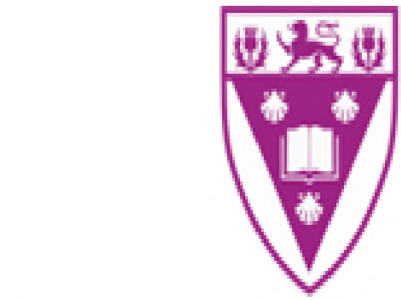
PERCEPTIONS AND LIVELIHOOD USES OF AN INVASIVE ALIEN TREE (*Acacia dealbata*) BY RURAL COMMUNITIES IN THE EASTERN CAPE



RHODES UNIVERSITY

Where leaders learn

Thesis submitted in fulfilment of the requirements for the degree of

Master of Science

at

Rhodes University

By

Ngorima Agripa

ABSTRACT

The negative impacts which invasive alien species have on ecosystems are well documented but there is paucity of information on their impacts on rural communities. Due to ecological impacts that may be associated with *Acacia dealbata* invasions the Agricultural Research Council Plant Protection Institute is considering releasing a biocontrol agent for *A. dealbata*. The actual social impacts of *A. dealbata* invasion and control are likely to be related to its importance in rural livelihoods. This thesis reports on the perceptions and livelihood uses of *A. dealbata* in the Eastern Cape. Three study sites were assessed, Matatiele, Mount Fletcher and Maclear. The study involved 150 household surveys, one focus group discussion and one transect walk at each site, key informant interviews and frequent house visits to acquire reliable data.

Results show that 100 % of households in the three sites use Silver Wattle extensively for firewood. In Matatiele 64 %, 72 % in Mount Fletcher and 84 % of households in Maclear use Silver Wattle for fencing. To carve tools 76 % in Matatiele, 76 % in Mount Fletcher and 84 % households in Maclear use Silver Wattle. For medicinal purposes 18 % in Matatiele, 20 % in Mount Fletcher and 16 % in Maclear use Silver Wattle, whilst 78 % in Matatiele, 80 % in Mount Fletcher and 80 % in Maclear use it for fodder purposes. Many respondents felt that Silver Wattle is too abundant within their areas such that it now has many negative impacts associated with it. Perceptions of local people towards *A. dealbata* are neither static nor uniform, but are influenced by time since the invasion and now abundance of the species. There are no alternatives which provide the same services provided by Silver Wattle. Benefits and constraints due to *A. dealbata* invasion are experienced by everyone irrespective of wealth and gender. In conclusion, Silver Wattle is a valuable resource to these rural communities, but increasing abundance is incurring high costs to grazing resources and landscape accessibility.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

DECLARATION

I, Agripa Ngorima, hereby declare that the work described in this thesis was carried out in the Department of Environmental Science, Rhodes University under the supervision of Professor Charlie Shackleton. The thesis has not been submitted to a university other than Rhodes University, Grahamstown, South Africa. The work presented here is that of the author unless otherwise stated.

Agripa Ngorima

…….

Date: 15 July 2016

ACKNOWLEDGMENTS

My deep gratitude goes out to my supervisor Professor Charlie Shackleton for awarding me the chance to do this project and whose guidance, support, advice and in-depth knowledge have been fundamental to this research and directing it in the right direction. I would also like to express my outmost gratitude to the ARC-PPRI for the funding of this research, especially Dr Alan Wood who has been supportive of this research from the beginning.

I wold also like to thank my family for all the encouragement, support and prayers during my study. My parents remain my source of hope and inspiration for the effort they have put into my academic endeavours. I would also like to thank my friends for all the support especially Current Masunungure, Glen Vembo, Aidan Gouws and Molline Gusha. I would also like to express my gratitude to Ms Kate Benyon for organising all the logistics of the research.

This research would not have succeeded without the voluntary and co-operative efforts of the communities in Matatiele, Mount Fletcher and Maclear. I would like to express my sincere appreciation to all the households which I interviewed and gave out their information. My gratitude also goes to Nophiwe my field assistant who was very helpful during my field-work. Above all, I thank my Lord and Saviour Jesus Christ in whom I do all things because he strengthens me.

CHAPTER ONE: INTRODUCTION

1.1 Sustainable Livelihoods

Rural households and communities engage in multiple activities to reduce vulnerability and poverty (Niehof, 2004). Pursuit of different livelihood strategies is largely determined by the assets available to each household (Niehof, 2004; Walter & Armstrong, 2014). Identifying the assets that underpin different livelihood strategies is important in analysing poverty and designing opportunities that promote sustainable livelihoods (Scoones, 1998). Examples of livelihood assets include human capital such as skills which are necessary for labour provision; physical capital such as land, livestock and agricultural tools; financial capital such as savings; social capital, such a social networks and membership of institutions and natural capital in the form of ecosystem goods and services. Use of natural capital resources has gained recognition as an important rural livelihood strategy (Shackleton & Shackleton, 2004).

Scoones (1998) defines a livelihood as the capabilities, assets and activities needed to construct a living. Most rural communities have access to many different asset forms but how they use them and their ability to accumulate them may play a role in determining sustainable livelihoods (Chambers & Conway, 1992). A livelihood is sustainable if it has the ability to recover from stresses and shocks or enhance capabilities and assets whilst not undermining the natural resource base (Scoones, 1998; Hussein & Nelson, 2016). Households unable to cope or adapt during shocks may be vulnerable to future changes, which undermines their sustainability (Scoones, 1998). Vulnerability, in turn, is a fundamental factor in determining poverty which unfortunately is frequently poorly understood (Adger, 2006). Resilience measures against a shock may be determined by the extent of vulnerability (World Bank, 2004).

1.2 Use of Natural Capital by Rural Communities

Rural households in most developing countries make extensive use of natural capital such as food, fuel, fodder, medicines and other products from the surrounding environments for subsistence and income generation (Shackleton *et al.*, 2007; Angelsen *et al.*, 2014). Approximately 60 million indigenous people worldwide are almost totally dependent on natural capital (World Bank, 2004). Globally, this has been estimated to provide US$ 508 million to developing countries annually (Angelsen *et al.*, 2014). The contribution at the

household level may vary from less than 10 % to over 90 % of household income (cash and non-cash) depending on the local context, the availability of other capitals and the degree of specialisation, with a global average of 28 % (Angelsen *et al.*, 2014). Thus, for some households the income from using natural capital is only supplementary, whereas for others it is their main livelihood activity (Vedeld *et al.*, 2007).

The same applies in the southern African region, where several studies have quantified the contribution of natural capital to rural livelihoods (Twine *et al.*, 2003; Shackleton & Shackleton, 2004; Shackleton *et al.*, 2007. Thondhlana *et al.*, 2013). Shackleton *et al.* (2001) noted that in South Africa approximately 9.2 million people live in the savanna biome and most are dependent on natural capital as an important component of their livelihoods. Williams & Shackleton (2002) reported that over 80 % of rural households in South Africa depend on firewood as their primary source of energy. Shackleton *et al.* (2007) further reported that almost 1.3 million m^3 of firewood is acquired from wooded biomes annually in South Africa. Trees are also used for medicinal purposes, 75 % to 90 % of rural dwellers worldwide use traditional medicines (Xego *et al.*, 2016). In South Africa, approximately 3 000 plant species are used for traditional medicines (Geldenhuys, 1999, Xego *et al.*, 2016). Approximately 20 000 tonnes of plant material are traded in the medicinal plant markets in South Africa annually, with an approximate value of ZAR 270 million per year (Xego *et al.*, 2016). Shackleton & Shackleton (2004) summarised that in rural South Africa, 5.3 tonnes of firewood, 104 kg of edible fruits and 185 poles were used on average per household per year, which at the time represented a mean annual gross value of approximately ZAR 3 854 per household.

The income share from natural capital or non-timber forest products (NTFPs) as most of these studies term it, is not static but varies between households and within households through time (Shackleton & Shackleton, 2006). Such variation is a function of the types of resources used, the local context and household attributes. For example, poorer households typically extract higher relative value of NTFPs than do richer households. Cavendish (2000) showed that in Zimbabwe income from the environment contributed up to 40 % of income of poor households compared to 29 % of richer households. Therefore, threats and over-exploitation of natural capital make poor people more vulnerable (Brocklesby & Hinshelwood, 2001). Poor households rely more on subsistence NTFPs such as firewood and wild foods (Wunder *et al.*, 2014). Similarly, households in more remote locations use more than those closer to urban centres and female-headed households tend to be more reliant on NTFPs than male-headed households (Shackleton & Shackleton, 2006). Benefits from the use of NTFPs are not confined

to rural areas only as they can be utilised in urban areas (Shackleton, 2005; Kaoma & Shackleton, 2015).

Shackleton & Shackleton (2004) categorised the use of NTFPs as daily nets and safety nets. The daily net role of NTFPs is through direct household consumption of energy, food, medicines and shelter (Shackleton & Shackleton, 2004). Simultaneously, the free availability of these resources, allows rural households to retain scarce cash income to purchase other goods and services which they cannot access from the surrounding environments and to invest in other capital forms, such as education of their children, or purchase of seeds and fertiliser (Shackleton *et al.*, 2007). Angelsen *et al.* (2014) state that income from NTFPs provides rural dwellers with a starting point out of poverty.

The safety net role of NTFPs is through assisting households to cope during times of economic, social and biophysical adversities (Arnold & Ruiz-Pérez, 2001; Wunder *et al.*, 2014). For instance, death or retrenchment of a breadwinner, or droughts and frosts leading to poor crop yields (Shackleton *et al.*, 2007) or as seasonal gap-fillers during income low periods such as between agricultural harvests (Angelsen *et al.*, 2014; Wunder *et al.*, 2014). Sudden exposure to shocks increases the likelihood of a household's use of NTFPs use by 13-16 % (Wunder *et al.*, 2014). Shackleton *et al.* (2007) describe how NTFPs act as a safety net through the following mechanisms:

(i) An increase in consumption of NTFPs which were already important, such as through substitution of purchased goods by an NTFP (e.g. use of firewood instead of purchasing paraffin).
(ii) Adoption of the use of an NTFP that the household did not previously use.
(iii) Selling natural resources to earn cash. Paumgarten & Shackleton (2011) showed that 8 % of households in Dixie and Dyala in the Eastern Cape province sold NTFPs as a safety net function.

1.2.1 Sustainable Rural Livelihoods Framework (SLF)

Assessment of the sustainability of rural livelihoods moved away from simple income accounting with the introduction of the sustainable livelihoods framework (SLF) (Chambers & Conway, 1992; Scoones, 2009). In particular, the SLF focussed attention of the diversity of capabilities and assets that households have and use. Chambers & Conway (1992) state that

the SLF has become a useful participatory tool to illustrate the complexity and diversity of livelihoods of poor people. Consequently, it is a useful tool for this study on the role of invasive alien plants in rural livelihoods. The SLF emphasises both the social and ecological components (WECD, 1987) and how these components may enhance or constrain livelihoods and shows their interactions (Serrat, 2008).

The SLF comprises of five key components (Fig. 1.1), namely vulnerability context, livelihood assets, transforming structures, livelihood strategies and livelihood outcomes (Mahdi *et al.*, 2009). The livelihood assets pentagon comprises of five types of capital assets which are used by households to develop livelihoods (DFID, 1999). According to Mahdi *et al.* (2009) these are:

(i) Natural capital – The natural resource base, ecosystem goods and services which are acquired by households.
(ii) Social capital – Social networks, relations and ability to reach wider organisations for political and economic purposes.
(iii) Human capital – Knowledge, skills and labour.
(iv) Physical capital – Infrastructure and means of production.
(v) Financial capital – Money, savings and credit.

Access to livelihood assets is influenced by external factors such as the vulnerability context and transforming structures (Mahdi *et al.*, 2009). Access to assets to reduce vulnerability is controlled by laws, policies and institutions of governance (Mahdi *et al.*, 2009). The SLF helps to understand how factors interact to shape a household's response and vulnerability (Reid & Vogel, 2006). Of particular relevance to this research is the use of this framework in focusing on key factors that shape livelihoods as well as identifying factors that enhance or constrain access to various livelihood assets.

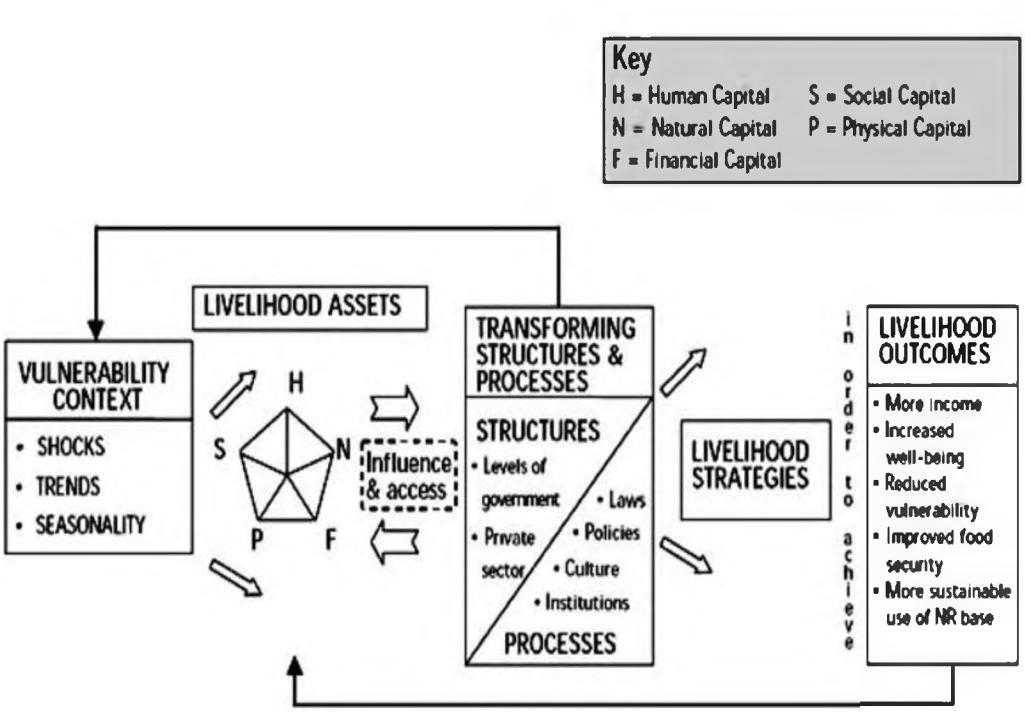


Figure 1.1. Sustainable rural livelihoods: framework for analysis

(From DFID, 1999)

1.2.2 Vulnerability

Vulnerability can be defined as how much a system is exposed to stresses and shocks which makes it susceptible and marginalised resulting in an inability to cope with adverse effects (Adger, 2006). Understanding the concept of vulnerability can provide guidelines to improve livelihoods through counteracting risk (Adger, 2006). Important parameters to vulnerability are stresses and shocks which a system is exposed to, sensitivity and adaptive strategies (Adger, 2006). Adaptive strategies may be physical, social or economic responses to stresses and shocks (Birkmann & Fernando, 2008). Shackleton *et al.* (2010) argue that poor people may be more vulnerable because of a broader range of shocks and risks they are exposed to and the situation is usually exacerbated by their lack of assets and alternatives to recover from the shocks. Vulnerability undermines livelihood sustainability and thereby drives people into poverty (Drimie & Casale, 2009). Knowledge of vulnerability contributes to identification of coping strategies towards resilience and converting stresses to opportunities (Folke, 2006). Within this research identifying vulnerability within and amongst different households may underlie different patterns of use and reliance on invasive alien plants (Wiegers *et al.*, 2006).

1.2.3 Resilience

Walker *et al.* (2004) defined resilience as the capacity of a system to absorb unsettling influences and restrategise allowing change which does not modify essential elements of the system. Resilience mainly focuses on the amount of disturbance a system can absorb before it changes its fundamental features (Berkes *et al.*, 2002). Resilience can be determined according to the ability of a community or household to acquire the necessary resources and organise itself before and during times of adversity (Uy *et al.*, 2011). The ability to absorb and control change is a fundamental characteristic in Social-Ecological Systems (SES) (Berkes *et al.*, 2002). More resilient systems, and households, are better able to cope with disturbances incurred from stresses and shocks, and find opportunities for renewal (Berkes *et al.*, 2012; Uy *et al.*, 2011). Folke (2006) elaborates that resilient systems may have the ability of self-organisation and adapting to disturbances. In a resilient SES disturbances can result in creating livelihood opportunities (Folke, 2006). Stresses can be termed as continuous or slowly accumulating pressures which occur within ranges of variability (Turner *et al.*, 2003). In contrast, a shock can be termed as a major spike in pressure beyond the normal range of variability (Turner *et al.*, 2003). Livelihood strategies must be sufficiently resilient and should be robust to allow people to resist shocks and stresses (Uy *et al.*, 2011).

1.3 Invasive Alien Species

Invasive alien species (IAS) are species whose native range has been changed accidentally or purposefully by people (Meyerson & Mooney, 2007; Holmes *et al.*, 2009). Their presence within receiving ecosystems typically causes economic, social and ecological problems (Geesing *et al.*, 2004). Consequently, they are regarded as a problem by many national and conservation agencies, who expend much effort on their control. These negative impacts have resulted in a significant loss in ecosystem services and goods totalling approximately US$ 1.4 trillion per year (Pimental *et al.*, 2000). Abundance of the IAS and the time since invasion influences the level of negative ecological impacts (Kumshick *et al.*, 2015).

