16	10
	No	144	90
Was it here when you were young?	Yes	145	91
	No	15	9
Status of Rosehip abundance	Increasing	117	73
	Decreasing	35	22
	No change	8	5
Do you consider rosehip as problematic?	Yes	123	23
	No	37	77

Ninety-five percent of respondents said they had noticed a change in rosehip abundance in their communities over the last 5-10 years (figure 4.2). Seventy-three percent of those who claimed to have seen a change said rosehip was increasing, while 22 percent said it was decreasing. The remaining 5% stated that it had remained constant. Of the 117 respondents who claimed it had increased, 35 percent attributed the increase to the production of many seeds that water, birds, and animals dispersed (figure 4.2). Thirteen percent mentioned that the increase could be due to pruning of the plant, which some harvesters do.

Out of 35 respondents who noticed a decrease, 15 percent blamed it on poor harvesting techniques such as overharvesting and cutting down plants (Figure 4.2). Sixteen percent speculated that the decline was caused by drought and land clearing for construction, which resulted in the removal of rosehip. Most respondents (77%) did not consider rosehip as problematic. Only a few respondents (23%) said they consider rosehip as problematic. The findings are synonymous with the literature on invasive alien species, which shows that majority of the local people are unable to differentiate between local species and invasive alien species on several occasions but instead regard them as an essential part of their livelihoods (Pfeiffer & Voeks, 2008; Shackleton *et al*., 2007; Shackleton *et al*., 2011).

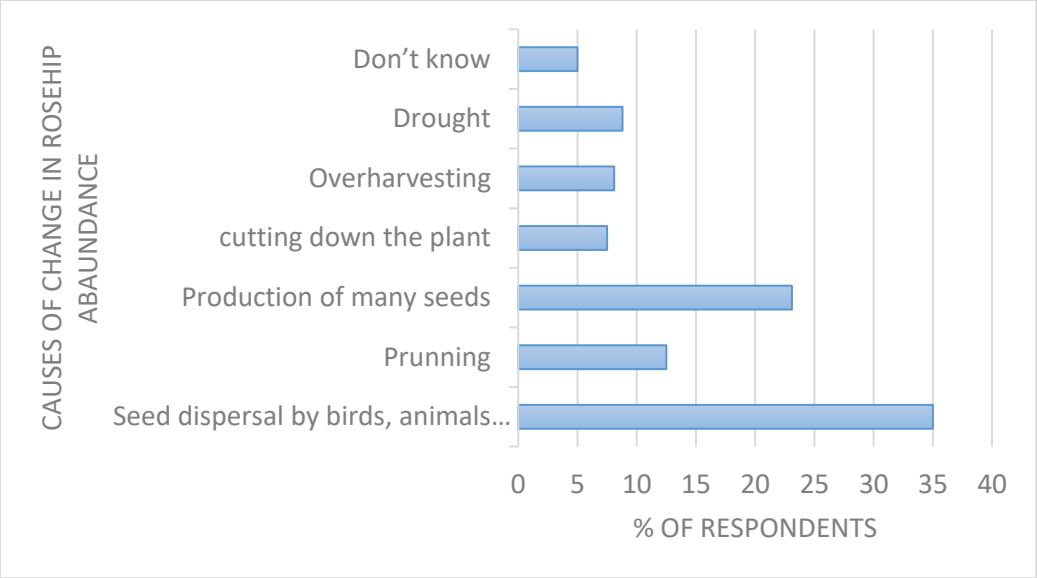

Figure 4.2: Factors that might have caused a change in rosehip abundance

4.3.2. Uses of Rosehip

All respondents indicated that the primary reason for rosehip harvesting was for commercial purposes. In addition, respondents were further questioned about the other uses of rosehip besides being sold for income generation. They demonstrated that rosehip could be used for a variety of uses, including jam making, eating as fruits, firewood, goat fodder, and soil erosion control. As illustrated in Figure 4.3, most respondents (39%) stated that rosehips are mostly used as food products such as making jam, tea, and juice and eaten as fruits, particularly by herd boys. Twenty-four percent showed that *Rosa rubiginosa* is mostly planted in the dongas for soil erosion control. Twenty-three respondents (14%) stated that they use *Rosa rubiginosa* as a secondary source of firewood when their primary sources, such as silver wattle, are scarce. Approximately twelve percent reported that rosehips help provide fodder for their animals, particularly goats during dry seasons.

According to Rai *et al*. (2012), the use of IAS is limited because the essential natural resource products they provide, such as firewood and fodder, are secondary rather than primary because they are used during the dry season when good quality fodder is scarce. The remaining 10% stated that *Rosa rubiginosa* is grown around homes to provide secure hedging (figure 4.3). This finding is consistent with the literature on invasive alien species, which shows that rosehip has become popular in Lesotho for income generation for rural communities who harvest it for sale to local companies, even though *Rosa rubiginosa* is used as edible fruits, jam making, and firewood by some people (Mokhobo *et al*., 2017; Kobisi *et al*., 2019).

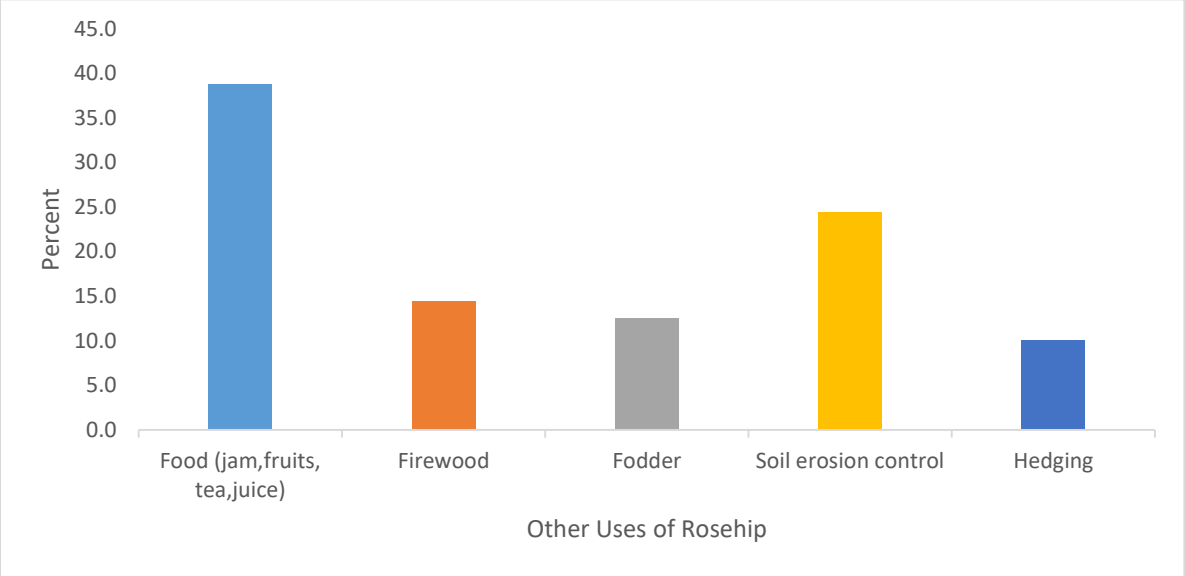

Figure 4.3: Other uses of Rosehip (*Rosa rubiginosa*)

4.3.3. Community Perceptions of Rosehip

Households' perceptions on social, economic, environmental, and ecological dimensions are illustrated in Tables 4.3, 4.4, 4.5, and 4.6 below. A 5-point Likert scale was used to collect responses, with 1 representing strong disagreement and 5 indicating strong agreement. The means of the replies were used to determine the general pattern of the local community's views on social, economic, environmental, and social conditions**.**

4.3.3.1 Social Dimensions

According to the means in Table 4.3, only one variable on social perspective (rosehip harvesting improves involvement in social groups) has a mean value of less than 3.5. This

implies that the vast majority of the respondents have a favourable social perception of rosehip. Most respondents agreed that rosehip harvesting allows them to connect with others in the rosehip sector. They also agreed that rosehip harvesting enhances the ability of individuals to cooperate through stokvels. Harvesters stated that they had formed a Stokvel, where they save money earned from selling rosehips and buy large quantities of fertilizer for the next planting season, which they then share among themselves. This implies that rosehip plays a valuable role in contributing to social capital by supporting community relationships and bringing people together in the community. Harvesting of rosehip helps build trust and solidarity among harvesters. Some revealed that when there are social activities, such as funerals, which are usually held on weekends, they attend such events and do not collect rosehips.

Table 4.3: Social perceptions of Rosehip

PERCEPTIONS	Mean	Std. Deviation
Social		
Rosehip harvesting helps people to connect with others in the rosehip sector	4.11	1.179
Harvesting of rosehip helps build trust and solidarity among harvesters	4.06	1.194
Rosehip harvesting enhances the ability of individuals to cooperate through stokvels	3.75	1.410
Rosehip harvesting improves involvement in social groups	2.07	1.059

4.3.3.2 Economic Dimensions

With respect to economic conditions (Table 4.4), no variable had a mean value of less than 3.5. This indicates that the general public views rosehip as having a beneficial economic impact. The majority of respondents agreed that rosehip harvesting creates job opportunities. Although rosehip is only available for three months, from March to June, it provides temporary jobs to vulnerable households before harvesting crops in the fields when they most need income. Also, respondents strongly agreed that rosehip is a source of household income. Even though rosehip is seasonal, most harvesters indicated that it was their most important source of income. This is consistent with previous research on the impact of invasive alien species on livelihoods (Shackleton *et al*., 2011; Kull *et al*., 2011; Ntsonge & Fraser, 2021), which discovered that income from IAS played a significant role in supplementing households for vulnerable

families. As a result, participants agreed that rosehip helps improve food security because they buy food after receiving money from the sale of rosehip.