1.3.1 Ecological Impacts

IAS are regarded as one of the biggest threats to existence of native species, causing what is termed as 'biological pollution' (Kannan *et al.*, 2014). IAS provide the second biggest threat to natural ecosystems and biodiversity after climate change (Kannan *et al.*, 2014) as they usurp

local vegetation (Rai *et al.*, 2012; van Wilgen *et al.,* 2012) and reduce indigenous species richness and abundance (Turpie *et al.*, 2008). Many IAS are termed ecosystem engineers due to their ability to significantly alter the environment they invade (Branch *et al.*, 2004), such as changes in hydrology, nutrient cycling and soil carbon (Sundaram *et al.*, 2012; Oelofse *et al.*, 2016). Such disruptions may increase the possibility of other threats to biodiversity such as fires, floods and erosion (Shackleton *et al.*, 2011).

In South Africa, IAS reduce national water runoff by approximately 3 300 million m^3 or 7 % annually (le Maitre *et al.*, 2000). This may be because of the higher evapotranspiration rates of the woody IAS (Gorgens & van Wilgen, 2004). Turpie *et al.* (2008) reports that in South Africa, IAS threaten up to 55 % of the country's species on the IUCN Red Data List. Another example in South Africa, is that of *Prosopis* invasion reducing species richness of birds and insect (Steenkamp & Chown, 1996) through increasing the mortality of *Acacia erioloba* and a general reduction in native species which offer habitat (Shackleton *et al.*, 2015). Oelofse *et al.* (2016) report that in Matatiele the soil organic carbon declined by depth as the invasive wattle stand increased. However, the effects of Black Wattle on the grasslands did not significantly alter the soil organic carbon (Oelofse *et al.*, 2016). Negative impacts of IAS on South African Fynbos biome have been estimated at approximately ZAR 700 million (USD 1=ZAR 14) per annum (Turpie *et al.*, 2008) and in Western Cape Fynbos ecosystem services have been reduced by US$ 11.75 billion due to IAS invasions (Shackleton *et al.*, 2011). Department of Water and Forestry (DWAF) (2005) estimated the costs due to *Acacia mearnsii* invasion at US$ 1.4 billion.

IAS may provide positive ecological impacts also. IAS such as *Prosopis* may provide shade, protection and food not only for livestock but wildlife also (Perera *et al.*, 2005). In Sri Lanka, which was invaded by *Prosopis* for a long period, it is extensively used for nesting and perching by migratory birds at the world famous bird sanctuary at Bundala (Perera *et al.*, 2005).

1.3.2 Social Impacts

IAS may also pose a range of social or economic costs (Pimentel, 2000). For example, when IAS invade agricultural land they inhibit agricultural activities (Pimental *et al.*, 2000). Pasiecznik *et al.* (2001) reported that in Mexico, 75 % of arable land had been turned into *P. juliflora* thickets which were no longer cultivatable. Mugasi *et al.* (2000) estimated that

livestock returns in Uganda had been reduced by over 50 % due to invasive species. Therefore, this may increase vulnerability of people whose livelihoods are livestock dependant (Mugasi *et al.*, 2000). Woody invasive plants may reduce the carrying capacity of livestock through replacing grasslands (Binggeli, 2001).

IAS may disrupt cultural ecosystem services as they replace some culturally important species (Pfeiffer & Oritz, 2007; Pfeiffer & Voeks, 2008) or invade culturally important sites (Richardson & van Wilgen, 2004; Pejchar & Mooney, 2009). Such depreciation in cultural places may diminish people's recognition of or identity with the area (Pfeiffer & Oritz, 2007). IAS invasion may lead to cultural erosion, which occurs if ancestral traditions are not passed on to the next generations (Pfeiffer & Voeks, 2008). A ripple effect exists whenever an indigenous species is replaced by an IAS (Pretty, 2002). The absence of culturally important species will result in certain traditions associated with them not being passed to future generations (Pfeiffer & Voeks, 2008).

IAS may also have negative impacts on certain landscapes. Shackleton *et al.* (2007) revealed that some villagers in Cathu, South Africa, did not want *A. mearnsii* growing in particular landscapes, such as near homesteads, sacred pools, river banks and grazing areas. Some IAS may increase the probability of certain diseases (Pejchar & Mooney, 2009). For instance, *Lantana camara* in East Africa provides habitats for tsetse fly (*Glossina spp.*) which is a vector of sleeping sickness to the local people (Leak, 1999). In some parts of Sri Lanka, local people have noted that their livelihoods are negatively impacted by *Prosopis* invasion as it reduces grazing lands and the thorny branches injure hands, feet, animal hooves and tyres (Perera *et al.*, 2005).

IAS may also reduce the presence and accessibility of NTFPs (Kunwar, 2003). This may constrain livelihoods and consequently increase vulnerability of natural resource dependant rural communities (Sundaram *et al.*, 2012). Rai & Scarborough (2015) in Nepal, showed that time taken by rural households to enter nearby forests had increased by 100 %, and 86 % of the households consequently reduced their entrance into the forests drastically due to *Mikania micrantha* invasion. The amount of firewood and fodder acquired from the natural forests declined significantly after *M. micrantha* invasion (Rai & Scarborough, 2015). Thorny IAS can inhibit people from accessing certain sites (Pfeiffer & Oritz, 2007). Sundram *et al.* (2012) in southeast India, supports this notion in which all villagers interviewed stated that invasive *L. camara* was making accessibility of firewood and other NTFPs difficult as it made dense

thorny thickets. Natural resource dependent communities incur extra costs to remove IAS (Rai & Scarborough, 2015). Kannan *et al.* (2016) reports that *L. camara* usurped natural forests which are sources of income and safety nets for rural communities in southern India. In Madlangala in the Eastern Cape (South Africa), infestation by Australian *Acacias* is high and 41 % of people stated that they provide cover for criminals, endangering lives of local people (de Neergaard *et al.*, 2005). Thieves may steal livestock which is a livelihood resource for local communities and endanger mostly women who are responsible for firewood collection and 52 % of the population are afraid of walking near the forests (de Neergaard *et al.*, 2005).

IAS can also have a positive social impacts on a community. They may provide habitat for culturally significant native wildlife species (Dickie *et al.,* 2014). For example in South Africa, *Eucalyptus* are noted to provide a suitable habitats for culturally important and iconic African fish eagles (Dickie *et al.,* 2014).

1.4 The Contribution of IAS to Rural Livelihoods

Most work on IAS has emphasised the resulting negative ecological and economic impacts (McNeely *et al.*, 2011). Whilst the deleterious effects IAS have on ecology and land uses are well studied (Le Maitre *et al.*, 2008) hitherto there is a paucity of information on the roles of IAS in rural livelihoods and the potential for poverty reduction (Shackleton *et al.*, 2007). Studies on drivers of use, incorporation, and preferences are limited (Kull *et al.*, 2011). The consequences of this is that control programmes for IAS are designed and implemented without due consideration of their value to local communities (Shackleton *et al.*, 2007; Kull *et al.*, 2011), which is also a reflection of the limited consideration of social impacts relative to ecological ones by both managers and researchers (dos Santos *et al.,* 2014).

Some IAS are receiving increased recognition and acceptance due to their ability to contribute positively to rural livelihoods (Shackleton *et al.*, 2007; Achigan-Dako *et al.*, 2011; dos Santos *et al.*, 2014; Kannan *et al.*, 2016), with a few case examples summarised in Table 1.1. For instance, Australian *Acacias* have a plethora of livelihood uses to rural communities around the world (Kull *et al.*, 2011). In southeastern India, *Lantana* is used by a number of communities as a raw material for craftwork, which provides income (Kannan *et al.*, 2016). Some rural people may have disregarded the negative effects of IAS in preference to the positive effects (de Neergaard *et al.*, 2005). They have assimilated IAS into their livelihoods

and use them to upgrade their lives and have, with time, branded some as of cultural importance (de Neergaard *et al.*, 2005; Nuñez & Simberloff; 2005, Shackleton *et al.*, 2007).

Table 1.1. Examples of IAS uses by local communities

Function	**Purpose**	**IAS species**	**Location**	**Reference**
Provision-ing	Firewood	Australian *Acacias*	South Africa	de Neegard *et al.*, 2005
		Prosopis	Kenya, India, Ethopia	Pasiecznik *et al.*, 2001; Mwangi & Swallow, 2008; Lemma &Mohammed, 2016
		Lantana camara	India	Kannan *et al.*, 2014
	Food	*Prosopis*	Mexico Kenya, Brazil	Binggeli, 2001; Geesing *et al.*, 2004
		Opuntia ficus-indica	South Africa	Shackleton *et al.*, 2007
	Medicine	*Acacia mearnsii* and *A. dealbata*	South Africa	de Neegard *et al.*, 2005 Semenya *et al.*, 2012
		Opuntia ficus-indica	South Africa Brazil	dos Santos *et al.*, 2014
		Ajuga sericifera	South Africa	Keirungi & Fabricius, 2005
		Lantana camara	India	Nayak *et al.*, 2008
		Prosopis	Kenya	Maundu *et al.*, 2009
	Fodder	*Prosopis*	Mexico Afar, Ethopia	Blanckaert *et al.*, 2007 Wakie *et al.*, 2016; Lemma & Mohammed, 2016
Income	Food (Flour)	*Prosopis*	Brazil	Geesing *et al.*, 2004
	Beer	*Opuntia ficus-indica*	South Africa	Beinart & Wotshela, 2008
	Firewood	Australian *Acacias* *Prosopis*	South Africa Kenya	de Neegard *et al.*, 2005 Maundu *et al.*, 2009
	Flowers	*Jacaranda mimosifolia*	South Africa	Le Maitre *et al.*, 2004
Aesthetics	Flowers	*Acacia dealbata*	Southern France	Binggeli, 2001
	Landscaping	*Leucaena leucocephala*	Brazil	Kunwar, 2003

dos Santos *et al.* (2014) argue that while some biologists may view IAS based on their negative ecological impacts, many local people view them just as plants and an important livelihood resource. Pfeiffer & Voeks (2008) agree and state that often local people may not differentiate between indigenous species and IAS, but rather view them as assets with potential value to their livelihoods. Shackleton *et al.* (2007) argue that some IAS play as pivotal livelihood roles equivalent to or surpassing the contributions of some native species. dos Santos *et al.* (2014) reports that in northeastern Brazil, which is semi-arid, local communities view direct use and services of IAS as more useful than those provided by indigenous species, with 97 % of IAS considered to be useful. In Kenya, in the Baringo and Garissa villages which have been invaded by *Prosopis* from 1973, life without it would be difficult as people have developed a dependency on it (Maundu *et al.*, 2009). This may be because people sell *Prosopis* products, a 40 kg bag of *Prosopis* pods costs US$ 2.7, a pole from *Prosopis* in Garissa costs US$ 1.1 and there is also trade charcoal made from *Prosopis* (Maundu *et al.*, 2009). Therefore, rural communities who receive benefits may welcome IAS in higher quantities because of their contribution to their livelihoods (Shackleton *et al.*, 2007). Shackleton *et al.* (2007) noted that in Tidbury, South Africa, 92 % of the villagers wanted Prickly Pear (*Opuntia ficus-indica*) in optimal densities because it provided food and fodder and the villages had incorporated it into local culture (Shackleton *et al.*, 2007).

Incorporation of IAS into local livelihoods can be via one of two mechanisms. Firstly, potentially useful IAS may be introduced directly because of their perceived beneficial traits. People then share planting material and plant them in their homestead, for example *Ajuga sericifera* in home gardens on the Transkei Wild Coast (Keirungi & Fabricius, 2005). In many instances these IAS with clear uses can escape from the areas in which they were planted and invade surrounding landscapes because of their characteristic rapid growth, excellent dispersal mechanisms and ability to thrive in different environmental and climatic conditions (Geesing *et al.*, 2004). Additionally, genetic versatility, high reproductive output, environmental plasticity and allelopathy may aid IAS to spread (Pfeiffer & Voeks, 2008). Secondly, local people may switch to using a previously unused IAS as it local abundance escalates which often results in a decline in indigenous species whilst at the same time making it more visible as a potential asset (Shackleton *et al.*, 2007; dos Santos *et al.*, 2014). Additionally, as the IAS increases the costs of harvesting it become less (Shackleton *et al.*, 2007). The importance of some IAS may result in changes to normal routines to incorporate them to local livelihoods, for example nomadic Madagascar pastoralists changed their normal routines so that they could

fully maximise invasive Prickly Pear (Kaufman, 2013). Adaptation strategies to IAS availability may include changing land uses, for example, IAS may be used to mark boundaries or another is the removal of livestock from the areas where IAS are prominent (Shackleton *et al.*, 2007).

Many IAS have been available for a considerable period and some local communities may have acclimatised to their presence and adapted to them (Shackleton *et al.*, 2007). Shackleton *et al.* (2007) argue that the use and incorporation of some IAS may be a long-term adaptation rather than a matter of coincidence and opportunity. This recognition of IAS use and adoption can result in the modification of the local culture (dos Santos *et al.*, 2014) or become viewed as sacred species and of paramount importance to the community (McNeely, 2001a). Shackleton *et al.* (2007) found out that *Opuntia ficus-indica* had received native species status in Tidbury village, and some people were offended when it was mentioned that it was an alien species.

Invasions of IAS are by-products of human values, decisions and behaviours. Therefore, socially uninformed decisions to control them may result in livelihood vulnerability related conflicts of interest (McNeely *et al.*, 2011; Rai *et al.*, 2012; dos Santos *et al.*, 2014). The orthodoxy that has been portrayed about IAS has in some situations led to poor decisions about control which are implemented without a clear picture of land uses and livelihoods (Shackleton & Gambiza, 2008). Removal of useful IAS can increase vulnerability of households which are dependant to them (de Neegard *et al.*, 2005). For example, in Australia, government methods of controlling invasive mammals were negatively affecting the Aborigines as they were an important food source for them (McNeely, 2001b). Agrawal *et al.* (2008) argues that often the local communities which are reliant on natural resources are voiceless when it comes to decision making as the majority of the forest lands are state owned. Most IAS control programs implemented without a change in the land uses of the area are ineffective, representing a waste of money and time as the areas become re-invaded by the same species or other IAS after a short period of time (Richardson *et al.*, 2000; Rango *et al.*, 2005; Shackleton & Gambiza, 2008).

Shackleton *et al.* (2007) argue that inclusion of traditional knowledge in ecological studies pertaining biological invasions would give a more insight on how communities residing in close proximity to forests regard biological invasions. Novoa *et al.* (2016) also argue for involvement of different stakeholders depending on how they are affected by invasion. Assessing the levels of knowledge and perceptions of IAS and the essence of them in people's

livelihoods helps to fully understand their costs and benefits which will be useful to create a successful policy framework (Shackleton *et al.*, 2015). Policy frameworks should be flexible enough to cater for different scenarios, perceptions and natures of conflict (Shackleton & Shackleton, 2016). Shaanker *et al.* (2010) note the need for a paradigm shift from eradication to adaptation in management of IAS. Once IAS which offer local communities with resources are eradicated, people may tend to focus on the indigenous species for the same services (Shackleton *et al.*, 2007). Therefore, some IAS potentially buffer indigenous species which provide the same resources (Shackleton *et al.*, 2007).

1.4.1 Analysing the Impacts of IAS on Rural Livelihoods

Shackleton *et al.* (2007) introduced a conceptual framework to analyse impacts and trade-offs in use and control of IAS (Fig. 1.2). The conceptual framework consists of four variables following time since invasion (Shackleton *et al.*, 2007). The first relates to the increasing abundance of IAS with time. Since it is time dependant it follows a density dependent, sigmoid curve (Shackleton *et al.*, 2007). The second curve considers the benefits, if any, which are accrued by the local community from the IAS. It shows that the higher the abundance the greater the benefits until a certain threshold point following the IAS abundance curve. The third trajectory depicts the costs which are associated with invasion by IAS. The costs include the ecosystem services costs and are additive and thus increase exponentially. The fourth curve shows the livelihood vulnerability. Vulnerability will be reduced if introducing the IAS provides new livelihood opportunities and probably capital injection while the costs will be minimal (Shackleton *et al.*, 2007). However, as the costs due to IAS increase, the benefits are outweighed and vulnerability will increase. Whether it will exceed the initial status will be affected by the final ratio of the costs and the benefits (Shackleton *et al.*, 2007).