Respondents also agreed that rosehip serves as a safety net in times of a crisis because they can generate income from the sales of rosehip while still waiting for their crops to mature. Most respondents also agreed that poor households rely more on rosehip harvesting to meet their basic needs. Rosehip collecting is stressful due to the long distances travelled, the low prices paid, and the discomfort of the thorns that prick and tear clothing. Given the unpleasant nature of the harvesting, no one would engage in this activity unless it was worthwhile. Lastly, respondents agreed that rosehip does not reduce crop yields (Table 4.4).

Table 4.4: Economic perceptions of Rosehip

PERCEPTIONS	Mean	Std. Deviation
Economic		
Rosehip harvesting creates job opportunities	4.28	0.940
Rosehip harvesting is a source of household income	4.46	0.699
Rosehip harvesting helps to improve household food security	4.42	0.609
Rosehip harvesting serves as a safety net in terms of a crisis	4.21	0.952
Poor households are more dependent on rosehip harvesting to fulfil basic needs	4.21	1.118
The plant does not reduce the yields of farming land	3.65	1.347

4.3.3.3 Environmental Dimensions

Similar to economic dimensions, none of the environmental perceptions had a mean value less than 3.5. Most respondents were undecided whether rosehip is safe for the environment (Table 4.5). This is attributed to the fact that people typically have negative perceptions of thorny plants such as rosehip when it comes to the environment (Shackleton *et al*., 2019). Only those who benefit from the plant believe it is not harmful to the environment. Additionally, respondents were unsure whether rosehip affected pasture productivity. This is because the grass continued to grow in the presence of rosehips. Others demonstrated that rosehip could be used as fodder for goats, particularly during the dry season. Respondents also agreed that

rosehips aid in the recovery of degraded forests because they act as nursery plants. This is consistent with the findings of De Pietri (1992), who stated that rosehips could act as nursing plants to aid in forest regeneration. Finally, the vast majority of respondents agreed that rosehip aids in soil erosion control. This is owing to the belief that the primary purpose of introducing rosehip in Lesotho was to control soil erosion.

Furthermore, respondents agreed that rosehip does not alter forest structure and regeneration. Rosehip thrives in the forest and poses no threat to the environment. Furthermore, respondents agreed that harvesting rosehip does not affect the plant's rate of growth or survival. This implies that harvesting is done correctly, allowing for long-term plant population survival. Finally, respondents were unsure whether rosehip harvesting depleted the plant's nutrients and lowered water quality.

Table 4.5: Environmental perceptions of Rosehip

PERCEPTIONS	Mean	Std. Deviation
Environmental		
Rosehip harvesting is not harmful to the environment	3.84	1.098
Rosehip does not have an impact on pasture productivity	3.48	1.405
Rosehip helps to recover degraded forests as they act as nurse plants	3.64	0.993
Rosehip does not exacerbate soil erosion processes	4.19	0.818
Rosehip harvesting does not alter the forest structure and regeneration	3.90	1.145
Harvesting of rosehip does not alter the rate of growth, reproduction, and survival of the harvested plant	3.89	1.085
Rosehip harvesting permits population persistence in the long term	3.90	0.998
Harvesting of rosehip does not deplete nutrient levels of the plant	3.39	0.965
The plant does not reduce water quantity	3.15	0.870

4.4. Rosehip Trade from Harvesting to Sale

4.4.1. Harvesting and marketing

All respondents who harvested rosehips did not hire or were hired to harvest rosehips; instead, they harvested rosehips for themselves. Harvesters stated that they collected in groups either with family members, friends, or neighbours. Rosehips are picked by hand; however, some noted that they knock the fruits to the ground with a long stick then later collect them. When harvesting, harvesters typically use 2 litre or 5-litre buckets as containers, then transfer to a larger bag after filling the bucket (Figure 4.4). All the harvesters said they only collect dry fruits because traders prefer them to unripe rosehips. Rosehip is harvested in the surrounding areas of all four sampling sites since it grows largely in the mountains of Lesotho. Harvesters did not specify set hours spent harvesting, instead stating that they work from early morning until sunset.

Figure 4.4: Women harvesting rosehip in Lesotho (Photos by Trilogy)

Rosehip harvesting is incredibly hard work, with several respondents mentioning spines and thorny stems, long distances, the threat of dangerous snakes, and relatively low prices as challenges in Figure 4.5.

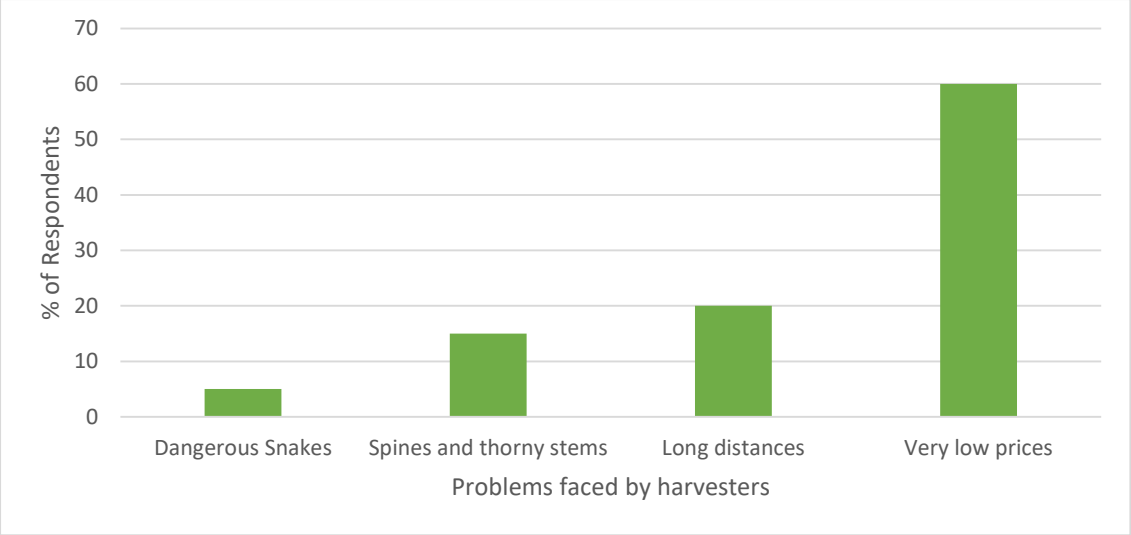

Figure 4.5: Main problems faced by harvesters

As shown in Figure 4.5, most respondents (60 percent) stated that the main issue they face as harvesters is being paid very low prices, making it difficult to meet all of their essential needs. Following that, 20% of respondents stated that they travelled long distances to harvest the rosehips. Dangerous snakes, spines, and thorn stems were among the most severe problems by 5% and 15% of respondents, respectively.

Harvesters use 20-litre buckets to standardize rosehip amounts before selling them, as shown in Figure 4.6. Harvesters noted that traders only buy rosehips in quantities of 20-litres or greater. The respondents sell their rosehips to traders from town who usually come to the village with their trucks or vans to buy. The sale takes place near the bus stop or at the community councils on a predetermined date. Sometimes, traders occasionally give money to a specific individual in the village who then buy rosehip on their behalf from harvesters. When enough rosehip has been collected, traders will come to collect it.

Figure 4.6: Harvesters measuring rosehip before the sale

Source: (Photos by the Rosehip Company Lesotho)

4.4.2. Descriptive Statistics on Rosehip harvesting and trade

The quantity harvested, local price, distance travelled, and income earned from rosehip are shown in Table 4.6. The average rosehip harvested per season per harvester was 216kg, with a minimum of 40kg and a maximum of 1000kg. The explanation for the low quantity harvested could be that just two of the 80 respondents reported that they had received training. The training was from the Rosehip Company which guided harvesters with regards to the appropriate methods and time of harvesting. In contrast, the remainder had never received training or education on sustainable and productive rosehip harvesting practices, leaving them with insufficient skills to improve their harvest. Furthermore, the average price per kg was M3.00, with a minimum of M2.50 and a maximum of M4.00 per kg (1 Lesotho loti = USD0.068). Respondents noted that the local price per kilogram varies depending on the trader and the rosehip's time of harvest. They explained that prices are low in the early months of harvesting (March and April) when plenty of rosehips are available, but prices rise towards the end of the harvesting season (mid-May) when rosehips become scarce. This explains the vast variation in prices paid in one season. This explains the wide range of prices paid throughout a single season. Harvesters revealed that because they have no say in pricing, they end up selling their fruits at whatever price the traders dictate due to high poverty levels.

Table 4.6: Descriptive statistics on rosehip harvesting and selling

	Mean ± Std. D	Minimum	Maximum
Quantity of rosehips harvested (kg)	216 ± 210	40	1000
Local Price (per kg)	3.00 ± 0.46	2.50	4.00
Distance from homestead (Km)	8.8 ± 4.8	1.0	20.0
Distance travelled to sell (km)	2.0 ± 0.98	1.0	5.0
Frequency of harvesting per week(days)	5.00 ± 1.08	3	7
Rosehip income earned per season (Maloti)	631.13 ± 598.3	120	3000

Note: Maloti (LSL) is the currency of Lesotho (Loti is pegged to the South African rand at 1:1 basis; thus, 1 LSL = 1 ZAR), LSL to the USD exchange rate at the time of conversion (2021) was 1 LSL = USD0.068

The average distance travelled from the homestead to the harvesting sites differed widely (Table 4.6). The average distance was 8.8 kilometres, with minimum and maximum distances of 1 and 20 kilometres. This was because, at the beginning of the harvesting season, harvesters collected rosehip from areas closest to where they lived. Later, when the rosehip was finished, they went to sites popular among other harvesters for having high quantities of rosehip. In addition, the average number of harvesting days per week was 5, with a minimum of 3 and a maximum of 7 days. Moreover, the average distance travelled to the selling site was 2km with a minimum of 1km and a maximum of 5km. This is because traders came to the community councils to buy, so the harvesters did not incur transportation costs. However, the long distances travelled to the selling site were due to some harvesters living far from community councils.

Lastly, the average rosehip income earned over the season was M613. The highest rosehip income received was M3000, while the lowest amount was M120. According to harvesters, the income earned per season is a function of the number of hours and days spent harvesting rosehip. Those who received a small sum devoted less of their time to harvesting. Thus, the wide variations in incomes resulted from the number of days spent harvesting over the season, with some spending only three days and others spending seven. This finding is consistent with Shackleton *et al.* (2011) and Ntsonge and Fraser (2021). They discovered that the income from prickly pear was determined mainly by the days and hours allocated to participating in the market activities.

As shown in figure 4.7, the harvesters' incomes earned through harvesting over the season varied, ranging from M120-M3000. This was related to the varying degrees of seriousness with which harvesters undertook harvesting. Most harvesters (46.3%) earned about M300 or less, followed by 27.5 percent who received between 301 and 800. The third group (13.7%) received between M801 and M1300. The fourth group (8.8%) received between 1300 and 1800. Only 3.7 percent received income higher than 1800 (Figure 4.7).

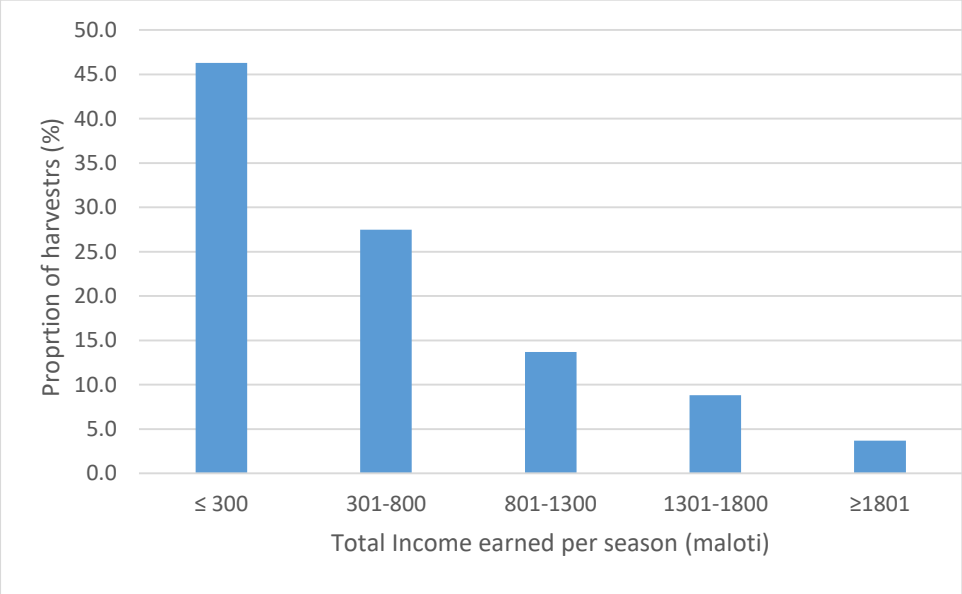

Figure 4.7: Distribution of seasonal incomes (maloti) earned by harvesters during the harvesting season

4.5. Contribution of Rosehip Income to Rural Livelihoods

This section shows the income contribution of Rosehip to livelihoods. The percentage share of various income sources to household income sources are shown. Also, the differences in household income sources between the groups of harvesters and non-harvesters are shown.

4.5.1. Percentage share of household income by sources

The percentage contribution of various income sources, including remittances, rosehip, wages, social grants, livestock, and crops to total household income are shown in Table 4.7. According to the findings in Table 4.7, remittances are the most crucial household income sources in the study areas accounting for 34 percent of total income. These results are consistent with those of Crush *et al.* (2010), who discovered that most households in Lesotho's rural communities rely on remittances for a livelihood due to high domestic unemployment and declining agricultural production. Social grants (including pensions and child support) are the second most important source of income for rural households, accounting for approximately 24 percent

of total household income. Wages (which included both permanent and temporary employment income) accounted for 23%, followed by crops and livestock, which accounted for 10% and 9%, respectively.

The results also revealed that rosehip income represented the lowest income component, accounting for only 2% of total household income. The reason for this pattern was that rosehip, unlike other income sources such as remittances and grants, was only available for three months, and rosehip prices are low, even though it takes a significant amount of time to fill a bucket with rosehip (M3/kg). The low contribution of rosehip to household income in the study areas indicates that harvesting rosehip is a low-income generating activity that does not contribute significantly to household income. However, given Lesotho's high unemployment rate (24.7%), the value of rosehip income to harvesters' livelihoods should not be underestimated because it provides another option in a variety of livelihood options that include social grants and other forms of temporary employment. Moreover, the income from rosehip is seen as low income when considered over the whole year, but it is only harvested for three months and over that period it plays a much more important role in the households. If reasonable prices are paid, rosehip income can make a significant difference in the lives of many poor households than it is now.

Table 4.7: Household annual income

Income type	**Average household annual income (**Maloti)	**Minimum**	**Maximum**	**Standard Deviation**	**Share (%) of income per year**
Remittances	11377	500	60000	12609	34
Social grants	8043	1080	9600	3190	24
Wage	7344	200	72000	11910	23
Crop	3232	80	24900	4298	10
Livestock	3058	140	14320	3574	9
Rosehip	631	120	3000	598	2
Total	33685	2120	183820	36179	100

4.5.2. The differences in household income sources between Harvesters and Non-harvesters

Table 4.8 present significant differences in reported household income sources which were discovered between harvesters and non-harvesters.

Table 4.8: Differences in income sources between the harvester and non-harvester groups

	Rosehip Harvesting		
	Harvester (n=80)	**Non-harvester** (n=80)	**Mann-Whitney U Test**
Income type	**Mean**	**Mean**	**Sig**
Remittances Income	16.55	29.52	0.001*
Rosehip Income	40.50	0	
Wage Income	16.25	22.32	0.132
Social Grants Income	12.00	13.79	0.389
Livestock Income	26.11	31.79	0.196
Crop Income	44.87	58.96	0 .016**

Significance level * (1%), ** (5%)

There was a significant difference between the groups with respect to remittances. Non-harvesters received nearly twice as much money from remittances as harvesters ($z= -3.212$, $p<0.001$). There was no significant difference between harvester and non-harvester groups regarding wages, social grants, and livestock incomes. Moreover, the non-harvester group obtained more income from crops than the harvester group ($z= -2.400$, $p<0.05$). Obviously, the harvester group received income rosehip, whereas the non-harvester group relied either on remittances or crops (Table 4.8). This implies that the harvesters were compelled to harvest rosehip to supplement their income.

4.6. Descriptive Statistics for Variables used in Regression Analysis

Significant continuous variables associated with rosehip harvesting were household size, wage income, household welfare, job creation, social networks, and environment conservation (Table 4.9).

Table 4.9: Mann-Whitney U test results for Continuous variables to be used for regression analysis

Variables	Harvester (n=80) Mean	Non-harvester (n=80) Mean	Mann-Whitney U Test Sig
Age	49.25	45.56	0.095
Education level (years completed)	6.18	6.61	0.550
Household size	4.41	3.48	0.010**
Social grants	1026.00	1487.50	0.478
Wage income	1372.50	5311.25	0.069***
Economic perception index 1: Household welfare improvement	0.11	-0.11	0.027**
Economic perception index 2: Job creation	1.13	0.85	0.043**
Social perception index 1: Social networks	0.26	-0.26	0.001*
Social perception index 2: Social development	1.12	0.86	0.335
Environmental perception index 1: Environment conservation	0.15	-0.15	0.004*
Environmental perception index 2: Soil conservation	1.12	0.87	0.191

Significance level * (1%), ** (5%) *** (10%)

Harvesters had a larger average household size ($z= -2.56$, $p<0.05$) than non-harvesters. This finding is consistent with the results of Ntsonge and Fraser (2021), who found that informal prickly pear marketers had a larger average household size. According to Meyer and Nishimwe-Niyimbanira (2016), large households, which are common among low-income families, are more likely to be poor. Furthermore, non-harvesters had more employed household members ($z= -3.15$, $p<0.05$) than harvesters (Table 4.9). As a result, to alleviate the effects of poverty, harvesters were forced to engage in several income-generating activities, such as rosehip harvesting, to contribute to household income. In terms of perceptions of rosehip, harvesters had more positive perceptions of rosehip than non-harvesters. This is because people typically perceive species differently depending on how they affect them; that

is, people have positive perceptions when they are positively impacted and negative perceptions when they are negatively impacted. (Pfeiffer & Voeks, 2008; Shackleton *et al*., 2019). There were no significant differences between the harvester and non-harvester groups regarding age, educational level, social grants, social development, and soil conservation.