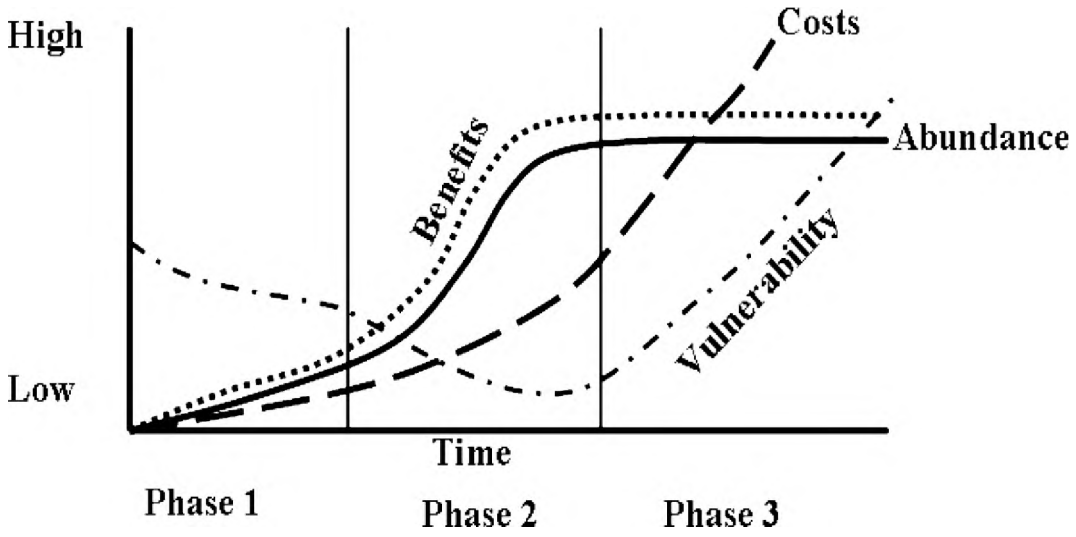


Figure 1.2. Conceptual framework for interpretation of impacts of IAS on rural livelihood

(From Shackleton *et al.*, 2007)

On the x-axis phase 1 represents the stage when invasion by the IAS is in its infancy and abundance is low (Shackleton *et al.*, 2007). During this stage if there are any benefits due to IAS invasion they are small and specifically directed towards the reason for its introduction. There is no need to control the species since costs are minimal (Shackleton *et al.*, 2007). Livelihoods and vulnerability of people at this stage are defined by other strategies they employ, not the invasion by IAS (Shackleton *et al.*, 2007). During the second phase, as its abundance increases people gain knowledge of the species, and consequently the benefits increase and this will influence some changes in local livelihoods (Shackleton *et al.*, 2007). However, the costs are increasing also and at the end of this stage intervention methods will begin to be considered including control of the IAS (Shackleton *et al.*, 2007). Control might be simple and orchestrated by local communities themselves. The final phase shows the stage when costs have exceeded the benefits, there will be two options which will include to mitigate the impacts or leave it and local livelihood vulnerability will be increased (Shackleton *et al.*, 2007). The final part of the last phase will depend on the control measures taken (Shackleton *et al.*, 2007).

The characteristics of IAS should be accounted for (Shackleton *et al.*, 2007). Shape and steepness of the curves of costs, benefits and abundance will depend upon species characteristics and local context (Shackleton *et al.*, 2007). This will produce four different species categories (Shackleton *et al.*, 2007), as a function of the competitive ability of the IAS

(strong or weak) and its usefulness (high or low) (Figure 1.3). These four categories will include useful highly competitive species, undesirable highly competitive species, undesirable weakly competitive and useful weakly competitive species (Shackleton *et al.*, 2007).

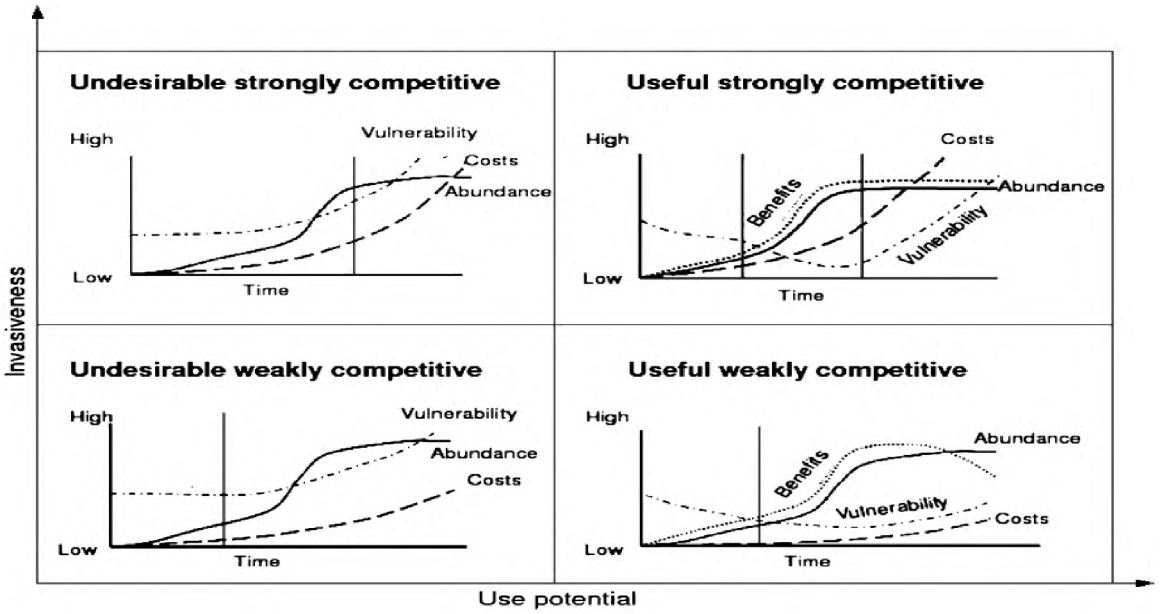


Figure 1. 2. Conceptual framework of different IAS. (Note x axis for weakly competitive species is longer as it takes longer for effects to occur.)

(From Shackleton *et al.*, 2007)

1.5 Factors which Influence Perceptions towards IAS by Rural Communities

Coates (2007) questions why some IAS are recognised and appreciated whilst others are termed a nuisance despite a long history of establishment. More research is required regarding factors which influence perceptions, knowledge and practices towards biological invasions (Coates, 2007; Shackleton & Shackleton, 2016). Coates (2007) argues that researching perceptions towards IAS provides subjective solutions rather than objective ones. The efficacy of IAS in contributing to people's livelihoods may determine if it is to be regarded as a weed or an essential resource (Shackleton *et al.*, 2007; Low, 2012; dos Santos *et al.*, 2014). Uses and perceptions of IAS may be as a result of the initial reason for the introduction and the time period it has been present (Kull *et al.*, 2011). Perceptions may change with time as knowledge and understanding of the IAS increases (van Wilgen *et al.*, 2012). Perceptions towards IAS may be negative when people are impacted negatively and positive when they are benefitting

from it (Pfeiffer & Voeks, 2008). For instance, IAS can be regarded as negative when they compete with culturally important species but when they supplement livestock fodder they are viewed as important (Achigan–Dako *et al.*, 2011; Sundaram *et al.*, 2012). In the Northern Cape (South Africa), the high abundance of invasive *Prosopis* influenced perceptions as there were more costs than benefits which resulted in 98 % of the respondents wishing that it be reduced in abundance (Shackleton *et al.*, 2014). Perceptions towards IAS may vary between age, gender, and type of livelihoods. Additionally, perceptions towards IAS may not be permanent but change as the value and priorities of local people change and perhaps previously overlooked negative impacts will now be considered (Robin & Carruthers, 2012).

1.6 Conflict of Interest regarding IAS

Because of the potential positive benefits associated with some IAS in particular settings, the control of IAS may result in a conflict of interests (van Wilgen & Richardson, 2014; Novoa *et al.*, 2016). A conflict in this context is described as the inability to account and balance trade-offs among ecosystem services or failure on settling the value of services between different stakeholders (Dickie *et al.*, 2014). Most IAS are species whose characteristics became contrary to the positive expectations, with some stakeholders deriving benefits from them and this may perpetuate irreconcilable differences between stakeholders (Low, 2012) because of different values (van Wilgen, 2012). Conflicts of interest amongst the various sectors regarding the control and benefits of IAS are often inevitable (Binggeli, 2001). For example, conflicts of interest might arise between groups when some may wish to increase carbon sequestration whilst others wish to minimise the detrimental impacts such as high water consumption (Jackson *et al.*, 2005; van Wilgen & Richardson, 2012).

On an international scale economic conflict towards IAS has resulted in some agencies and funders in direct opposition with each other (Dickie *et al.*, 2014). The World Agroforestry Centre (ICRAF) is found opposing itself sometimes when it both encourages and cautions planting of *Prosopis* in Africa (Low, 2012). Internationally acclaimed agencies such as the FAO are promoting planting of some weedy species with a known history of invasion in other countries (McNeely, 2001a). Similarly, in South Africa, the Working for Water programme established to control IAS (Le Maitre *et al.*, 2000, van Wilgen *et al.*, 2012) receives substantial funding whilst the Department of Agriculture, Forestry and Fisheries is encouraging growth of Australian *Acacias* in woodlots as a move to alleviate poverty (Aitken *et al.*, 2009).

Conflict may arise over assumptions regarding the responsibility over the spread of IAS (van Wilgen & Richardson, 2014). For instance, in South Africa plantation forestry was introduced by the government and responsibility was later assumed by the private sector (van Wilgen & Richardson, 2014). Therefore, the private sector can argue that invasions were already taking place before they took over the sector, hence they are exonerated of responsibility for the negative impacts (van Wilgen & Richardson, 2014). There are some groups who advocate for 'nature to take its course' regarding IAS and state that controlling IAS is a form of 'xenophobia' on plants (Kaufman, 2013).

1.7 Control of IAS and Working for Water Project (WfW)

Due to the potential for social and economic conflicts of interest regarding IAS, successful control of IAS is not simple. It requires knowledge and understanding of ecology and social aspects, so that a holistic approach can be taken to facilitate long-term solutions (Shackleton & Gambiza, 2008). Control of IAS should not focus solely on ecological impacts but also on how they affect livelihoods of people (Shackleton *et al.*, 2007; Larson *et al.*, 2011; Kannan *et al.*, 2014). Humans may be the cause of invasion, feel the consequences of invasions, determine the level of invasion and may be the solution to these problems (Mooney, 2005) as their activities may augment or reduce IAS within a particular area (McNeely, 2001a). Management of IAS should be localised not globalised, they should be managed depending on how it affects particular ecosystems (van Wilgen & Richardson, 2014) and communities (Shackleton *et al.*, 2007). Management and control of IAS without stakeholders' perceptions can lead to problematic situations and even direct confrontations (Novoa *et al.*, 2016). The way IAS are to be controlled in a water-stressed South African fynbos region will be different to the management in humid ecosystems such as in southeast Asia (van Wilgen & Richardson, 2014).

Chemical and mechanical techniques can be used to control IAS invasion (van Wilgen *et al.*, 2012). However, it has been noted that these are usually most effective when combined with biological control (van Wilgen *et al.*, 2012). In South Africa, biological control of Australian *Acacias* was done using an insect which was not harmful to other species (Dennill & Donnelly, 1991). However, biological and chemical control of the IAS has resulted in controversy as in some instances they have been noted to affect non-target species (Dickie *et al.*, 2014).

Upon realising the gravity of IAS in South Africa the government initiated on the Working for Water project to control their spread (Le Maitre *et al.*, 2000). The programme commenced in October 1995 (van Wilgen *et al.*, 2004). It had two objectives, which were to protect water resources through eradicating IAS near water courses and rivers (van Wilgen *et al.*, 2004) and to reduce unemployment through employing poor people (Marais *et al.*, 2004; van Wilgen *et al.*, 2004). The programme is under the jurisdiction of Department of Agriculture, Forestry and Fisheries (van Wilgen *et al.*, 2004). The programme was implemented across the country but more intense work was done in KwaZulu-Natal, Western Cape and Eastern Cape provinces (de Neergaard *et al.*, 2005).

The programme is also driven towards restoration of ecosystem services, predominantly water supply, which had been compromised by IAS (de Neergaard *et al.*, 2005; van Wilgen *et al.*, 2008). The type and intensity of IAS invasion are the main determinants of the level of streamflow reduction (Le Maitre *et al.*, 2000). WfW focuses on both manual and biological control agents (Turpie *et al.*, 2008). Manual control entails clearing trees using chainsaws, spraying of chemicals and returning to the site for a period of five years to clear any regrowth (Turpie *et al.*, 2008). Australian *Acacias* constitute the majority (40 %) of the area cleared to date (Marais *et al.*, 2004). It is a legal obligation for private landowners to clear their lands of any IAS as inscribed in the Conservation of Agricultural Resource Act of 1983 and the National Environmental Management: Biodiversity Act of 2004. The general policy of the WfW programme is based on private landowners contributing to the initial cost of clearing and making sure that no more invasion occurs when sites have been cleared by the WFW (van Wilgen *et al.*, 2008).

1.8 Introduction of Australian *Acacias* in South Africa

Propagation of several Australian *Acacias* was implemented as a part of national policy in the late 19th and early 20th centuries for a plethora of purposes, including rehabilitating degraded landscapes, improving soil productivity and providing services (Witt, 2005). Australian *Acacias* have been propagated in South Africa for the past 150 years (Dunlop & MacLennan, 2002) as part of a small, yet important, plantation forestry industry (Dunlop & MacLennan, 2002). Institutions such as the Commonwealth Forestry Conferences also helped in the spread and establishment of Australian *Acacias* (Witt, 2005). Prompted by the need to be self-sufficient towards wood products, the government in 1910, engaged forestry companies to

establish large plantations and farmers who planted *Acacias* were given incentives (Witt, 2005). Upon introduction many African people quickly adopted Australian *Acacias* in their livelihoods using them as a resource and commodity (Witt, 2005). Local people were encouraged to plant and use Australian *Acacias* as a way of alleviating pressure on native vegetation (Witt, 2005). By 1950, South Africa had the biggest *A. mearnsii* tannin production industry in the world (Witt, 2005). However, these successes soon resulted in extensive, self-replicating invasions of Australian *Acacias* into landscapes and habitats beyond the plantations where they were first established (Kull *et al.*, 2011). van Wilgen *et al.* (2011) argue that invasions by Australian *Acacias* in South Africa have increased by 40 % over the past 15 years. Furthermore, 70 % of South African land is susceptible to further infestation by Australian *Acacias* (Low, 2012).

1.8.1 Silver Wattle (*A. dealbata*)

A. dealbata (Subfamily *Phyllodineae*) is an evergreen tree which is native to and ubiquitous in southeastern Australia, especially in New South Wales and Victoria (Lorenzo *et al.*, 2010a; Maslin & Mcdonald, 2004). It belongs to the Mimosaceae family (Lorenzo *et al.*, 2010b). *A. dealbata* is a small tree which has an erect stature from 2 m to 35 m (Searle, 1997). The trunk of the tree is 5 cm to 75 cm in diameter and it has an open crown of up to 10 m wide (Searle, 1997). The bark is silver grey, usually smooth and branchlets are angular, brownish black, hard and moderately fissured (Searle, 1997). The rachis of *A. dealbata* contains hairy glands on the upper surface close to the base each pair of pinnae (Searle, 1997). The leaves are bipinnate and are usually 2.5 cm up to 15 cm long and 4 cm up to 10 cm wide and are pale yellow green to silver greyish in colour (Searle, 1997). *A. dealbata* thrives in areas with a mean annual rainfall between 500 mm to 1 600 mm (Lorenzo *et al.*, 2010b). It grows well at altitudes ranging from 350 m to 1 000 m (May & Attiwill, 2003). Silver Wattle is found at higher altitude than other Australian *Acacias* because it is more resistant to cold weather (Cossalter, 1986). *A. dealbata* is capable of occupying large amount of area with different temperatures from tropical, sub-tropical and warm temperate regions (Maslin & Mcdonald, 2004). It is a nodulated legume, and therefore it fixes nitrogen into the soil (Brockwell *et al.*, 2005). The capability to fix nitrogen helps Australian *Acacias* to grow in high abundance within the leached soils which are common in the Cape region of South Africa. (Low, 2012).

The flowering season of *A. dealbata* is late winter to late spring (Searle, 1997). The flowers are large axillary raceme inflorescences consisting of bright yellow flower heads (Searle, 1997). After flowering the pods mature five to six months later. High rainfall triggers a higher inflorescence production (Lorenzo *et al.*, 2010). A variety of insects pollinate *A. dealbata* (Kenrick, 2003). The pollen on the flowers is spatially arranged and this may enhance pest pollination (Kenrick, 2003). It has separate male and female flowers, which reduces self-pollination (Lorenzo *et al.*, 2010). The seeds of *A. dealbata* are longitudinally oriented with a white aril (Lorenzo *et al.*, 2010) which facilitates dispersal by birds (Davidson & Morton, 1984) and ants (Edwards & Westoby, 1996).

A. dealbata produces copious hard-coated seeds (Seaarle, 1997). The pods are approximately 48 cm long and 8-12 mm wide (Searle, 1997), and are usually flat and straight, but might be twisted (Searle, 1997). Fire induces germination of *A. dealbata* breaking the seed dormancy (Danthu *et al.*, 2003). The abundance of the species can also be exacerbated by a plethora of the seed dispersal agents such water, wind, animals and human beings (Kull *et al.*, 2008).

A. dealbata is a high water user (de Neergaard *et al.*, 2005) which exacerbates the impacts of encroachment into grasslands and arable lands (de Neergaard *et al.*, 2005). The ability of Silver Wattle to successfully invade most areas can be attributed to several attributes (Lorenzo *et al.*, 2010a). It has hard-coated seeds capable of staying viable for decades, it is able to thrive on dystrophic soils and it has simplified pollination which simplifies dispersal mechanisms (Lorenzo *et al.*, 2010b). The seeds are induced into germination by fire therefore, cleared areas maybe reinvaded once control methods cease (Low, 2012). It exhibits phenotypic plasticity which is the ability to change physiological features to acclimatise to different environmental conditions (Lorenzo *et al.*, 2010a). Its high water use efficiency allows it to survive in areas with limited water availability (Lorenzo *et al.*, 2010b). It has the ability of cross breeding with other wattle species (Sheppard *et al.*, 2006) creating a multitudes of hybrids which are capable of invading many areas (Lorenzo *et al.*, 2010a). *A. dealbata* exhibits allelopathy (Lorenzo *et al.*, 2010b).

1.8.2 Value of *A. dealbata* to Rural Communities

To rural communities, *A. dealbata* may be useful because it provides them with several services and goods (de Neergaard *et al.*, 2005). *A. dealbata* can be used for restoration of degraded

landscapes. For instance, in the Highlands of Madagascar, it was valued for greening and rehabilitating the landscapes (Kull *et al.*, 2011). The species provides excellent charcoal and poles for construction (Kull *et al.*, 2011). de Neergaard *et al.* (2005) reported that in the same area, 19 % of households sold firewood from *A. dealbata* to earn some income. de Neergaard *et al.* (2005) reports that in Madlangala area in South Africa virtually all households use *A. dealbata* as a source of energy. Ninety percent of the population in the area used it as their primary source of energy and the remainder use it as secondary energy source (de Neergaard *et al.*, 2005). *A. dealbata* may be used for tanbark (de Neergaard *et al.*, 2005).

The nodulation of *A. dealbata* allows it to fix nitrogen and this can improve soil fertility (Rama Devi & Prasad, 1991). The litter of *A. dealbata* can be used as compost when applied to arable lands and added to the soil (de Neergaard *et al.*, 2005). This may improve soil fertility and may increase crop yields (Kull *et al.*, 2011). It produces yellow flowers which are appreciated for their aesthetic value (Maslin and Macdonald, 2004). In Chile the aesthetic value bolsters tourism as it beautifies the area (Kull *et al.*, 2011). In southeastern France some of the flowers of *A. dealbata* are sold and about 550 tonnes of flowers are produced annually (Kull *et al.*, 2011). It has medicinal purposes also; 45 % of people in the Madlangala area in South Africa, stated that they use *Acacias* (Black and Silver wattle) to treat diarrhoea and toothache (de Neergaard *et al.*, 2005). The pods and leaves of *A. dealbata* may provide fodder for livestock (Maslin and Macdonald, 2004).

Rural communities not only derive positive values from *A. dealbata* but they also recognised negative concerns. Usually *A. dealbata* occurs in thickets which may provide cover for criminals (de Neergaard *et al.*, 2005). Forty-one percent of the respondents in Madlangala stated that high densities allowed criminals to hide, endangering the communities, especially women who are responsible for collecting firewood (de Neergaard *et al.*, 2005). Grasslands used for cattle grazing may be converted into bushlands through *A. dealbata* invasions (de Neergaard *et al.*, 2005). It has a high water consumption, and in South Africa it is ranked third in terms of water use (de Neergaard *et al.*, 2005). van Wilgen *et al.* (2012) quantified the value of water loses and land cover by Australian *Acacia* as ZAR 4 billion annually.

1.9 Rationale for the Study, Objectives and Key Questions

This study examined a typical conflict of interest regarding IAS. *A. dealbata* is widely used by local communities whilst, at a broader scale it negatively impacts biodiversity and ecosystem services. Due to the ecological impacts that may be associated with *A. dealbata*, the Agricultural Research Council Plant Protection Institute is considering to release a biocontrol agent for *A. dealbata*. The actual social impact of *A. dealbata* invasion and its control is likely to be related to its importance to the rural livelihoods. Therefore, control of the species may increase vulnerability of local livelihoods through reduction of an important livelihood resource. Therefore, there is need to examine and understand such uses and perceptions of *A. dealbata* and its contributions to livelihoods, as a foundation to determine the potential consequences if the biocontrol is released.

The objective of this study was to assess the perceptions and livelihood uses of *Acacia dealbata* by local communities. To achieve this, the following questions were addressed:

1. What is the importance of *A. dealbata* to local livelihoods in the Eastern Cape?
2. What are the benefits and costs that local communities experience due to their use, management and responses to *A. dealbata*?
3. How do use, perceptions, costs and benefits change in relation to either time since invasion or extent of invasion?
4. What are the locally available alternatives which may provide the same services and goods as *A. dealbata*?
5. Who most experiences opportunities and constraints due to *A. dealbata* invasion?

Linked to these questions and information provided in the introduction four hypotheses were posed:

1. *A. dealbata* is important to livelihoods of rural people.
2. Local communities experience benefits in their use, management and response to *A. dealbata* until a certain threshold where costs outweigh benefits.
3. Economically challenged households experience increased opportunities, benefits and threats due to *A. dealbata* invasion.

CHAPTER TWO: STUDY AREA AND METHODS

2.1 Eastern Cape

The Eastern Cape province is located in the southeastern parts of South Africa. It is the second largest province in South Africa covering 169 580 km^2 (Makiwane & Chimere-Dan, 2010). Approximately 6.74 million people live in the Eastern Cape (Makiwane & Chimere-Dan, 2010), of which 53 % of the population are female. *IsiXhosa* is the most spoken language within the province.

The province is the poorest in the country. The low socio-economic status is elaborated and categorised by the high migration rates of young adults looking for better opportunities in other provinces (Makiwane & Chimere-Dan, 2010). The Eastern Cape has the highest unemployment rate (27.7 %) and poorest education system in the country (Makiwane & Chimere-Dan, 2010). The province's infrastructural capacity is poor and the majority of the workers receive low income (Makiwane & Chimere-Dan, 2010).

Makiwane & Chimere-Dan (2010) also note that the province is made up of many female-headed households. HIV prevalence in the province is high compared to other provinces. Deaths associated with AIDS by 2009 were approximated to be 41.9 % (Makiwane & Chimere-Dan, 2010).

2.2 General Overview of Study Sites

Three sites were selected for the study to provide an understanding of how *A. dealbata* is perceived and its uses by local communities. The three study sites were Matatiele area comprising Nkasela village ($S30^0$2071 $E28^0$766), Caba village($S30^0$38839 $E28^0$6779) and Outspan village ($S30^0$2404 $E28^0$8394) the approximate altitude of the area is 1 488 m (Figure 2.1). The second area was Mount Fletcher with Prinstu village ($S30^0$5873 $E28^0$3148) Fletcherville village ($S30^0$1237 $E28^0$4737) and HaQhadi village ($S30^0$6121 $E28^0$4627) altitude is approximately 1 400 m (Figure 2.2). The last was Maclear with Thsikitsha village ($S30^0$9255 $E28^0$56277) Katkop ($S30^0$8844 $E28^0$5116) and Chevy Chase ($S30^0$84263 $E28^0$51342) where elevation is approximately 1 549 (Figure 2.3). Matatiele is found in the foothills of Drakensberg mountains, on the border of the province of KwaZulu-Natal. It is situated 20 km from the southern frontier of Lesotho. The Fletcherville area is located 69 km from northeast of Maclear.

All these areas were chosen because of the substantial of invasion by *A. dealbata* near the villages and also tangible evidence of use of *A. dealbata* by local communities. The main economic activities in Matatiele include agriculture, trade and community services whilst, in Maclear and Fletcherville areas the main economic activities include social services, agriculture, wholesale and retail. Table 2.1 below shows the characteristics of the study area.

Table 2. 1. Characteristics of study sites

Attribute	Matatiele	Mt Fletcher	Maclear
District municipality	Alfred Nzo	Joe Gqabi	Joe Gqabi
Local municipality	Matatiele	Elundini	Elundini
Population size (people)	203 843	138 141	138 141
Average household number (people)	4.0	3.6	3.6
% Male	46.0	43.6	43.6
% Female	54.0	54.4	54.4
Dependent population:			
>65 years (%)	7.0	8.3	8.3
<15 years (%)	40.3	35.4	35.4
On social grants	41.3	38.8	38.8
Education levels			
No education (%)	9.4	21	21
Matric only	6.0	3	3
Employment			
Unemployed (%)	11.6	23.1	23.1
Employed (%)	26.6	13.25	13.25
Not economically active (%)	59.4	63.4	63.4
Water Access			
Clean Water (%)	49	46.9	46.9
Unclean water (%)	51	53.9	53.9
Electrified houses (%)	45	69	69
Annual rainfall range (mm)	550-1 000	600-800	600-800
Temperature range (^{0}C)	8-35	11-42	11-42

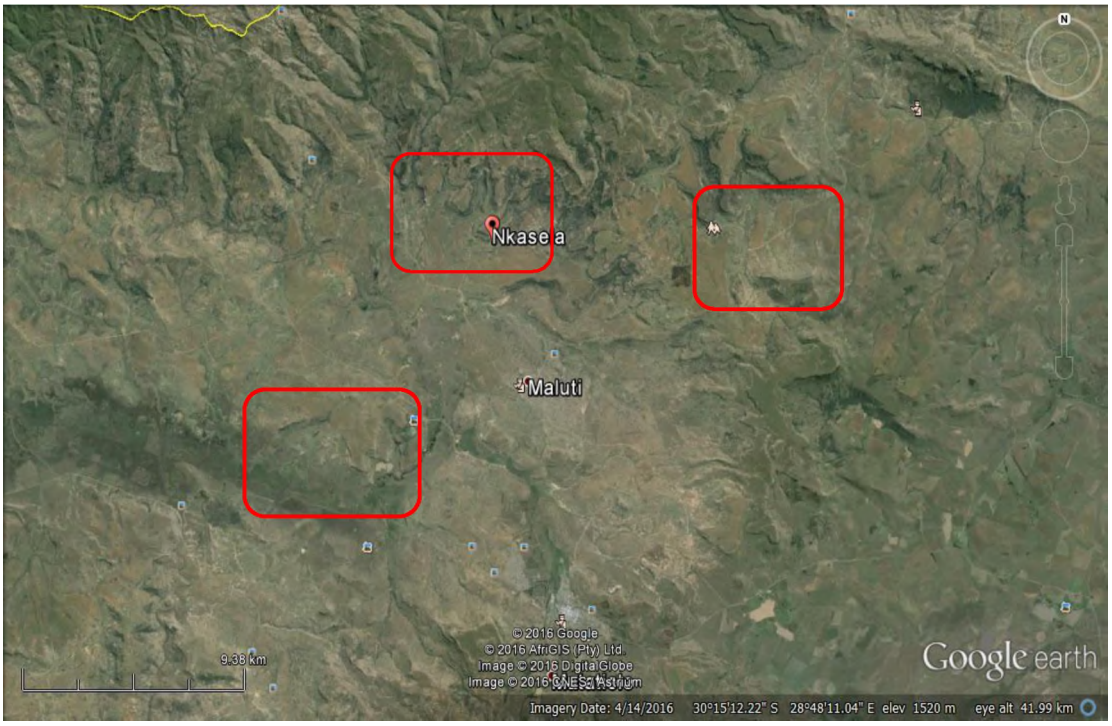


Figure 2.1. Matatiele study sites, rectangles show sampled areas

Figure 2.2. Mount Fletcher study sites

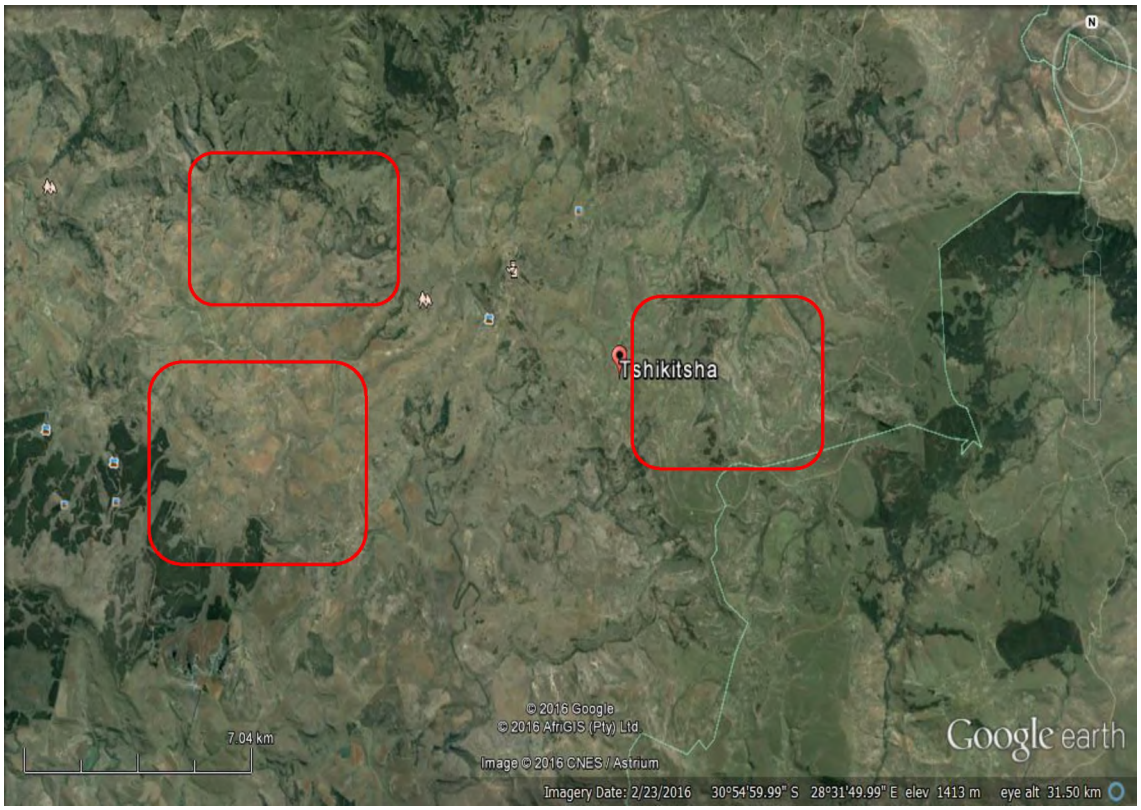


Figure 2.3. Maclear study sites

2.3 Methods

The research approach of household surveys, focus group discussions and key informant interviews were used. The data from the different approaches complemented each other as a means of triangulation.

Research was be done in accordance to Rhodes University and Ethical Standards guidelines and commenced only after it has been approved by the relevant ethics committee. Prior to commencement the research and its objectives were introduced to the local traditional leaders and ward councillors to provide a detailed insights to the purpose of the study. After getting permission from the relevant authorities, individuals were approached for their participation. Participation in all the activities was completely voluntary and confidentiality and anonymity of participants was assured. All interviews were done in the local languages with the help of an interpreter.

The conceptual frameworks used in this study incorporate different factors which interact across a complex social-ecological system and therefore, a combination of approaches and methods were used to provide a better understanding of livelihood uses and perceptions of *A.*

dealbata. Use of multiple methods and a transdisciplinary approach is gaining recognition in sustainability science research due to the intricacy of the studies (Hirsh Hadorn *et al.*, 2006). There are increased requirements of fusing results acquired from combining qualitative and quantitative methods (Sharp, 2007). Sharp (2007) argues that incorporation of information acquired from participatory methods is extremely important as it elaborates areas which require further research.

2.4 Focus Group Discussions

Focus group discussions involve formally constituted, well-organised groups of people to interactively discuss a specific issue (Hennink, 2013). The main aim of focus group discussions is to provide a range of views on a specific issue for a period of time normally 60-90 minutes and to create a comfortable platform for them to discuss an issue (Hennink, 2013). Participatory Learning Action (PLA) techniques were employed during focus group discussions to examine peoples' livelihoods, particularly with respect to their perceptions on and livelihood use of *A. dealbata*. Participatory methods are highly qualitative, visual and tangible (Chambers, 2007). PLA changed the role of the researcher into that of a facilitator and takes cognisance of local knowledge and capacity (Chambers, 2007). Focus groups were done before household interviews to provide a baseline understanding of the study. Focus groups were also done as a communication tool for the purpose of the study and provided a platform for research to be investigated and outlined before household surveys commenced. Focus group discussions looked at the vulnerability context of the communities. Focus groups added triangulation to findings from interviews and to get a perspective from the community about their responses towards *A. dealbata* invasions and their livelihoods. The focus group discussions were used because of their capacity of expounding differentiating thoughts and improve in-depth discussions of the thoughts which have been presented (Newing, 2010).

Different PLA techniques were employed to provide insight of contextual data which would not be revealed from household surveys such as timeline trends, seasonal calendars and density preferences. A village representative accompanied the researcher to the village head to ask for permission and assistance in conveying the focus group discussions. One focus group discussion was done per site, involving eight to twelve people of both genders. All participants were first gathered for general introductions and were informed about the purpose of the study. Each focus group took approximately 60-90 minutes. The focus group discussions focused on:

- Attitude of the community to *A. dealbata* invasion on grazing lands and sacred areas.
- Community uses of *A. dealbata.*
- High abundance of *A. dealbata* which may provide cover for criminals.
- Presence of *A. dealbata* near local community water sources.

- **Participatory mapping**

A participatory exercise was done to determine each group's preferred density of *A. dealbata.* Firstly, participatory mapping was done, in which the researcher, with the help of villagers and aerial photos, drew a demarcated map of the areas. Participatory mapping entails combining information pertaining natural resources, sites of significance of a geographical area and put it on a map with the help of local people (Newing, 2010). Herlihy & Knapp (2003) state that participatory mapping recognises the cognitive knowledge of the local people about their local environment and the transformation of the knowledge into modes understandable to both communities and other agencies.

The participants were provided with four pictures depicting various Silver Wattle densities. The pictures consisted of densities from the highest density to the lowest of Silver Wattle. The congregants were asked to pick their preferred densities in each distinctive landscape such as homesteads, fields, grazing areas and travel routes as identified from the participatory mapping. In this exercise two different groups were separated according to gender so at to get the preferred densities according to each gender.