A Chi-square ($\chi 2$) test was used to identify whether the harvesting of rosehip is specific to any particular demographic characteristic and variables. Significant categorical variables associated with rosehip harvesting were gender and main occupation (Table 4.10). Females were more engaged in rosehip harvesting than males ($\chi 2 = 14.03$, df = 1, $p<0.01$). According to Godoy (2004) and Nwosu and Ndinda (2018), gender substantially influences one's vulnerability to poverty, with women being more prone to falling into and becoming trapped in poverty. Women were more likely to turn to rosehip collecting since they had lower levels of education therefore, they were in greater need of income to support their families. Rosehip harvesting provides an opportunity to generate revenue with relatively minimal skill requirements, as illiteracy rates indicate the limits on women's access to various forms of assets (Nwosu & Ndinda, 2018). This may also be because most women in the study areas were household heads; as a result, they had to find means to survive. Shackleton *et al*. (2011) and Nwosu and Ndinda (2018) revealed that female-headed households are more vulnerable to poverty than male-headed households due to a larger dependency ratio.

More non-harvesters salaried jobs than harvesters (45%) ($\chi 2= 2.98$, df = 6, $p<0.05$). Human capital is limited in all four areas, with the majority of harvesters citing unemployment as the primary reason they were engaged in rosehip harvesting. The high unemployment rate was due to a lack of education, as most of the harvesters had only primary school education. According to Hapazari (2019), due to a lack of earning options in Lesotho, some families go without income and rely primarily on subsistence farming, which often exposes them to risks and further descent into poverty. There were no significant differences between harvester and non-harvester groups regarding group membership.

Table 4.10: Chi-Square results for Categorical variables to be used in regression analysis

	Harvesters	Non-Harvesters			Effect size
Variables	**Frequency**	**Frequency**	**χ 2**	**Sig**	**Cramer's V**
Gender			14.03	0.000*	.296
Female	69	48			
Male	11	32			
Occupation of household head			2.98	0.000*	0.084
Salaried job	19	29			
Otherwise	61	51			
Group membership			2.58	0.108	.127
Yes	54	63			
No	26	17			

Significance level *(1), ** (5%)

4.7. Econometric Results

The econometric analysis employed probit regression analysis to determine factors influencing a household's decision to participate in rosehip harvesting. Households' perceptions of rosehip were collected using a 5-point Likert scale where 1 means strong disagreement and 5 means strong agreement, implying that the household head perceives rosehip to have positive impacts. Principal component analysis (PCA) was used to generate the social, economic, and environmental perception indices, which were then used as explanatory variables in the probit model. The polychoric correlation matrix, which measures the association between ordinal variables, was used in this study because the variables were not continuous.

Table 4.11 demonstrates the PCA results obtained prior to generating the Social Perception indices. Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests were used to determine whether the data was adequate for principal component analysis. In the KMO test, where values range from 0 to 1, values greater than 0.5 are recommended as being acceptable for applying PCA (Kaiser, 1974). The KMO value was 0.525 (Table 4.11), making it suitable for conducting PCA. The statistically significant Bartlett's sphericity test ($p< 0.05$) indicates enough correlation between variables to proceed with the PCA analysis. Two components with eigenvalues greater than one were retained using the Kaiser criterion. A cut-off point of 0.50 was adopted in this study (Babaee, 2010; Hadia *et al*., 2016).

Table 4.11: Generation of the Social Perception Index: PCA Results

	Principal Components	
	Social networks	Social development
Rosehip harvesting helps people to connect with others in the rosehip sector	**0.804**	-0.001
Rosehip harvesting improves involvement in social groups	**0.730**	0.100
Harvesting of rosehip helps build trust and solidarity among harvesters	-0.119	**0.830**
Rosehip harvesting enhances the ability of individuals to cooperate through stokvels	0.241	**0.672**
Summary statistics		
Eigenvalues	1.345	1.056
% variance	31.287	28.745
Cumulative % of variance	60.031	
KMO statistics	0.525	
Bartlett's test of sphericity	16.332	
p-value	0.012	

Note: Bold items indicate significant factor loadings

The first principal component (PC1) has higher explanatory power, accounting for 31 percent of the variation in overall household social perceptions of rosehip. The second principal component (PC2) accounted for 28.7 percent of the variation. The two PCs explained sixty percent of the total variation in the data. As a result, both PCs were retained because they account for such a large proportion of the variance in the variables that they may be used to generate the social perception indices without much loss in information (Muchara *et al*., 2014). The first component was named social networks because it is dominated by two variables that emphasise rosehip's importance in bringing people together and improving participation in social groups. PC2 was named social development because it is dominated by rosehip's ability to build solidarity among harvesters and improve cooperation through a Stokvel. The generated indices were then used as explanatory variables to represent households' social perceptions of rosehip.

The PCA results obtained prior to generating the Economic Perception indices are shown in Table 4.12. The KMO data sufficiency test for the performance of the principal analysis for economic perception demonstrates that the data was suitable for the analysis because the acquired value is greater than 0.5. (0.611). Similarly, Bartlett's sphericity test value is 0.00, which is less than the significant level of 0.05, indicating that the correlation matrix contains important information (Table 4.12). The Kaiser criterion was used to retain two components

with eigenvalues greater than one, and a cut-off point of 0.50 was used (Babaee, 2010; Hadia *et al*., 2016). The first principal component has higher explanatory power, accounting for 32 percent of the variation in overall household economic perceptions of rosehip. The second principal component accounted for 22.7 percent of the variation. The two PCs explained about 54 percent of the total variation in the data. As a result, both PCs were retained because they account for a large proportion of the variance that they may be used to generate indices without much loss in information.

Table 4.12: Generation of the Economic Perception Index: PCA Results

	Principal Components	
	Household welfare improvement	Job creation
Rosehip harvesting is a source of household income	**0.649**	0.157
Rosehip harvesting helps to improve household food security	**0.671**	0.100
Rosehip harvesting serves as a safety net in terms of a crisis	**0.714**	-0.196
Poor households are more dependent on rosehip harvesting to fulfil basic needs	-0.162	**0.854**
Rosehip harvesting creates job opportunities	0.398	**0.615**
Summary statistics		
Eigenvalues	1.608	1.136
% variance	32.165	22.728
Cumulative % of variance	54.892	
KMO statistics	0.611	
Bartlett's test of sphericity	40.053	
p-value	0.000	

Note: Bold items indicate significant factor loadings

The first principal component was named household welfare improvement. It is dominated by three variables demonstrating that rosehip contributes to household income, acts as a safety net in times of crisis, and improves household food security because people can buy food after receiving income. The second principal component is dominated by two variables that indicate that rosehip creates job opportunities for poor households because they rely on it to meet their basic needs. As a result, PC2 was given the name job creation. In addition, the generated indices were used as explanatory variables to represent households' economic perceptions of rosehip.

Finally, the Kaiser-Meyer-Olkin (KMO) and Bartlett's sphericity tests were used to determine whether the data was adequate for principal component analysis. Table 4.13 displays the PCA

results obtained prior to generating the Environmental Perception indices. The KMO value was 0.525, making it suitable for performing PCA. The statistically significant Bartlett's sphericity test ($p = 0.005$) indicates that there is enough correlation between variables to proceed with the PCA analysis. The Kaiser criterion was used to retain two components with eigenvalues greater than one, and a cut-off point of 0.50 was also used.

Table 4.13: Generation of the Environmental Perception Index: PCA Results

	Principal Components	
	Environment conservation	Soil conservation
Rosehip helps in the recovery of degraded forests as they act as nurse plants	**0.731**	-.288
Harvesting of rosehip does not alter the rate of growth, reproduction, and survival of the harvested plant	**0.690**	.332
Rosehip improves the forest structure and regeneration	**0.677**	-.351
Rosehip improves pasture productivity	**0.634**	-.079
Rosehip harvesting is not harmful to the environment	0.095	**0.723**
Rosehip helps to control soil erosion	-.087	**0.578**
Summary statistics		
Eigenvalues	1.427	1.069
% variance	28.547	21.380
Cumulative % of variance	49.928	
KMO statistics	0.525	
Bartlett's test of sphericity	25.413	
p-value	0.005	

Note: Bold items indicate significant factor loadings

The first principal component has higher explanatory power, accounting for about 29 percent of the variation in overall household social perceptions of rosehip. The second principal component accounted for 21 percent of the variation. The two PCs explained almost fifty percent of the total variation in the data. As a result, both PCs were retained because they account for such a large proportion of the variance in the variables that they may be used to generate the environmental perception indices. Moreover, the first principal component is named environment conservation, dominated by rosehip's importance on pasture productivity, recovery of degraded forest, and forest structure and regeneration improvement. The second

PC is dominated by soil erosion control and rosehip's friendly nature on the environment; therefore, PC2 was named soil conservation. The generated indices were then used as explanatory variables to represent the environmental perceptions of rosehip among households.

4.7.1. Factors influencing Individuals decisions to participate in Rosehip Harvesting

The Variance Inflation Factor and the Pairwise correlation tests were carried out to test for multicollinearity. Multicollinearity occurs when explanatory variables are linearly related. According to Gujarati (2003), the presence of multicollinearity causes the model to yield high variance inflation factors and high standard errors of coefficients, high R^2 value with low t-statistic values. Prior to regression analysis, the Pairwise correlation test and the variance inflation factor (VIF) for each variable were assessed to check for multicollinearity using STATA software version 14 (Table 4.14). The variables had correlation coefficients less than 0.6 showing that multicollinearity is not a severe concern for the data (Senders, 2012; Phali, 2015; Rekha, 2019). Furthermore, if the VIF of a variable exceeds 10, that variable is said to be highly collinear, meaning it can be excluded from the model. The results showed that none of the variables of the Probit model had a VIF greater than 10 (Table 4.14). This indicates that multicollinearity is not a significant issue among the independent variables.

Table 4.14: Variance inflation factors for explanatory variables used to model the household decision to participate in rosehip harvesting

Variables	VIF
Age of the household head	1.96
Gender of household head	1.23
Education of the household head	1.48
Household size	1.15
Occupation of the household head	1.11
Group membership	1.20
Social grants	1.50
Wage income	1.12
Economic perception index 1: Household welfare improvement	2.03
Economic perception index 2: Job creation	2.00
Social perception index 1: Social networks	2.74
Social perception index 2: Social development	2.76
Environmental perception index 1: Environment conservation	1.16
Environmental perception index 2: Soil conservation	1.12
Mean VIF	1.61

Table 4.15 demonstrates the probit model results of the factors that affect the household decision to participate in rosehip harvesting or not to participate as a collector. The probit model

fits the data well because the likelihood ratio chi-square of 77.51 was highly significant at 1 percent. Given that the data is cross-sectional, the pseudo R^2 of 30 percent indicates an excellent model fit. The results revealed that household size, social networks, household welfare, job creation, and environment conservation significantly and positively influence participation in rosehip harvesting. Gender, education level, and wage income negatively influence the decision to participate in rosehip harvesting.

Table 4.15: Probit regression of factors influencing individual's decisions to participate or not in rosehip harvesting

Dependent variable: household participate or not in rosehip as a collector (1= Yes, 0= No)			
Variables description	**Coefficients**	**Standard Error**	**Marginal effects**
Age of household head	-0.018	0.003	0.013
Gender of household head 1= Male 2= Female	-1.103*	0.300	-0.402
Education of household head	-0.412**	0.226	-0.164
Household size	0.463**	0.213	0.184
Occupation of household head 1= Salaried job 0= Otherwise	-0.013	0.266	-0.005
Social grants	-0.000	0.000	-0.00003
Wage income	-0.000*	0.000	-0.00003
Group membership 1= Yes 2= No	-0.397	0.300	-0.157
Social perception index 1: Social networks	0.556*	0.200	0.222
Social perception index 2: Social Development	0.148	0.127	0.059
Economic perception index 1: Household welfare improvement	0.313**	0.164	0.125
Economic perception index 2: Job creation	0.142***	0.080	0.056
Environmental perception index 1: Environment conservation	0.212**	0.123	0.084
Environmental perception index 2: Soil conservation	0.075	0.091	0.030
Constant	0.705	0.806	

Log likelihood = -77.505, LR $chi^2(14)$ = 66.80, Prob > chi^2 = 0.000, Pseudo R^2 = 0.301

Significance level * (1%), ** (5%), *** (10%)

Male-headed households have a 40 percent lower probability of participating in rosehip harvesting. Consistent with prior expectations, the negative correlation of gender with the individual's decision to participate in rosehip harvesting suggests that women relied more on rosehip harvesting than men because they are likely to have larger households and thus greater

demands on them, particularly in female-headed households. According to Adongo *et al.* (2019), most men do not participate in harvesting because it is assumed that collecting forest products is the responsibility of women. Descriptive results in Table 4.10 showed that, out of 80 respondents involved in rosehip harvesting, 69 were female and only 11 were male. Kamanga *et al*. (2008) argued that women frequently have a higher workload and are often poorer than their male equivalents. Also, Hutchinson *et al.* (2020) discovered that men primarily feel the impact of rosehip on grazing lands and local medicinal species because livestock herding is their primary responsibility; as a result, they may not participate in rosehip harvesting because it affects them negatively.

The findings also revealed that the education level of the household head is statistically significant at a 5% level and has a negative association with participating in rosehip harvesting as expected. A unit increase in the years of education reduces the probability of participating in rosehip harvesting by sixteen percent. This could be because higher-educated households are more likely to have higher-paying employment and hence are less likely to be involved in rosehip harvesting. This finding is consistent with the findings of Tassou (2017) and Mulenga *et al*. (2011), who argued that education increases one's chances of finding employment compared to lower-educated households, which are mostly poor and vulnerable. Descriptive results in Table 4.6 showed lower education levels among the harvesters. As a result, they are compelled to extract forest resources to earn a living. Furthermore, when people get more educated, they better understand exotic species and their impacts on community-valued species; as a result, they may refrain from participating in their extraction because they perceive them as a threat. According to Remmele and Lindemann-Matthies (2019), laypeople perceive IAS differently from those with higher levels of education because people with lower levels of education are uninformed of the harmful consequences of the IAS. Human capital was low in all study regions due to a lack of education since most respondents (70 percent) reported having either primary education or no education at all (Table 4.1).

Household size is statistically significant at a 5% level and positively influences a household's decision to collect rosehip as expected. For a unit increase in the household size, the probability of collecting rosehip increased by 18 percent. This implies that people with larger household sizes were compelled to participate in rosehip harvesting more than those with fewer members because they have more people to feed. As seen in the descriptive statistics in Table 4.9, harvesters had larger household sizes than non-harvesters. This finding backs up previous research that found a positive and significant relationship between household size and forest

resources dependency (Aung *et al*., 2014; Moe & Liu, 2016; Adongo *et al*., 2019). According to Suleiman *et al*. (2017), large families have limited land holdings and high food dependency ratios, so they rely on natural resource collection due to the availability of family labour. However, a family with productive people may experience less poverty if most of them work and contribute to the household's livelihood portfolio, either formally or informally (Ntsonge & Fraser, 2021).

Consistent with *a priori* expectations, wage income is highly statistically significant at a 1% level and negatively associated with household participation in rosehip harvesting. For a unit increase in wage income, the probability of participating in rosehip harvesting reduces by 0.0003 percent. This research backs up the notion that the level of income in a family affects its choices when it comes to adapting livelihood strategies. According to Babulo *et al*. (2008), the number of livelihood strategies pursued by households is determined by their assets. The findings also revealed that, when compared to high-income families, low-income households derived the most significant share of their household income from rosehip. Descriptive results in Figure 4.1 showed that only three percent of household in the study areas had regular salaried jobs. Suleiman *et al*. (2017) observed that households that earn wages are more likely to invest their time in other parts of the economy rather than relying on natural resource collection. Higher-income households can achieve livelihood outcomes by purchasing food to reduce food insecurity (DFID, 1999). In contrast, low-income households extensively rely on natural resource gathering to supplement their financial capital as a means of navigating their vulnerability to economic and environmental shocks, as well as agricultural variability (Mulenga *et al*., 2011; Gautam & Andersen, 2016). Financial capital was low in all four community councils, as most rosehip harvesters stated that the primary reason they engaged in rosehip harvesting was that they were unemployed.

Social perception (social networks) is highly statistically significant at a 1% level and positively associated with a household's participation in rosehip harvesting. People aware of rosehip's ability to build social networks in the community have a 20 percent higher probability of participating in rosehip harvesting than those who are not informed. This is aligned with the findings of Faham *et al*. (2008), who noted that social networks are an excellent predictor for participation in natural resource activities. This is related to the reason that membership in any social network is crucial in disseminating valuable information on other poverty-reduction measures during meetings and striving for a common goal (Suleiman *et al*., 2017). This was also the case in this study, as participants reported being able to form a Stokvel in which they

save money obtained from selling rosehips and buy larger quantities of fertiliser for the following planting season, which they then distribute among themselves. This indicates that rosehip contributes to social capital through strengthening community bonds and bringing people together in the community. According to Abdurrahman (2013), social capital can assist members in increasing their capacity by expanding their knowledge and skills and changing their perspectives about the relevance of natural resources in their social conditions.