During this process the current density levels of Silver Wattle within the communities. To rank the density levels of Silver Wattle, pictures of Silver Wattle abundance were taken at each site. They were categorised into the following classes, high abundance, medium and low abundance depending on the intensity of the abundance.

- **Seasonal calendar**

The participants were asked to construct a seasonal calendar, which consisted of the main activities they carry out during the year and the problems encountered and opportunities experienced throughout the whole year. The seasonal calendar was used to show livelihood strategies, when they were vulnerable and try to rank the communities use and frequency use of *A. dealbata.*

- **Historical timeline trend**

A time trend, change assessment was done. These provided chronologies of events and provided major dates as recollected by the community (Chambers, 2007) in respect to the use of Silver Wattle. Historical timelines are useful tool for analysing vulnerability. The participants pointed out important past events which made them vulnerable and identified the effects of *A. dealbata* invasions in terms of whether it increased or reduced vulnerability. This PLA emphasised inclusion of elderly people so they could reflect back in time over at least two generations. This exercise determined thresholds in use of *A. dealbata* and the drivers of the thresholds.

- **Transect walks**

In each site, one transect walk was done per site comprising of five to ten elderly members from the community. During the transect walks direct observations, listening, questioning and learning about *A. dealbata* were done. Transect walks focused mainly on the following:

- Main land use in the area and specific locations.
- Main concerns regarding Silver Wattle presence in the area.
- Who owns Silver Wattle within the community?
- Conflicts regarding Silver Wattle on a community level.
- Laws which affected access to Silver Wattle in different places.

2.5 Household Surveys

Individual households (50 in each study site) were randomly selected for interviews using GIS (ArcView 4). The latest high-resolution aerial maps of the study areas available were digitised and polygons were used to mark the boundaries of the study areas. The boundary was approximated to the nearest 100 m for the edge of the closest houses to incorporate houses that might have been built after the photographs were taken. All the grids marked in the study areas which did not have households were unmarked. When a household that was selected did not wish to be part of the research or was absent, the nearest available neighbouring household to the right was selected. The pictures were downloaded and were printed in colour, and taken to the field to help in identification. The GPS co-ordinates were also taken and used in the field.

Household interviews were carried out to assess the perceptions and livelihood uses of *A. dealbata* at individual household level. In this study a household was defined as comprising of a person or group of people who are tied by kinship and stay together under a single roof or within a single compound and are accountable to one house head and share a common source of food. The household head was interviewed if available; if absent the most senior member of the household was interviewed. Household interviews lasted between 45-60 minutes. All interviews were done using the local home language which is *isiXhosa* and *IsiSotho* a few times in Matatiele. Household interviews focused on (see appendix 1):

- Use of *A. dealbata*, purpose and frequency of use.
- Attitude of the household towards the presence of *A. dealbata* in particular landscapes.
- Availability of alternative species.
- Sale *A. dealbata* products and what they do with the money they acquire from selling the products.
- Quantities of Silver Wattle which they collect per use. Quantities were used to calculate the resource value as [Resource value = Quantity * Price].
- Identification of coping strategies to shocks and if they have experienced any in the last two years. Households provided their coping strategies and how *A. dealbata* use may be a coping strategy.

Bearing in mind that this project involved a conflict of interest, there were fears that some households may exaggerate their usage of Silver Wattle as means to increase support if it is removed. A process was carried out in which the researcher frequently visited the households to assess the real uses and frequencies of the uses and if the household was willing travel with the researcher to their collection areas.

2.6 Key Informant Interviews

The methods mentioned above were complemented by key informant interviews. Key informants were engaged to acquire more detailed information about the community and invasions by *A. dealbata* for triangulation. The key informants interviewed included: the Department of Environmental Affairs provided information on the state and history of plantation forestry, community forestry in the woodlots and control strategies of IAS. Working for Water programme staff gave information on the programme in the area and its review up to the current situation. Local municipality officials gave information of their integrated

development plans (IDP) and any plans to control IAS. Major stakeholders such as consultancies which had been provided tenders to control IAS were also interviewed. They gave more information on their action plans and areas they had cleared. Village heads provided general background information regarding the rural communities such as the village numbers and history of invasion by *A. dealbata*.

2.7 Data Analysis

The data that were saved in Microsoft Excel where it was organised prior to being imported to Statistica for analysis. Household attributes, number of people including number of individuals employed, number of individuals accepting social grants and number of domesticated animals per specific family were collected. Every household attribute was standardised by dividing it with the highest number of that particular attribute. Households were ranked and put in wealth quartiles. This was done after the standardised household attributes were all compiled together and added, the households were ranked according to who had the highest value of the standardised attributes. This criteria was based what the communities views in respect to what constitutes a wealthy family.

The data were disaggregated according to site and wealth levels. Frequency counts, means of percentages and tables were used to elaborate the frequency of proportions. Pearson's Chi-Squared test was done to analyse any significant associations amongst categorical variables. A p value of less than 0.05 was regarded as significant. To test significant difference between means amongst the three sites for continuous variables one way ANOVA was employed as the data was normally distributed. Principal Component Analysis (PCA) was carried out to determine factors which influence perceptions towards *A. dealbata* invasion. However, there was little variation with the main axis having a factor of 13. 5 % which is too small to provide insight on the relationships.

CHAPTER THREE: RESULTS

3.1 Perceptions of Invasion

Every respondent recognised Silver Wattle by sight and stated that they knew Silver Wattle, referring to it by the local names *Dywabasi* in i*siXhosa* or it was *Skamore* in *isiSotho*. No one had any literal interpretation or meaning for these local names. All respondents perceived Silver Wattle to have been there before they were born. As expressed by one respondent "*I was conceived while it was there and I will die to leave it here*". One of the oldest respondents in Matatiele, who was 79 years old, mentioned that his grandfather had been responsible for planting Silver Wattle in the region. During focus group discussions and transect walks it was revealed that the communities did not know that Silver Wattle is alien, with most expressing surprise when the researcher mentioned that it is originally from Australia.

Eighty-eight percent of the respondents in Matatiele, 94 % in Mount Fletcher and 96 % in Maclear stated that they have noted a change in the abundance of the Silver Wattle in their communities in the past ten years. Of the respondents who noted a change nearly all, 88 % in Matatiele, 90 % in Mount Fletcher and 98 % in Maclear, stated that Silver Wattle was increasing in their community while a few stated that it was decreasing, no one mentioned that it had remained unchanged. Those who stated that it has increased, attributed the increase to production of many seeds which were easily dispersed by water and the wind. They also mentioned that the increase may be due to fertile soils in the area and good rainfall. Respondents at the focus group discussions during the historical timeline trends noted that the introduction of electricity may also have resulted in an increase of Silver Wattle due to a reduction in it being used for firewood. The majority of respondents observed that currently Silver Wattle no longer grows to large sizes as was in the case in previous decades. They felt that there are no longer many alternatives as before which allowed Silver Wattle to grow in size as villagers had a larger pool to select from. Rocky and hilly locations and near water sources were identified as the areas Silver Wattle favours the most. It was also noted that the streambanks of the Tina river in the Fletcherville village had a high abundance of Silver Wattle.

Those respondents who noted that it was decreasing, especially in Chevy Chase near Maclear, ascribed it to a contractor who had been given authorisation to cut it. The contractor produces charcoal which he sells at the local timber company, PG Bison. A portion of the money is given to the community and for employment of the local people.

Information obtained from key informants such as Environmental Rural Solutions (ERS) in Matatiele and Working for Water in Ugie showed they had plans to remove Silver Wattle. ERS had successfully cleared Silver Wattle in one ward in Matatiele and were using cattle to rehabilitate the area so that they can revert the area to grasslands. Working for Water had cleared small areas near Maclear, and to provide the people with substitute resources they had plans to plant peach trees as replacements. However, this plan was still in its infancy. A community meeting that was attended by the researcher in Matatiele where a consultancy company was proposing to clear Silver Wattle to supply PG Bison with charcoal was met with resistance. Although, the consultancy proposed to provide the local people with employment, the people were sceptical of allowing it to happen as they wanted Silver Wattle because it provided them with resources. By the time the researcher left the area no agreement had been reached.

Transect walks revealed that Silver Wattle belonged to the whole community with the Chief being in control of the trees. During the household surveys, a few respondents refused to talk to the researcher as they stated that all jurisdiction pertaining Silver Wattle belonged to the Chief. Transect walks revealed that there were conflicts pertaining to Silver Wattle in the Matatiele, Mount Fletcher and Maclear communities. Some villagers, especially those for who Silver Wattle was in close proximity to their households, wanted it gone, yet others wanted it maintained. So heated were the debates in Bethel village in Matatiele and Chevy Chase village in Maclear that meetings were convened by the community leaders to discuss issues regarding the species. Both meetings were attended by the researcher and tempers rose as community members confronted each other due to mixed feelings regarding Silver Wattle.

3.2 Uses of Silver Wattle

Respondents were asked about their uses of Silver Wattle. The respondents across all three sites showed that Silver Wattle has many different uses, including firewood, fencing, tools, medicines and fodder (Fig. 3.1).

All respondents within the three sites use Silver Wattle for firewood. There is a slight difference in number of respondents who use it for fodder purposes. Respondents in Maclear use Silver Wattle for fencing purposes and to carve tools more than those in Matatiele and Mount Fletcher.

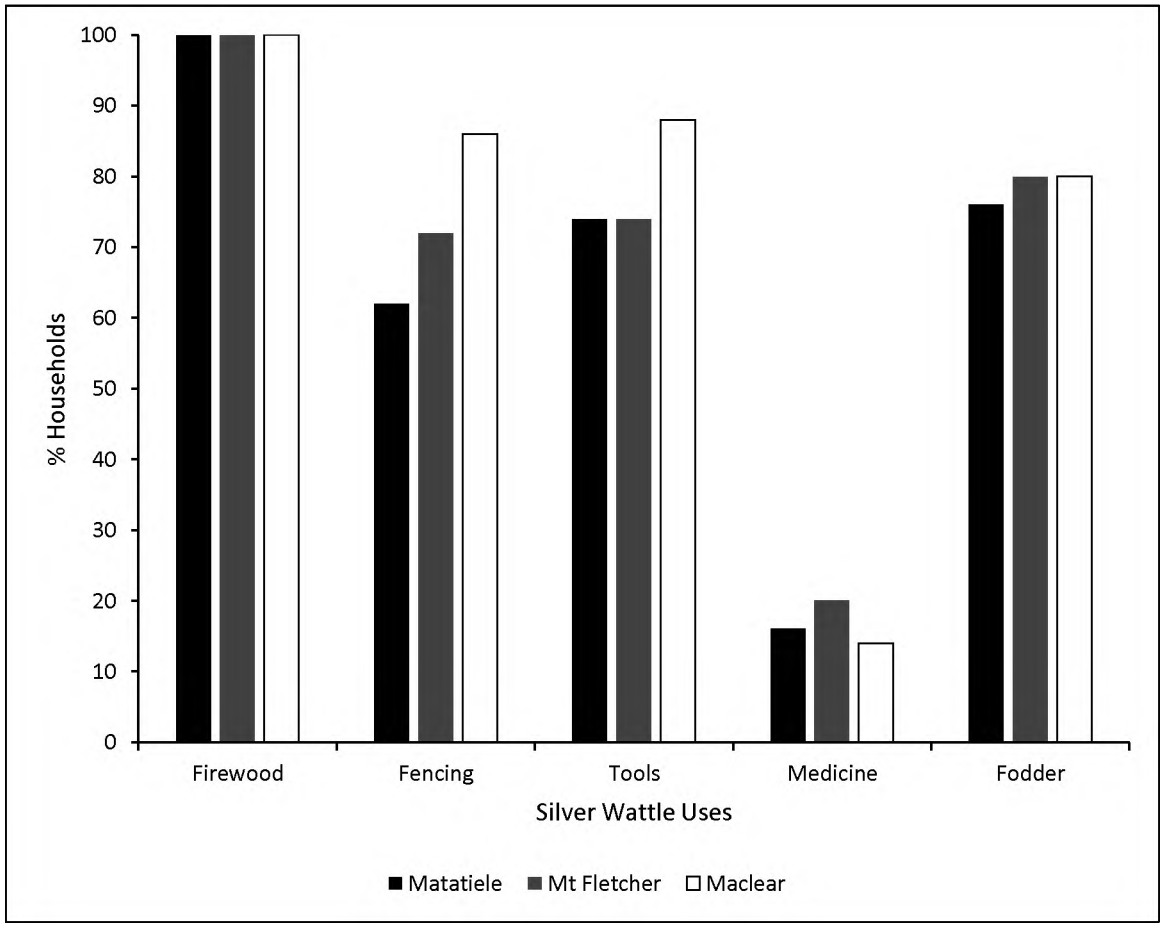


Figure 3.1. Proportion of households which use Silver Wattle for different purposes

3.2.1 Uses of Silver Wattle and Household Wealth

Socio-economic status of the respondents within the community can influence use of resources such as Silver Wattle as a livelihood strategy. Respondents with higher incomes may use it less as they can afford other options, unlike economically marginalised households (Figure 3.2). However, all respondents across wealth quartiles use Silver Wattle for firewood. However, more respondents in the low-income quartile use Silver Wattle for fencing and carving tools than those in the highest income quartile. Fewer respondents in the low income quartile use Silver Wattle for fodder purposes as they may not have the livestock to feed. Livestock was regarded as a key asset which was in determining wealth status. However, none of the differences across wealth quartiles were significantly different (Table 3.1).

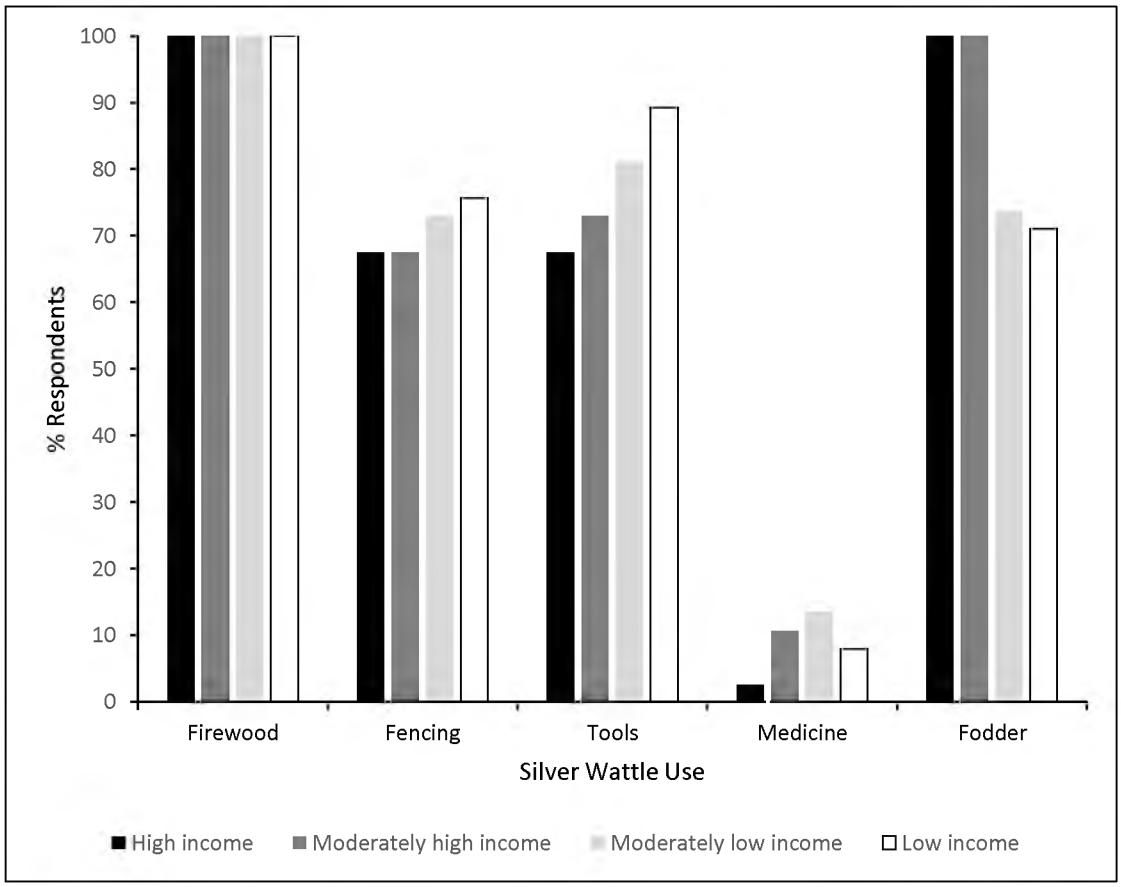


Figure 3.2. Relative uses of Silver of Silver Wattle by income quartile

Table 3.1. Significance testing of uses of Silver Wattle by wealth class

Use	χ^2 value	Degree of freedom	Significance (P)
Firewood	4.00	3	> 0.05
Fencing	5.00	3	> 0.05
Tools	5.50	3	> 0.05
Medicinal purposes	6.00	3	> 0.05
Fodder	5.75	3	> 0.05

3.3 Firewood

Every household that was interviewed stated that they use Silver Wattle for firewood. Silver Wattle use for firewood is independent of site ($\chi^2 = 3.00$, df = 2, $p > 0.05$). The majority of respondents collected Silver Wattle, with a small percentage buying it (Table 3.2). There was

little difference in the mode of procurement among the three sites. The high percentage collecting Silver Wattle indicates high local abundance and distribution, allowing easy access for nearly all households.