The positive correlation between household welfare improvement (economic perception) and participation in rosehip harvesting suggests that people who believe rosehip positively impacts household welfare are 13 percent more likely to participate in rosehip harvesting, as expected. The finding is consistent with previous research on the impact of invasive alien species on livelihoods (Shackleton *et al*., 2011; Kull *et al*., 2011; Mulenga *et al*., 2011; Ntsonge & Fraser, 2021), which found that most rural households participate in forests products extraction to improve their household welfare. In this study, a higher proportion of poor households were engaged in rosehip harvesting than wealthier households with several sources of income. Some harvesters reported that their lives have improved after harvesting since they can afford what they want due to the rosehip money. Furthermore, job creation has a significant and positive influence on household participation in rosehip harvesting. Those who believe that rosehip creates job opportunities have a 6 percent higher probability of participating in rosehip harvesting. This implies that, despite the reality that rosehip is only available for three months, it plays a significant role in providing seasonal employment to vulnerable households given to Lesotho's high unemployment rate.

Environmental perception (environment conservation) is statistically significant at a 5% level and positively associated with the household's participation in rosehip harvesting. This relationship is consistent with prior expectations as people who do not see any negative impacts on rosehip were expected to engage in rosehip harvesting. People who recognise the environmental benefits of rosehip are eight percent more likely to participate in rosehip harvesting than those who do not. This suggests that whoever believes rosehip negatively affects the environment, such as reducing grazing and farming lands, may refrain from harvesting rosehip. Kull *et al.* (2011) discovered that despite Australian acacias' invasive nature, local communities worldwide value them for their perceived soil, climatic, and fuelwood benefits. Perceptions of IAS may be favourable when people are positively impacted and negative when they are negatively impacted (Pfeiffer & Voeks, 2008; Shackleton *et al*., 2019).

4.8. Chapter Summary

This chapter presented the findings and discussed them in the context of the Sustainable livelihood framework. The main reason for the increased participation of women in rosehip harvesting was unemployment. When compared to other household income sources such as remittances, social grants, wages, and agricultural income, rosehip income was the least significant. However, because of limited employment opportunities, rosehip income was discovered to be a significant contributor to the livelihoods of the poor, female, and uneducated. Rosehip was also perceived positively by the majority of respondents in terms of social, economic, and environmental conditions, with only a few negative perceptions. The next chapter gives a summary of the study findings, the conclusion, as well as policy recommendations.

CHAPTER 5
SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1. Recap of the purpose of the study

The aim of this study was to determine the household's perceptions of rosehip and the role it plays in rural livelihoods in Lesotho. Three objectives were outlined to reach this goal. The first objective was to understand the community perceptions towards rosehip on social, economic and environmental dimensions. The second objective was to determine significance of the income from rosehip trade to the livelihoods of rural communities. Lastly, to determine the factors influencing the household's decision to participate in rosehip harvesting as a collector or not. The sustainable livelihood framework was used as the conceptual guide for this study to understand the contribution of rosehip to rural livelihoods.

5.2. Summary of Research Findings

This section provides the summary of findings for the study on perceptions of rosehip and its role in the livelihoods of rural communities in the Leribe District of Lesotho. The empirical results from the previous chapter are used to summarize the findings based on each objective.

- **Community perceptions towards rosehip**

All the participants were familiar with rosehip, but the majority were unaware that it did not originate in Lesotho. Most households in the study areas had favourable perceptions towards rosehip. The present study confirmed the findings of Kueffer (2013) and Shackleton *et al*. (2011) that the decision for an individual or a group of people to regard an IAS as beneficial or problematic is influenced by some factors that shape their perceptions of the species. Using the sustainable livelihood framework (DFID, 1999) and the results in chapter four, it can be argued that rosehip is a sustainable livelihood. The findings indicated that rosehip contributes to social capital. Harvesters stated that they had formed social groups where they share information on other poverty-reduction strategies. They also mentioned that they contribute money from selling rosehip and purchasing fertiliser for the following planting season. As a result, it can be asserted that rosehips play an important role in bringing people together, encouraging them to cooperate, creating trust and solidarity, and assisting them in decision making.

Rosehip is also seen as having a positive economic impact on members of the community. This is attributed to rosehip providing households with financial capital, as the primary reason for rosehip harvesting was for income generation. The households involved in rosehip harvesting were extremely poor, with low education levels that limited their chances of obtaining formal employment. As a result, rosehip is preferred by most households because it is an income-generating opportunity that improves household welfare. However, financial capital was limited in the study areas because it mainly was obtained through informal means due to low education levels and old age. This finding aligns with previous literature (Shackleton *et* al., 2011; Ntsonge & Fraser, 2021), which found that low education levels, illiteracy, and old age were the major reasons for prickly pear traders' participation in informal markets and that trading allowed them to earn cash.

In terms of environmental perceptions, the study revealed that rosehip was not a serious environmental concern because only 24 percent of the participants indicated that they considered it as problematic. The adverse effects of rosehip on the environment, on the other hand, were mainly felt by people who were not involved in rosehip harvesting. Furthermore, rosehip provided natural capital in the form of fodder and firewood, as a result, it was approved by some households. When primary sources of firewood, such as silver wattle, were scarce, households turned to rosehip as a replacement. During the dry season, they also used rosehip as fodder for animals, particularly goats. Therefore, it can be argued that the livelihood impact of an invasive alien species impacts how the local community perceives it.

- **Contribution of rosehip to household income**

When rosehip income was compared to total household income, it was discovered that rosehip income was the lowest income component, accounting for only 2% of total household income. However, its importance to low-income households who rely on it for most of their income should not be underestimated. Rosehip makes a significant contribution to low-income households since this study discovered a positive correlation between low-income households and participation in rosehip harvesting. This suggests that poorer households have an enormous need for harvesting since they have fewer other sources of income than wealthier ones. The results of this study are aligned with previous studies (Kamanga *et* al., 2008; Shackleton *et al*., 2011; Angelsen *et al*., 2014), which found that the poorest households benefited the most from natural resources. The poorer the household, the more income the income from rosehip.

Remittance income accounted for approximately 34% of total household income across all 160 interviewed households. This suggests that the income from remittance contributed the most to household income. According to Crush *et al*. (2010), most households in rural areas in Lesotho rely on remittances for a living due to declining agricultural production and high domestic unemployment. Social grants accounted for about 24 percent of total household income following remittances, making it the second most crucial income component. This study is consistent with Mugido and Shackleton (2019), who discovered that rural households rely mostly on social grants. Without them, they risk severe poverty levels, forcing them to pursue alternative income sources such as natural resource collecting. Crop and livestock revenue contributed 10% and 9% of total income, respectively. The findings support the findings of Hlalele *et al*. (2019), who found that, despite having a higher percentage of arable land in the Leribe District, agricultural productivity is declining due to land degradation, soil erosion, a shortage of inputs, and climate change.

Interestingly, the share of rosehip income to total household income for the 160 interviewed rural households was only 2 percent. On the other hand, rosehip income accounted for about 10% of the household income for 80 households involved in rosehip harvesting. This percentage is slightly higher, indicating that rosehip is more important to harvesters. Furthermore, agricultural income (crops and livestock) accounted for around 19% of total household income for the 160 interviewed households. Similarly, agricultural income was the most significant income component, accounting for around 44 percent of the total household income of the 80 households involved in rosehip harvesting. This is related to the reasons that harvesters mentioned that they spend a portion of the rosehip income to purchase fertilisers, seeds, and animal feeds.

Twenty-five percent of the harvesters reported that rosehip was their sole source of household income, with only four percent relying on old-age pensions as their primary source of income. Those who stated that rosehip harvesting was not their primary source of income stated that they required it to supplement their household income. As a result, this suggests that rosehip offers harvesting households income-generating opportunities, enabling them to diversify their income sources. Even though rosehip income is seasonal, its contribution to harvesters' livelihoods and helps alleviate cash problems. When asked how they would be affected if the government banned rosehip because it did not originate in Lesotho, harvesters highlighted increased poverty as their biggest concern. According to Pheko (2019), the Rose Canina

Company Lesotho exports approximately 132 000kg of rosehip per month. This clearly shows that rosehip harvesting is one of the livelihood strategies used by rural communities.

Despite the fact that rosehip harvesting is exceptionally difficult, households identified a need for cash and a lack of job opportunities as the primary reasons for harvesting rosehip. Previous literature undertaken (Shackleton *et al*., 2007; Shackleton *et al.,* 2011; Ntsonge & Fraser, 2021; Mudigo, 2016) found that although the income from natural resources is unsatisfactory, it is essential to poor and marginalised rural households. Therefore, the findings of this study confirm that, while rosehip income may not constitute the majority of household income, it is an important component of rural livelihoods, particularly for households with no other sources of income.

- **Determinants of household's decision to participate in rosehip harvesting**

The Probit model results revealed a negative, highly statistically significant correlation between the gender of the household head, education level, and rosehip harvesting participation. Females are more likely than males to harvest rosehip. It was determined that women, as a marginalised group, are forced to harvest rosehip because they are more likely to have larger families to care for, as 65 percent of households involved in rosehip harvesting were female-headed. It can also be argued that females were motivated to harvest rosehip because it is a cheap income source that does not require skilled labour. Furthermore, higher-educated household heads are less likely to collect rosehip because they are more likely to secure higher-paying jobs. Similarly, household heads with salaried jobs are less likely to harvest rosehip, choosing to invest their time in other parts of the economy than relying on rosehip harvesting. It can then be concluded that rosehip is important for poor and uneducated households' heads because they can improve their income through harvesting. A similar conclusion was reached by Cavendish 2000; Kull *et al*., 2011; Shackleton *et al.,* 2011; Ntsonge & Fraser, 2021 that it is often the poor and those with less education who benefit the most from natural resources.