Table 3.2. Methods used to procure Silver Wattle firewood

Site	Collect (%)	Buy (%)	Both (%)
Matatiele	94	4	2
Mount Fletcher	92	8	0
Maclear	90	6	4
Mean	92	6	2

Of the respondents who collected Silver Wattle firewood they had varied frequencies of collection (Figure 3.3). To underscore Silver Wattle importance for firewood, many respondents collected it daily, or several times a week.

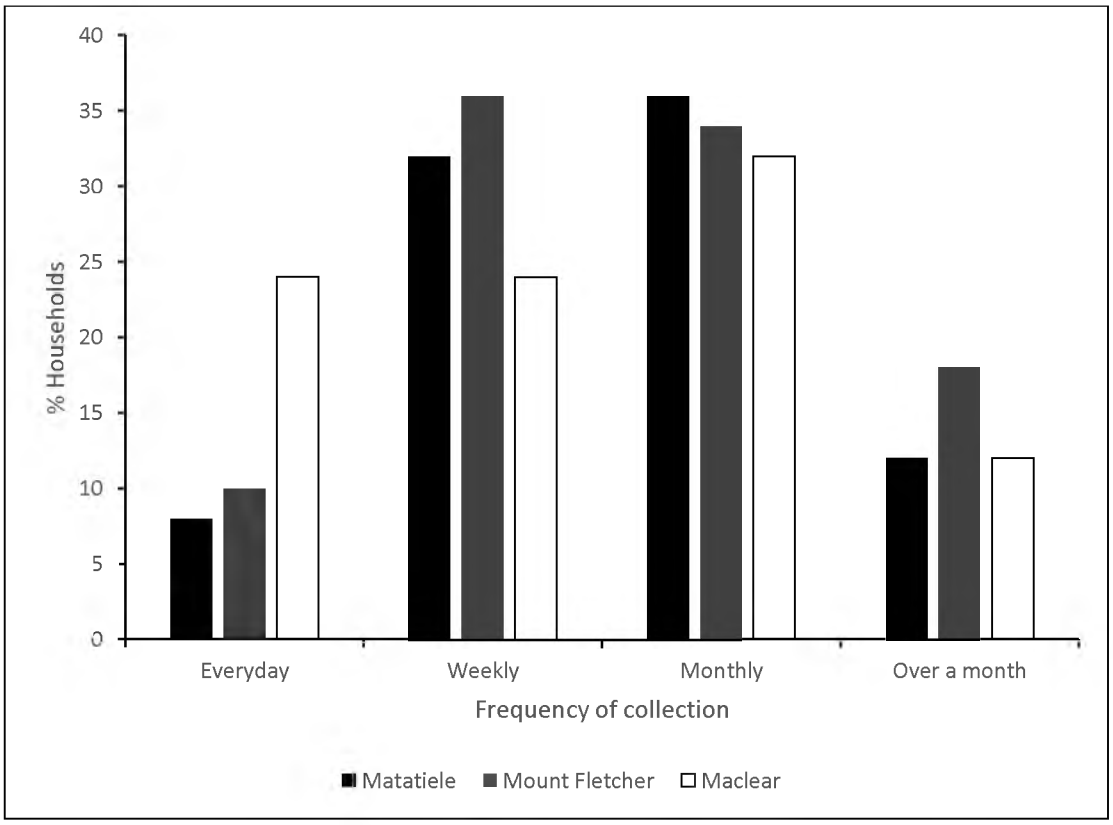


Figure 3.3. Frequencies of collection of Silver Wattle for firewood

Respondents in Maclear collected Silver Wattle for firewood more frequently (daily) than in Matatiele and Mount Fletcher. A village in Maclear, Chevy Chase, did not have electricity and so households relied on Silver Wattle more for energy purposes. Respondents who collected Silver Wattle on a daily or weekly basis, did so via means of headloads, which did not last long. Those who collected less often, especially on a monthly basis, used their cattle to transport the large amounts which would last longer (Figure 3.4).

Figure 3.4. Bundle of Silver Wattle for firewood (Photo by Charlie Shackleton)

Forty-six percent of the respondents in Matatiele, 32 % in Mount Fletcher and 48 % in Maclear noted that they increased their collection of Silver Wattle firewood during the cooler winter period and during important occasions such as celebrations and funerals. Prices varied according to quantities purchased. A headload cost ZAR 20 and the biggest unit bought which was a truck load, in Matatiele cost ZAR 800 and this was bought for a funeral. Respondents buy the firewood from fellow villagers except in Fletcherville village, where a farmer who resides in nearby Citervalle area often visits them with his own vehicle and sells.

Most respondents (85 % in Matatiele, 87 % in Mount Fletcher and 90 % in Maclear) stated that Silver Wattle was their primary energy source. The remaining households used Silver Wattle as their secondary energy source. They noted that Silver Wattle produced excellent firewood, with fine charcoal and usually smokeless fires which was better than some of the alternatives. A relatively high amount of Silver Wattle for firewood is used per annum. Consequently, a considerable resource value accrued for firewood purposes each month (Table 3.3).

Table 3.3. Average quantity and resource value (± S.E) for Silver Wattle use for firewood per annum per household (Excluding rituals and celebrations)

Site	Average Quantity (kg)	Value (ZAR)
Matatiele	1 840 ± 138	2 300 ± 136
Mount Fletcher	1 735 ± 105	2 284 ± 108
Maclear	1 700 ± 98	2 154 ± 98
Mean	1 758 ± 114	2 246 ± 114

There was no significant difference in the quantity of firewood used across the three sites ($F = 0.98$, $p = 0.378$). Consequently, there was little difference in the resource value per site. Silver Wattle was also used for firewood purposes during cultural activities such as ritual celebrations where it was used to cook food which people would eat during these cultural activities. They also noted that they use it to warm themselves during those rituals, mostly those occurring overnight. Resource use value per year, on each site is significantly higher in areas where the abundance of Silver Wattle is high ($F=162.\ 20$, $p<0.05$). With more abundance there is more interaction with species and less time required to travel to procure Silver Wattle (Figure 3.5).

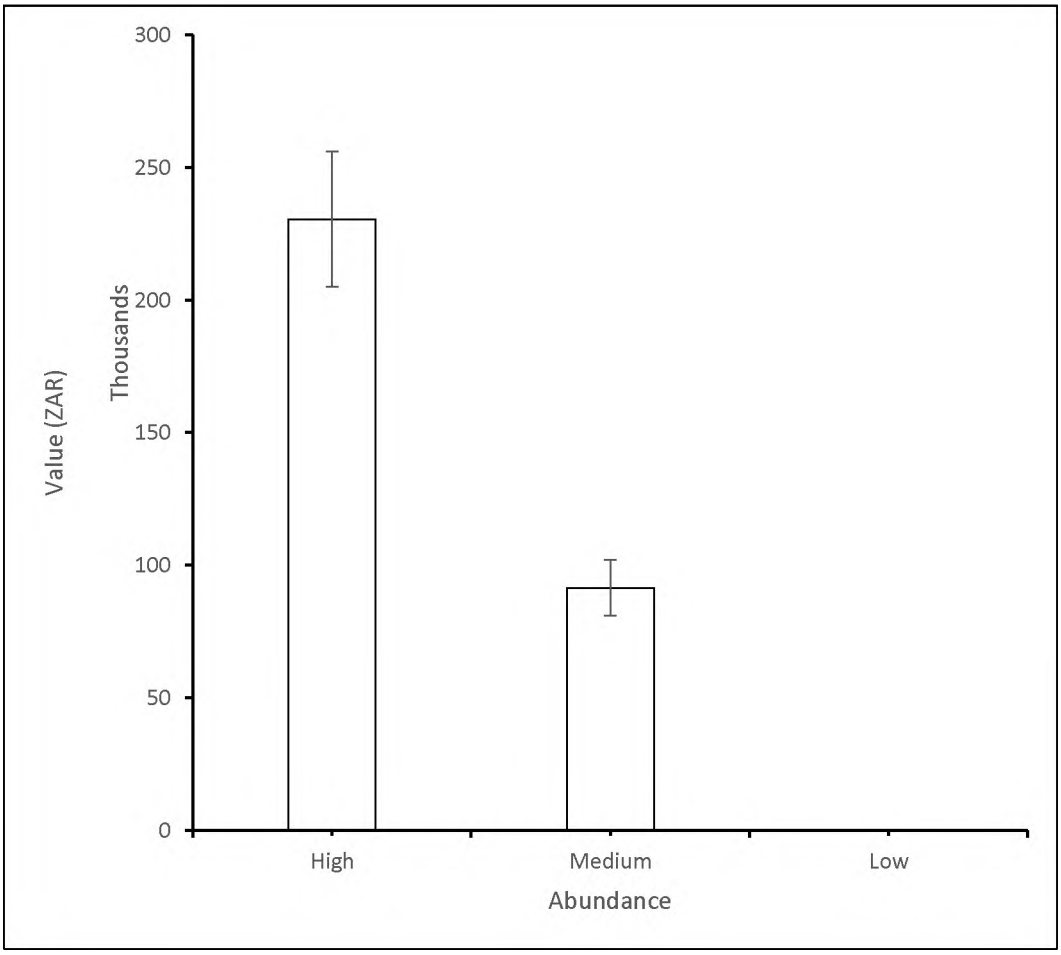


Figure 3.5. Silver Wattle firewood resource value according to abundance

3.3.1 Firewood Collection Frequency According to Wealth

Respondents in the low-income quartile and moderately low-income quartile collect Silver Wattle for firewood significantly more frequently (every day and weekly) than the moderately high-income and high-income respondents ($\chi^2 = 6.35$, df = 3 $p < 0.05$). Consequently, a higher proportion of the higher-income respondents had last collected Silver Wattle for firewood a longer period ago than the low-income respondents. Higher frequency of use of Silver Wattle firewood by the low-income quartile shows that they may not have other alternatives as compared to the high-income quartile (Fig. 3.6). Also that they collect their own rather than buy. All respondents, who bought Silver Wattle, 4 % in Matatiele, 8 % in Mount Fletcher and 6 % in Maclear belonged to the high-income quartile.

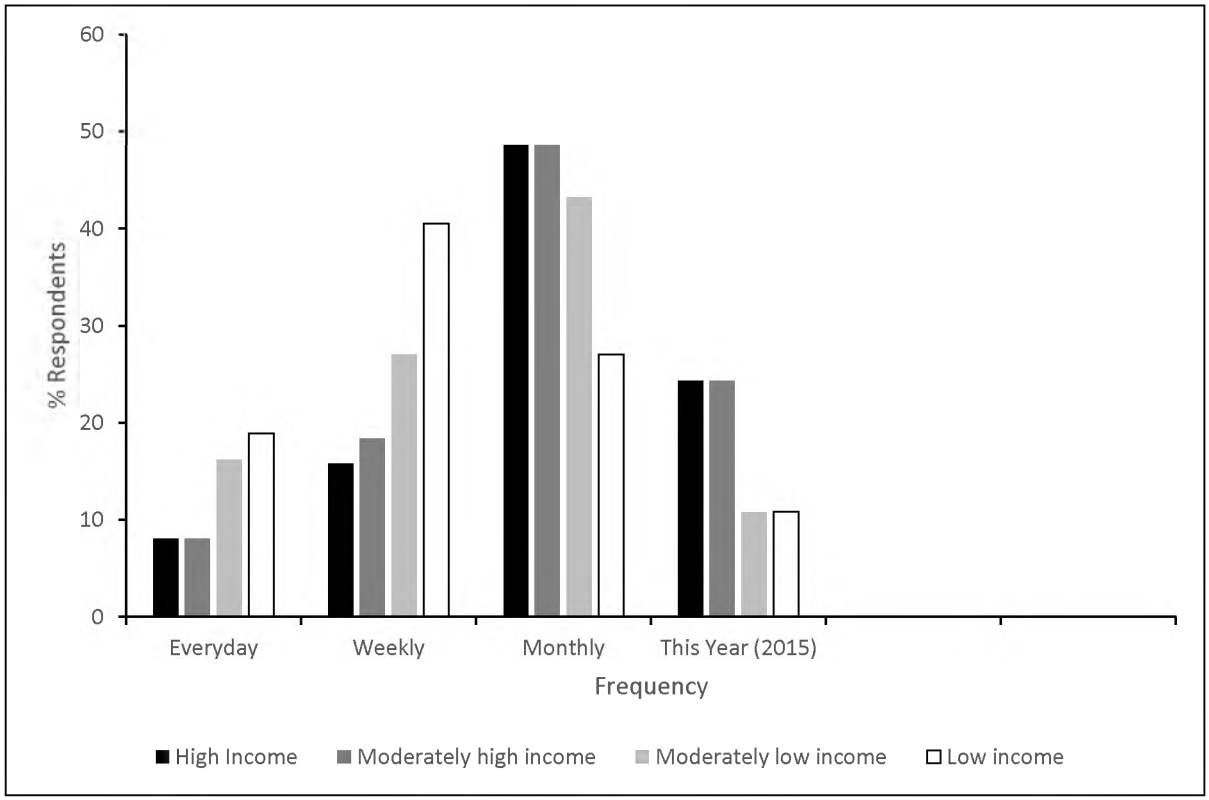


Figure 3.6. Frequency of firewood collection by wealth class

However, despite a higher frequency in collection by the low-income quartile they used approximately the same amount or slightly less Silver Wattle for firewood than the richer respondents (Table 3.4) ($F=1.36$, $p=0.26$). A higher number of richer respondents own cattle to collect in higher quantities than head bundles used mostly by the poorer respondents. The marginally higher quantity collected by richer respondents resulted in a marginally higher resource value of Silver Wattle firewood when compared to poorer respondents even though the difference is not significant.

Table 3.4. Quantities of Silver Wattle firewood (± S.E) collected per year and income levels per household

Wealth Quartile	Quantity (kg)	Value
High	1 741 ± 124	2 288 ± 134
Moderately high	1 817 ± 98	2 414 ± 85
Moderately poor	1 726 ± 112	2 248 ± 116
Poor	1 564 ± 97	2 100 ± 98
Mean	1 658 ± 114	2 246 ± 114

3.3.2 Alternatives for Silver Wattle Firewood

The majority of the respondents (94 % in Matatiele, 98 % in Mount Fletcher and 98 % in Maclear) stated that they used alternatives for firewood acquired from Silver Wattle while the remaining stated that they did not have any alternative energy source. Respondents within each site use a several of firewood alternatives (Figure 3.7).

Alternatives which are used for energy purposes included electricity, paraffin and gas. These are bought from the surrounding towns. Some respondents also collect cow dung which they use fuel for cooking and warming themselves. The tree species which are used as alternatives included *Eucalyptus* and *Populus canescens* both of which are alien and invasive species invading riverine landscapes.

The highest number of respondents stated that they use electricity as most of the houses are electrified and paraffin or gas as a substitute when they are not using Silver Wattle for firewood. A considerable proportion of respondents especially who owned livestock used cow dung for energy purposes. A few who did not own livestock stated that they travel to pasture lands to collect cow dung.

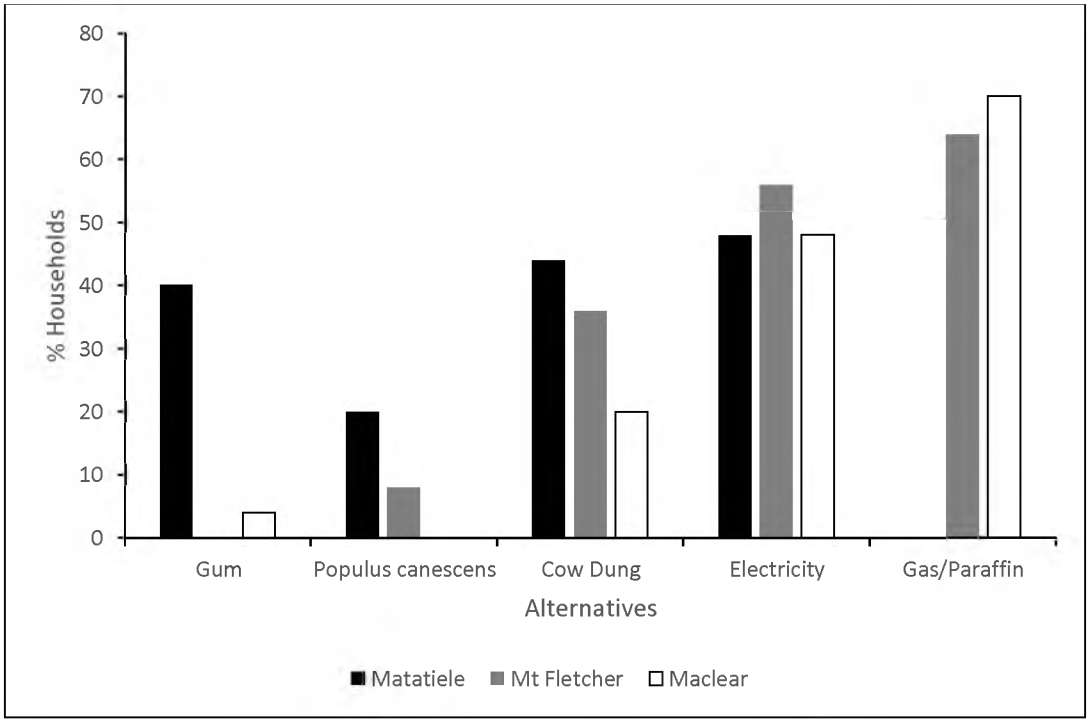


Figure 3.7. Alternatives for firewood acquired from Silver Wattle per site

When asked which one they preferred as an energy source, Silver Wattle or alternative energy source, the majority of the respondents preferred firewood from Silver Wattle as the energy source (Table 3.5). The majority of respondents who preferred Silver Wattle firewood to other energy sources stated that Silver Wattle produced good firewood with excellent charcoal and was easier to use compared to other energy sources. When compared to cow dung respondents stated that it produced less smoke and that it lasts longer. They also stated that Silver Wattle is easily accessible as it was close to their homesteads and that there was no need to spend money when compared to other energy sources such as electricity, paraffin or gas. Therefore, the money they would have spent on electricity or paraffin and gas could be channeled to other livelihood activities.

Table 3.5. Relative preference for energy source per site (%)

Site	Silver Wattle	Alternative	Don't know
Matatiele	94	2	6
Mount Fletcher	90	10	0
Maclear	84	14	2
Mean	89	9	3

Younger generation and elderly women were the ones who mainly preferred electricity and gas or paraffin. Younger generation women preferred electricity because they felt that it was easier to use, whilst the elderly noted that they had difficulties walking to collect Silver Wattle firewood. The importance of Silver Wattle and natural resources for the livelihoods of the people was highlighted during the focus group discussions and transect walks in Matatiele and Fletcherville where the locals asked what the government intended to plant if it controlled Silver Wattle, one would provide them with the same resources.

3.4 Fencing

Silver Wattle is used for fencing purposes (Fig. 3.1). Respondents in Maclear used Silver Wattle more than other villagers at other sites though not significantly ($\chi^2 = 6.00$, df = 2, $p > 0.05$). Respondents used different methods to procure Silver Wattle for fencing purposes, with most collecting it for fencing (Table 3.6).

Table 3.6. Procurement of Silver Wattle for fencing per site and users (%)

Site	Collect	Buy	Both
Matatiele	88	8	4
Mount Fletcher	90	7	3
Maclear	93	6	2
Mean	90	7	3

To access poles for fencing all respondents stated that they have to seek permission from the headman because they would be harvesting large trees. There were no specific frequencies for the collection of poles for fencing, respondents stated they collected mainly to repair any rotten poles. Hence, the researcher had to ask when they had last collected. Frequency of collection of Silver Wattle for fencing differed with site (Figure 3.8).

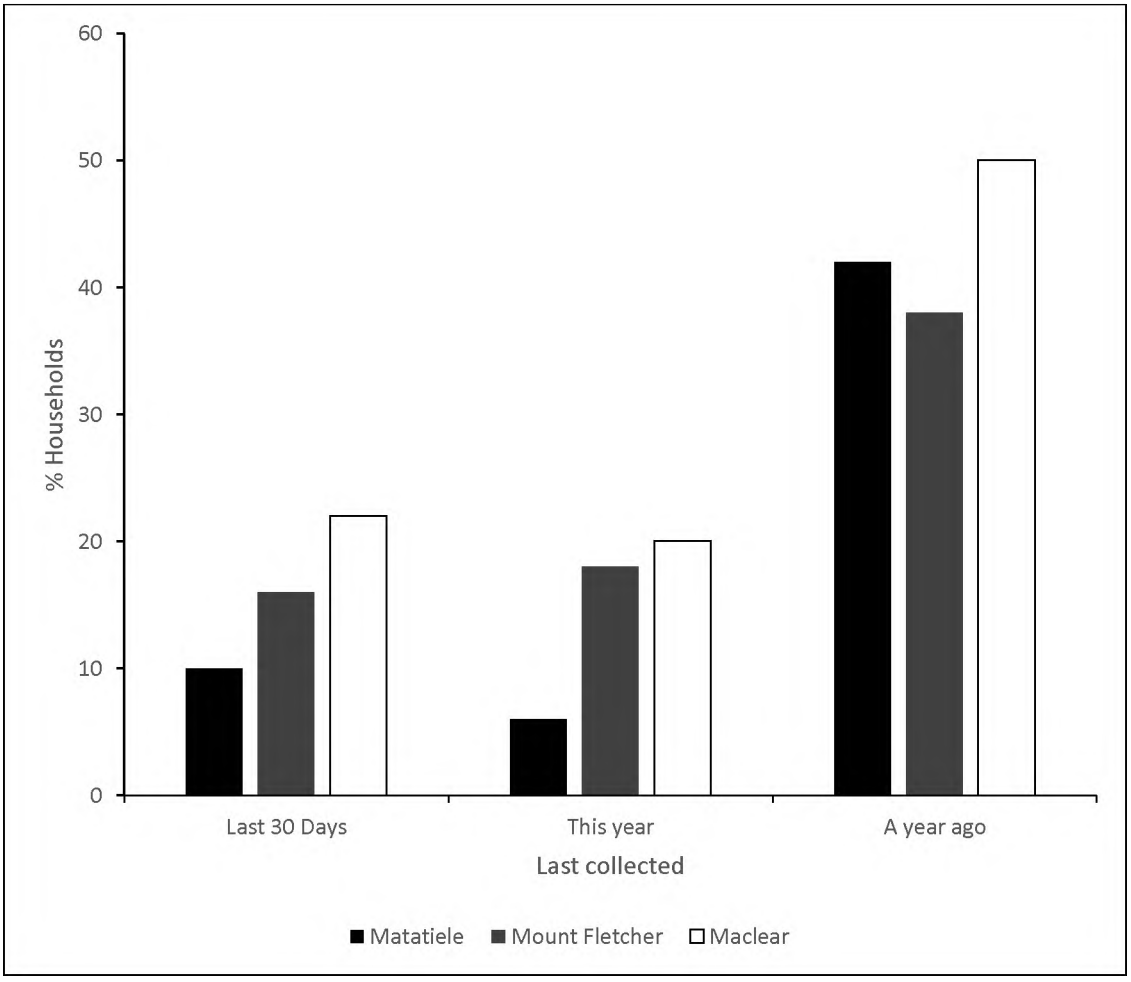


Figure 3.8. Period when Silver Wattle was last collected for fencing

Most respondents had last collected Silver Wattle for fencing more than a year previously. However, most respondents expressed that Silver Wattle poles rot quickly which meant that they had to replace them frequently. This resulted in households preferring to buy treated poles at surrounding towns. People who bought Silver Wattle for fencing bought each pole for ZAR 10 from fellow villagers. Despite not having a specific frequency of Silver Wattle collection for fencing, respondents approximated the number of poles they used per annum which was used to translate into resource value (Table 3.7). Respondents in Maclear used more poles for fencing than those in the other two sites though not significantly ($F=1.33$, $p = 0.16$).

Table 3.7. Resource valuation (± S.E) for Silver Wattle fencing use per annum per household

Site	Average number of poles	Value (ZAR)
Matatiele	40 ± 5	403 ± 54
Mount Fletcher	51 ± 5	516 ± 49
Maclear	65 ± 4	655 ± 37
Mean	52 ± 5	525 ± 47

Silver Wattle resource value for fencing is also higher in areas with higher abundance of Silver Wattle (Figure 3.9). There is significant difference in the resource value with difference in abundance ($F=145$, $p<0.05$). Resource value is per year, on each study site.

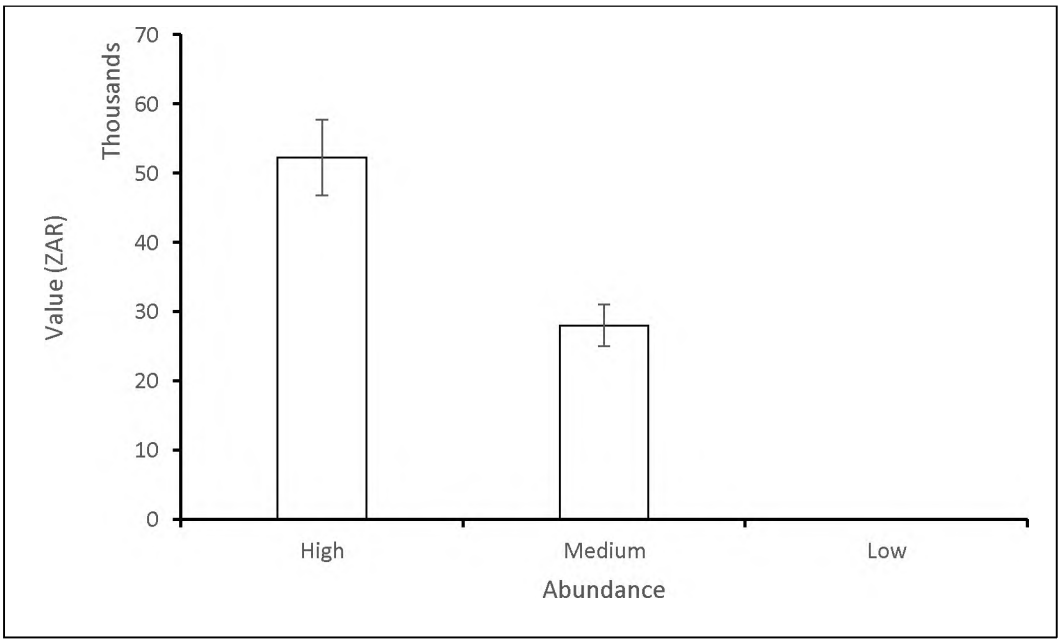


Figure 3.9. Silver Wattle fencing resource value and abundance

3.4.1 Frequency of Silver Wattle Use for Fencing According to Wealth Classes

Silver Wattle is used for fencing by respondents in all wealth quartiles within the community, although not significantly different (χ^2 = 4.00, d.f = 3, p > 0.05). Therefore, to get a deeper detail of the importance of Silver Wattle for fencing purposes according to wealth, respondents in each quartile were asked when they had last collected for fencing (Figure 3.10).

Most of the respondents in all the wealth quartiles had last collected Silver Wattle for fencing more than a year previously. Slightly more respondents within the low-income and moderately low-income quartiles had collected Silver Wattle in the year of 2015 than the high-income quartiles (χ^2=6.00, d.f = 3, p > 0.05). There was no significant difference in approximated quantity of Silver Wattle used for fencing among the income quartiles (F = 0.175, p = 0.913). Likewise, almost the same resource value for fencing was used was not significant between wealth quartiles by all incomes (Table 3.8).

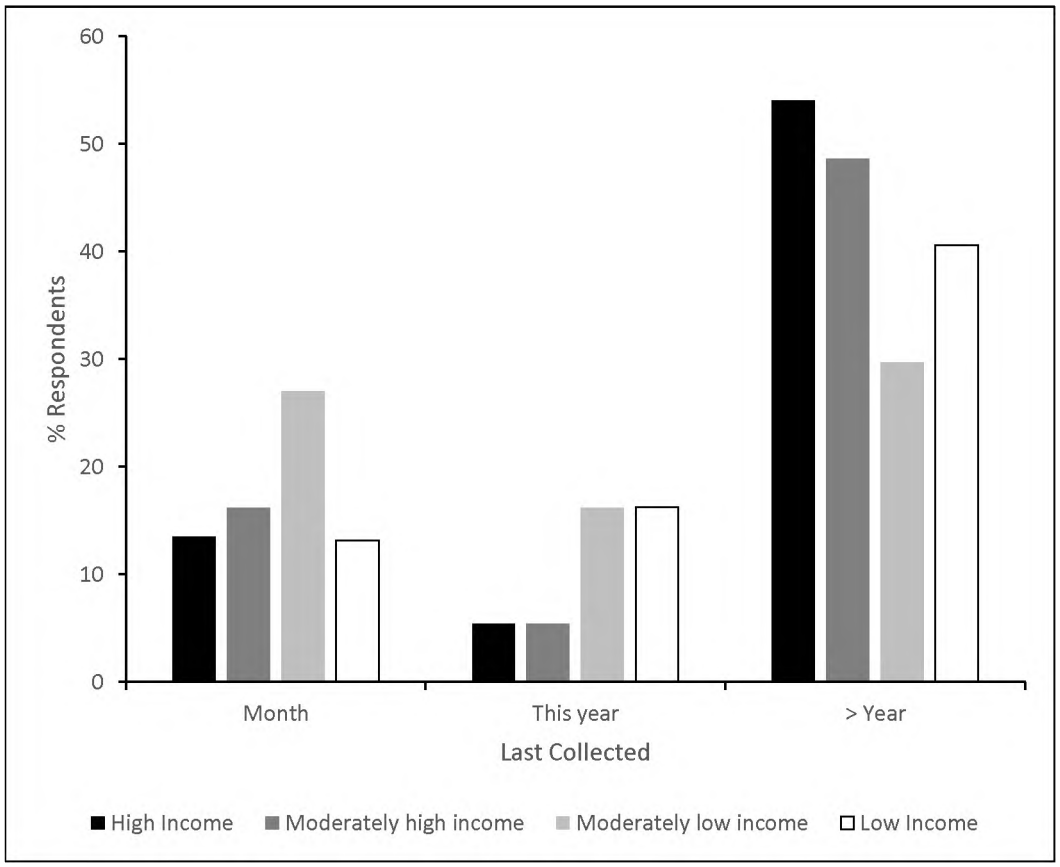


Figure 3.10. Last collection of Silver Wattle for fencing according to wealth quartiles

Table 3.8. Resource value (± S.E) for Silver Wattle fencing per annum and income quartiles

Income	Number of poles	Resource value (ZAR)
High	59 ± 4	590 ± 43
Moderately high	52 ± 4	520 ± 41
Moderately poor	51 ± 4	510 ± 41
Poor	53 ± 4	530 ± 44
Mean	52 ± 4	525 ± 43

3.4.2 Alternatives for Silver Wattle Fencing

Of the respondents who use Silver Wattle for fencing, 77 % in Matatiele, 86 % in Mount Fletcher and 70 % in Maclear stated that they used alternatives at times, while the remainder stated that they rely only on Silver Wattle for fencing. The data show that treated poles were the most used alternative to Silver Wattle poles for fencing (Figure 3.11). The poles are bought from the surrounding towns for ZAR 67 per 2.1 m pole at the hardware shops. Therefore, to rank which one is an important fencing source according to local communities they were asked to state which one was their preferred fencing source (Figure 3.12).

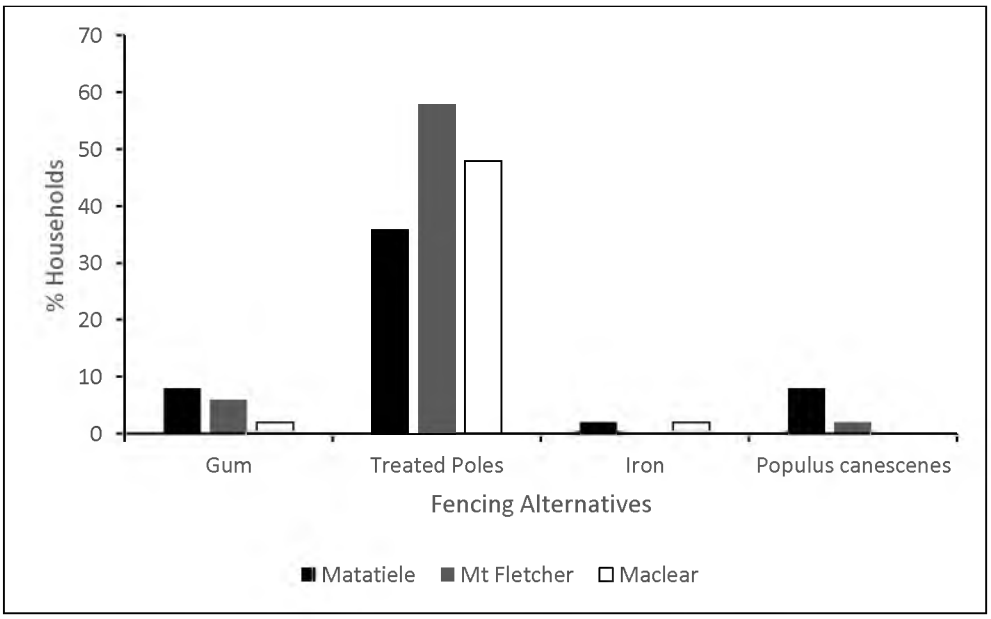


Figure 3.11. Alternatives for Silver Wattle fencing

The majority of the respondents in Matatiele and Mount Fletcher preferred alternative fencing sources more than in Maclear, where a higher number of respondents preferred Silver Wattle for fencing purposes. Respondents in Matatiele and Mount Fletcher preferred alternative fencing sources, especially treated poles they bought from neighbouring towns to Silver Wattle. The main reason was that Silver Wattle rots faster than treated poles. Some noted that Silver Wattle poles were not as attractive as poles they bought from nearby towns. Those respondents who preferred Silver Wattle the poles did so because it is free and can be accessed easily. These respondents noted the poles bought from surrounding towns were expensive and they could not afford to use them around the whole yard for which they would require many poles.