The findings also revealed a positive statistically significant correlation between household size, social perception, economic perception, environmental perception, and participation in rosehip harvesting. As expected, households with larger household sizes are more likely to participate in rosehip harvesting due to the availability of family labour. The findings are directly in line with previous research on forest resources (Aung *et al*., 2014; Moe & Liu, 2016; Adongo *et al*., 2019) which discovered a positive and significant relationship between

household size and forest resources dependency. Another popular explanation is that larger households have high food dependency ratios forcing them to participate in rosehip for income generation.

In terms of perceptions, the study found that the more people are aware of the social, economic, and environmental benefits of rosehip on the environment, the more likely they are to harvest rosehip. Overall, these findings are in accordance with previous findings (Shackleton *et al.,* 2019; Kapitza *et al.,* 2019; Sosa *et al.*, 2021) that reported that increased knowledge about invasive species issues can change how the community perceives them. For sustainable development to succeed, a three-dimensional approach that includes environmental, social, and economic concerns is essential because ignoring one aspect in favour of the other may limit the success of livelihood intervention strategies, particularly in places where local citizens depend on alien plant species for a living (Patriota, 2012; Ntsonge & Fraser, 2021). In contrast, the probit regression analysis did not find any significant relationship between participation in rosehip harvesting and factors such as the age of household head, occupation of household head, social grants, group membership, *social perception index:* social development, and *environmental perception index*: soil conservation.

5.3. Conclusion

Based on the findings mentioned above, it is concluded that the benefits and impacts of invasive species are felt differently by different community members at different times. The rosehip's most harmful effects are perceived by those who do not receive the benefits (such as non-harvesters) and others whose land uses are impacted, such as male members who lose grasslands due to the dense infestations of *Rosa rubiginosa*. This study's evidence suggests that IAS are neither evenly problematic nor evenly beneficial. The impact of IAS on people is determined by various factors, including socioeconomic status, time, and size of invasion. The fact that most rural communities use invasive alien species and see them as beneficial to their livelihoods implies that this species can be valuable. Aside from the 80 harvesters included in this study, it was discovered that some non-harvesters still used rosehip for subsistence purposes such as firewood and fodder for their animals. As a result, it is concluded that rural communities have adjusted to the use of IAS while becoming dependent on their presence. However, the abundance of rosehip is linked to adverse effects such as blocking animal and human movement and reducing grazing and farming lands.

Evidence from this study suggests that rosehip harvesting provides a supplementary income that contributes towards alleviating poverty in Lesotho's rural communities. The contribution rosehip makes to the livelihoods of harvesting households is mostly variable and depends on the necessity for cash in the household. It is mostly the low income, uneducated and female-headed households who are more dependent on rosehip harvesting for income generation due to lack of other sources of income. This suggests that rosehip harvesting is viable for marginalised households with fewer job opportunities and are less prepared to insure against uncertainties than higher-income households. Thus, while rosehip income is extremely low and seasonal, it is essential to relieve cash flow problems for the poor. Moreover, rosehip is part of the risk-reducing strategy or income diversification because some households use it to complement other sources of income, such as agricultural production.

The social, economic, and natural environment benefits that a species provides influence rural communities' perceptions. Also, perceptions of rosehip are greatly influenced by its benefits, impacts, the length of time it has been available in the area, as well as its abundance. Households' perceptions of rosehip have proven that rosehip is a valuable species used for various livelihood activities. Positive perceptions stem from its benefits, while negative perceptions stem from environmental impacts. However, the results showed most people in rural areas have little knowledge of invasive alien species, with only a small percentage having heard the terms. They consider all species found in their communities to be local species. This results from low human capital across all the study areas due to low education levels and old age. Therefore, it is crucial to have knowledge on invasive alien species and their threshold points to discover the efficient point to intervene in their management to avoid more detrimental impacts.

5.4. Policy Recommendations

The majority of those who took part in this study knew very little about invasive alien species. As a result, the study encourages environmental education and indigenous knowledge among community members, which would include knowledge and recognition of invasive alien species and their potential benefits and threats. This would create environmental knowledge and awareness that would help to avoid misidentifications of native and non-native species. This can be accomplished through village chiefs and extension officers, who have day-to-day communication engagements with households. Furthermore, awareness strategies like information outreach campaigns should be promoted, focusing on the social, economic, and

environmental dimensions of rosehip, as perceptions were among the key factors influencing rosehip harvesting participation. This would also lead to a better understanding of IAS issues among community members.

The findings also revealed that harvesters are paid very little for rosehip. In 2019, the Rose Canina Company Lesotho announced that their prices for rosehip range from M65 to M100 per 20 litre bucket, based on the season and demand. However, harvesters in this study stated that the income they received from traders ranged from M40 to M70 per 20 litre bucket of rosehip. Considering this, it is recommended that the private sector which includes the rosehip companies intervene to avoid traders from manipulating harvesters. This can be accomplished making sure the rosehip companies provide harvesters with equipment and transportation to directly transport the rosehip to their companies so that they can earn a good income. Community councillors may also organize ways for the rosehip companies to send their workers to purchase rosehip from harvesters directly. Harvesters can then sell at higher prices rather than to middlemen (traders) who pay extremely low prices.

Furthermore, livelihood benefits highlight the potential contribution of rosehip trade to rural communities in alleviating poverty; therefore, it is recommended that the private sector establish and manages small agro-processing industries focusing on products used daily. These products could include jam, body lotions, bath soap, and vitamin C-rich juices. This would greatly benefit those involved directly in the rosehip trading and the whole district, as the agro-processing industry would assist in developing skills, employment opportunities, and an increase in the national gross domestic product (GDP).

Most harvesters indicated that they would like to have a high abundance of rosehip; thus, it is recommended that policymakers and decision-makers acknowledge the rosehip sector to widen rural development. The government may establish a plantation of rosehip as a sustainable livelihood that can be harvested in large quantities throughout the year. The findings revealed that rosehip trade, if well monitored, can be as important as other sectors in rural communities for alleviating poverty. However, unlike other sectors such as agricultural production, it receives no government support because it is relatively invisible due to a lack of empirical evidence and research demonstrating the role of rosehip in rural livelihoods. Therefore, rosehip should be given support, visibility, and recognition among the livelihood strategies used by poor people to sustain their livelihoods. Supporting the rosehip trade will help secure the

livelihoods of the lowest income group while also promoting its economic benefits as a tool for poverty alleviation.

It is recommended that the private sectors should prioritize financial support programs that would promote off-farm income generating activities such as handicraft and value addition for agricultural produce. This will help reduce household overreliance on rosehip harvesting for livelihoods and income generation.

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APPENDIX

1. Informed Consent Declaration

RHODES UNIVERSITY

Where leaders learn

Project Title: **Rural Household's Perceptions of Rosehip and the Role it Plays in Rural Livelihoods in Lesotho**

Thato Makhorole from the Department of Economics and Economic History, Rhodes University has requested my permission to participate in the above-mentioned research project.

The nature and the purpose of the research project and of this informed consent declaration have been explained to me in a language that I understand.

I am aware that:

1. The purpose of the research project is to understand community perceptions of rosehip and determine the contribution of the income from rosehip trade to rural livelihoods.

2. The Rhodes University has given ethical clearance to this research project and I have seen/may request to see the clearance certificate.

3. By participating in this research project, I will be contributing towards a furthering of the contribution of invasive alien species to rural livelihoods in Lesotho. This research will aid in understanding the benefits and negative impacts of rosehip as providing much needed knowledge on that species. It will also aid policy makers in coming up with strategies that can promote sustainable use and commercialisation of this species.

4. I will participate in the project by answering interview questions that will seek to ascertain the household's perceptions of rosehip as well as the role it plays in rural livelihoods.

5. My participation is entirely voluntary and should I at any stage wish to withdraw from participating further, I may do so without any negative consequences.

6. I will not be compensated for participating in the research, but my out-of-pocket expenses will be reimbursed.

7. The following risks are associated with my participation:
a). The embarrassment as a result of not knowing the answers to some questions or the exposure caused by results being available for public evaluation.

b). The following steps have been taken to prevent the risks: Questions are phrased in such a way that respondents will feel comfortable responding without feeling as if they lack knowledge. The respondent's personal details and information will not be published or made available in any of the published work and all stored data will be done so without the personal details of the participants.

c). There is a <1% chance that the risk will materialise

8. The researcher intends publishing the research results in the form of in the form of a masters thesis as well as several academic papers. However, confidentiality and anonymity of records will be maintained and that my name and identity will not be revealed to anyone who has not been involved in the conducting of the research.

9. I will not receive feedback/will receive feedback in the form of letter or email regarding the results obtained during the study.

10. I agree/disagree to the researcher's use of voice recording of my comments and opinions during interviews

11. Any further questions that I might have concerning the research, or my participation will be answered by Thato Makhorole – **thatomakhorole@gmail.com**; **0839258910**

12. By signing this informed consent declaration, I am not waiving any legal claims, rights or remedies.

13. A copy of this informed consent declaration will be given to me, and the original will be kept on record.

I, ……., have read the above information / confirm that the above information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction. I fully understand what is expected of me during the research.

I have not been pressurised in any way and I voluntarily agree to participate in the above-mentioned project.

……. …….

Participants signature **Date**

Any queries should be directed to Thato Makhorole, available at thatomakhorole@gmail.com or on 0839258910.

2. Household Questionnaire

My name is **Thato Makhorole** from the Department of Economics and Economic History, Rhodes University. This questionnaire will seek information on **RURAL HOUSEHOLDS PERCEPTIONS ON ROSEHIP AND THE ROLE IT PLAYS IN RURAL LIVELIHOODS IN LESOTHO.** This research project is conducted to find out if rosehip is a useful resource to rural communities and if it is making a positive contribution to rural livelihoods. This information will be used to make recommendations to the government for policy formation regarding this plant so that people can continue to benefit from it now. All the information provided will be treated confidential and will solely be used for the study, not anything else not related to the study. Your cooperation and contribution to this study are greatly appreciated.

IDENTIFICATION

Name of respondent		District Name	
Cell No		Enumerator's Name	
Village Name		Date of interview	

A. PERSONAL INFORMATION

A1. Household head	**A2**. Age	**A3**. Gender	**A4**. Education level	**A5**. Marital Status	**A6**. Main Occupation
1= Yes 0= No		1= Male 0= Female	Number of completed years in education (grades)	1=Single 2=Married 3=Divorced 4=Widowed	1=Self-employed 2=Student 3=Regular salaried job 4=Retired 5=Fulltime rosehip harvester

					6. Temporary job 7=Other(specify)------- ----------

A7. What is the total number of your household members? *	
A8. How many of the household members are employed?	
A9. How many years have you been involved in rosehip harvesting?	
A10. How many household members are involved in harvesting?	

*Household head refers to the de facto household head that stays in the household for 4 or more days per week *Please include only those who stay in the household for 3 or more days per week*

B. KNOWLEDGE OF ROSEHIP

B1. Do you know *Rosa rubiginosa* (rosehip)? 1=Yes 0=No	
B2. Have you heard of Invasive Alien Species? 1=Yes 0=No	
B3. If yes, what is your understanding of Invasive Alien Species (IAS)? Explain _____ _____	
B4. For how long has the rosehip been here? (years)	
B5. Was it here when you were young? 1=Yes 0=No	
B6. If no, when did you first notice rosehip?	
B7. According to your knowledge, what is the key importance of rosehip? _____ _____	
B8. Have you noticed any change in rosehip abundance over the last 5-10 years? 1=Yes 0=No	
B9. If yes, how has it changed? 1=Increased 2= Decreased	
B10. What do you think might have caused that change? _____ _____	
B11. Are there any activities that are no longer performed because of rosehip? 1=Yes 0=No	

B12. What are the rosehips mostly harvested for? _____	
B13. Do you consider rosehip as problematic? 1= Yes 0= No	
B14. If yes, what are the negative impacts of rosehip you have experienced? 1= Decreases available farming land 2= blocks human and animal movement 3= reduces water quality 4= reduces grazing land 5= Creates fire hazards 6= Other (specify)_____ _____ _____	
B15. How would you compare the presence of rosehip with other invasive species within the area? _____ _____	

C. ROSEHIP HARVESTING AND MARKETING

C1.	**C2.** Quantity harvested	**C3.** Quantity sold	**C4.** Local Price per kg	**C5.** Means of payment Code **A**	**C6.** Distance from homestead to harvesting side	**C7.** Market outlet sold **Code B**	**C8**. Market distance from home
Rosehip							

Code A: 1=Cash 2=EFT 3=other (specify)

Code B: Local trader 2=local shops 3= other (specify)

C9. How often do you harvest rosehip? (days per week)	
C10. Has the price paid changed over the past 2 years? 1=Yes 0=No	
C11. If yes, how has it changed? 1=Increased 2= Decreased	

C12. What do you use the money acquired from selling rosehips for? 1= Buying food 2= School Fees 3= Other (specify)_____		
C13. Did you hire any labour for harvesting? 1=Yes 0=No		
C14. If yes, how much did you pay them?	Permanent	
	Temporary	
C15. Is harvesting of rosehip primarily used to fill unforeseen or emergency gaps (such as loss of other income sources or due to sudden cash needs)? 1=Yes 0=No		
C16. How would it affect your livelihood if government banned rosehip since it is not originally from Lesotho? _____ _____		
C17. Are you aware of any laws that control harvesting of rosehips? 1=Yes 0=No		
C18. What is the difference between good and bad periods/years in harvesting in terms of price? _____ ____		
C19. Is there any improvement in your livelihoods since you started harvesting rosehip? 1=Yes 0=No		
C20. If yes, how has it improved? _____		
C21. Have you ever failed to sell your rosehip due to lack of buyers? 1=Yes 0=No		
C22. What are the main problems you face as a harvester? 1= Travelling long distance 2= Lack of buyers 3=Very low prices 4= Poor level of market access 5= other (specify)_____		
C23. Did you or any member of your household receive training on harvesting? 1=Yes 0=No		
C24. If yes, who provided training?		

1= Local extension officers 2= Local trader 3= Rosehip Company 4= other (specify)_____	

D. PERCEPTIONS OF ROSEHIP

D1. On a scale of 1-5, please rank the following questions related to your perception of rosehip harvesting as a livelihood strategy**. 1=Strongly disagree 2= Disagree 3= Neutral 4= Agree 5= Strongly agree**

SOCIAL DIMENSIONS	**Rank**
a. Rosehip harvesting helps me to connect with other people in the rosehip sector	
b. Harvesting of rosehip helps build trust and solidarity among harvesters	
c. Rosehip harvesting enhances the ability of individuals to cooperate through Stokvel	
d. Rosehip harvesting improves involvement in social groups	
ECONOMIC DIMENSIONS	
e. Rosehip harvesting creates job opportunities	
f. Rosehip harvesting is a source of household income	
g. Rosehip harvesting helps to improve household food security	
h. Rosehip harvesting serves as a safety net in terms of a crisis	
i. Poor households are more dependent on rosehip harvesting to fulfil basic needs	
j. The plant reduces the yields of farming land	
ENVIRONMENTAL DIMENSIONS	
k. Rosehip harvesting is not harmful to the environment	
l. Rosehip does not have an impact on pasture productivity	
m. Rosehip helps to in recover degraded forests as they act as nurse plants	
n. Rosehip does not exacerbate soil erosion processes	
o. The plant creates fire hazards	
p. Rosehip harvesting does not alter the forest structure and regeneration	
q. Harvesting of rosehip does not alter the rate of growth, reproduction and survival of the harvested plant	
r. Rosehip harvesting permits population persistence in the long term	
s. Harvesting of rosehip does not deplete nutrient levels of the plant	
t. The plant significantly reduces water quantity	

E. INCOME SOURCES

Please fill in the table below by stating your income from each category

	E1. Amount received each time	**E2**. How often? (e.g. monthly)	**E3**. Number of times in the past 12 months	**E4.** Total Amount
a. Remittances				
b. Rosehip harvesting				
c. Permanent employment				
d. Old-age pensions				
e. Permanent employment				
f. Temporary employment				
g. Livestock				
h. Crops				
i. Other (specify): _____				

F. **PHYSICAL HOUSEHOLD ASSET ENDOWMENTS**:

Please indicate assets that you have access to:

	F1. Do you own or hire assets? 1= Own 2= Hire 3= Borrow 4= Do not have access	**F2.** Number of assets held if owned	**F3.** Total value of owned assets
a. Wheel barrow			
b. House			
c. Television			
d. Radio			
e. Car			
f. Cell phone			
g. plough			

h. Truck			
i. Electricity or gas stove			
j. Bakkie			

G. LIVESTOCK PRODUCTION

Please indicate your livestock production by completing the following table below

Livestock Type	**G1. Sheep**	**G2. Goats**	**G3. Cattle**	**G4. Pigs**	**G5. Donkeys**	**G6. Horses**	**G7. Other specify _____**
a. Number owned							
b. Money spent on feed, vet services, etc since January 2021							
c. Number sold since January 2021							
d. Number slaughtered							
e. Number given to others as gifts or fines							
f. Main livestock market*							
g. Total amount from sales since January							

**** Main market codes: 1=Local butchery 2= Neighbours 3= Supermarket 4 = Hawkers 5= other (specify)***

G. CROP PRODUCTION

Please indicate your annual crop production by completing the following table below

Crops	**G8. Area planted (ha)**	**G9. Fertiliser cost**	**G10. Herbicide cost**	**G11. Pesticide cost**	**G12. Quantity harvested**	**G13. Quantity sold**	**G14. Quantity consumed at home**
a. Maize							
b. Beans							
c. Cabbage							
d. Tomato							
e. Sorghum							
f. other (specify) ___ _____							

H. SOCIAL CAPITAL

Group	**H1.** Number of years as a group member	**H2.** Position in the group 1= Chairperson 2= Secretary 3= Treasury 4= General member	**H3.** Level of participation in decision making 1= Low 2= Moderate 3= High	**H4.** Are you satisfied with your level of participation in decision-process making? 1= Not satisfied 2= Neutral 3= Satisfied
a. Rosehip harvesters' association				

b. Savings and credit group				
c. Religious group				
d. Other (specify)				