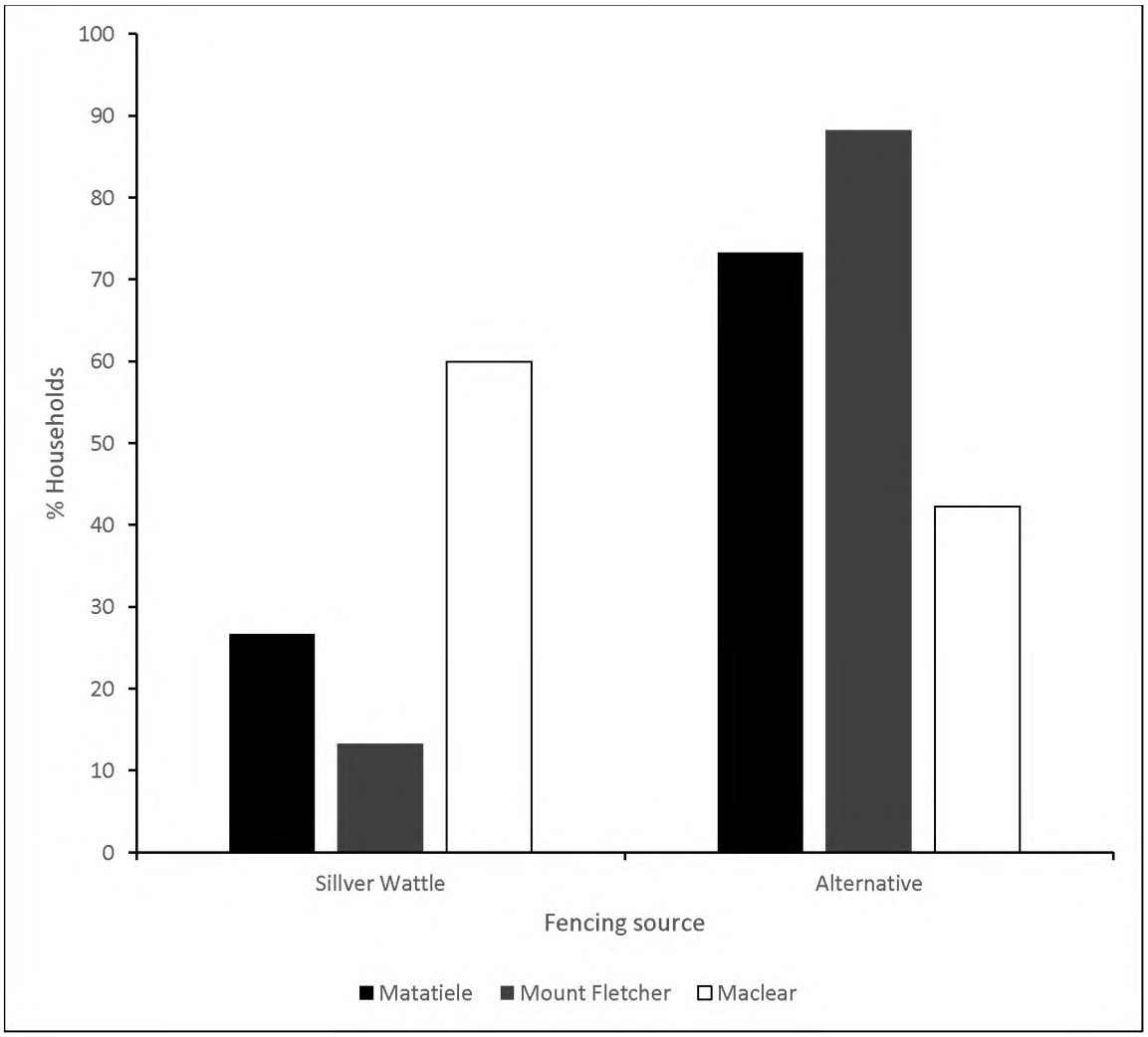


Figure 3.12. Preferred fencing source per site

3.5 Tools

Silver Wattle is used to make tools such as axe handles, hoe handles, washing lines and ladders (Figure 3.13). Two respondents in Matatiele mentioned a unique way in which Silver Wattle is used as a tool, stating that they use it during the burial of a person and a funeral. They stated that it is placed at the bottom of a grave such that the coffin will be placed on top of the poles of Silver Wattle. Apparently villagers in Maclear use Silver Wattle for tools more frequently than other two sites, although not significantly ($\chi^2 = 3.00$, df = 2, $p > 0.05$). Methods of procuring Silver Wattle for tools did not differ among the three sites (Table 3.9), with the majority of respondents collecting on their own. The majority of the respondents stated that there were no specific frequencies for the collection of wood for carving tools, as they usually collect when the need arises to replace broken tools.

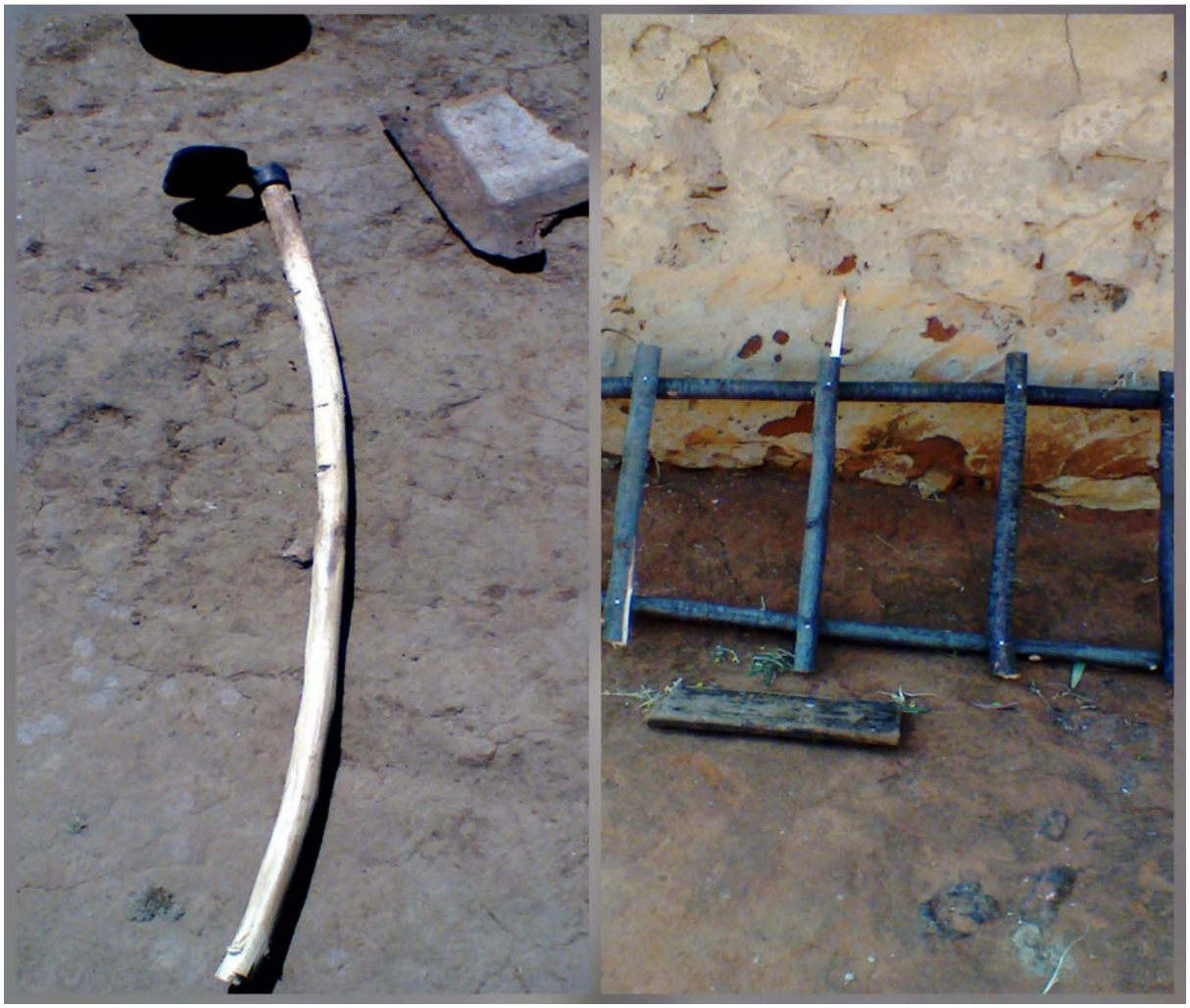


Figure 3.13. Hoe handle and ladder made from Silver Wattle (Photo by Agripa Ngorima)

Table 3.9. Procurement of Silver Wattle for tools (%)

Method used	Collect	Buy	Both
Matatiele	96	2	2
Mount Fletcher	100	0	0
Maclear	100	0	0
Mean	97	1	1

To get an estimation of the frequency of use, respondents were asked when they had last collected Silver Wattle for carving tools (Figure 3.14). Most respondents had last collected Silver Wattle for tools over a year prior to the research. Most respondents used iron tools which they acquired from the hardware stores in the surrounding towns. The iron tools are more durable than those made from Silver Wattle. Therefore, the people's frequency of collecting the Silver Wattle for to make tools is reduced. Some respondents felt that Silver Wattle tools were not as beautiful as compared to iron tools and respondents would not pride themselves in using them.

Most respondents stated that they increased collection during the commencement of the farming season. During the farming season they will need more tools to use for their farming purposes, hence the increase in Silver Wattle for tools. Despite not having a specific frequency of collecting poles for carving tools, households provided an approximate number of poles per year (Table 3.10). There was no significant difference in the amount of poles used to carve tools amongst the three site ($F = 1.47$; $p = 0.22$).

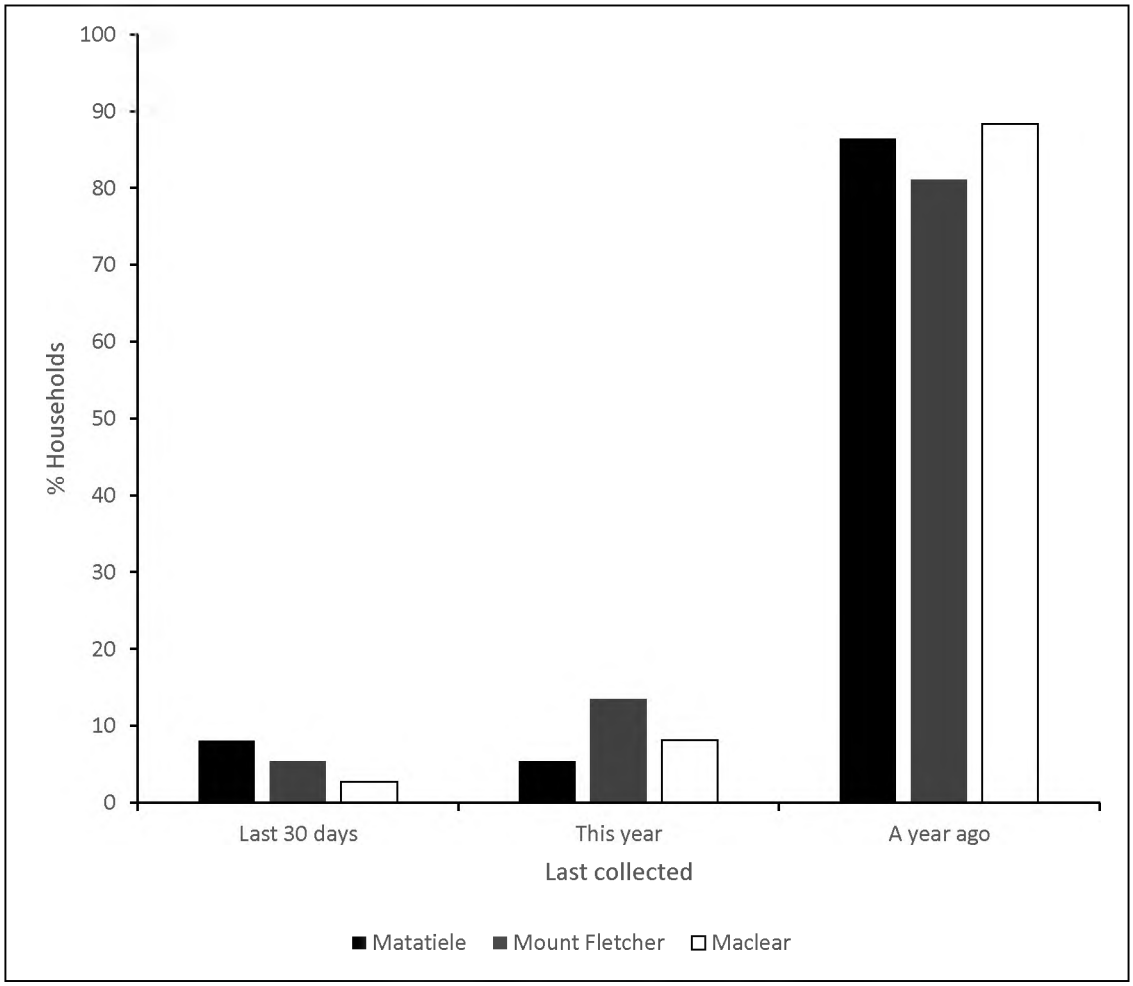


Figure 3.14. Periods when Silver Wattle was last collected for tools per site

Table 3.10. Quantity and resource valuation (± S.E) for Silver Wattle tools use for per annum per household

Site	Average no of poles	Price (ZAR)
Matatiele	26 ± 2	261 ± 22
Mount Fletcher	32 ± 3	317 ± 29
Maclear	38 ± 2	377 ± 23
Mean	32 ± 3	318 ± 25

A higher resource value per year, site for tools is significantly acquired in areas where there is higher abundance of Silver Wattle than in areas of medium abundance ($F=128$, $p<0.05$) (Figure 3.15). With more abundance there is more interaction with species and less time required to travel to procure Silver Wattle. Time to travel to collect Silver Wattle is also reduced.

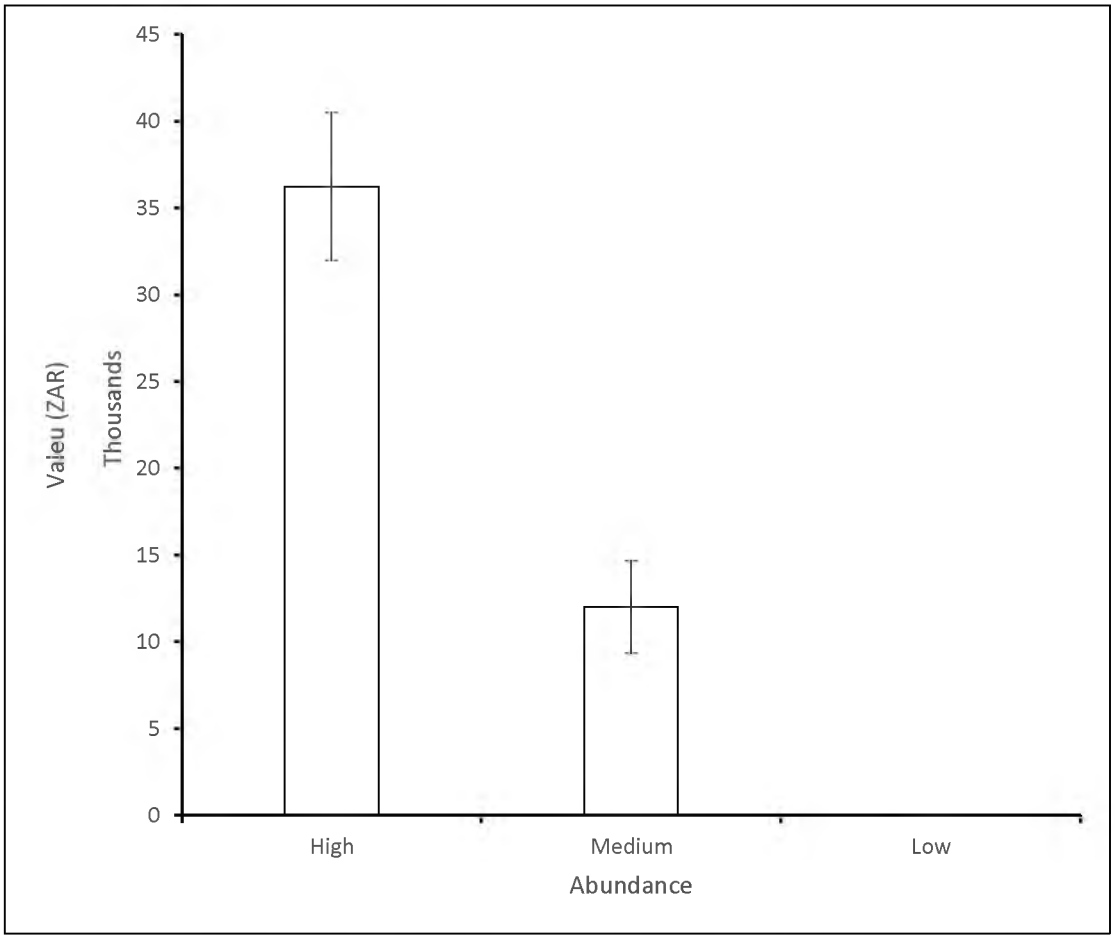


Figure 3.15. Resource value for Silver Wattle tools and abundance

3.5.1 Frequency of Silver Wattle Use For Tools According to Wealth Classes

Figure 3.2 above (page 36) shows that significantly more poor respondents use Silver Wattle for tools than richer respondents ($\chi^2 = 8.72$, d.f = 3, $p < 0.05$). Respondents of each quartile do not frequently use Silver Wattle to carve tools as they had last collected for that over a year ago (Fig. 3.16). Almost, a similar small number of respondents in each quartile had last collected Silver Wattle to carve tools in a period of 30 days before by the time the research was conducted. There was no significant difference in the number of poles of Silver Wattle extracted for carving tools amongst the wealth classes ($F = 0.758$, $p = 0.52$) and therefore also no difference in resource value (Table 3.11).

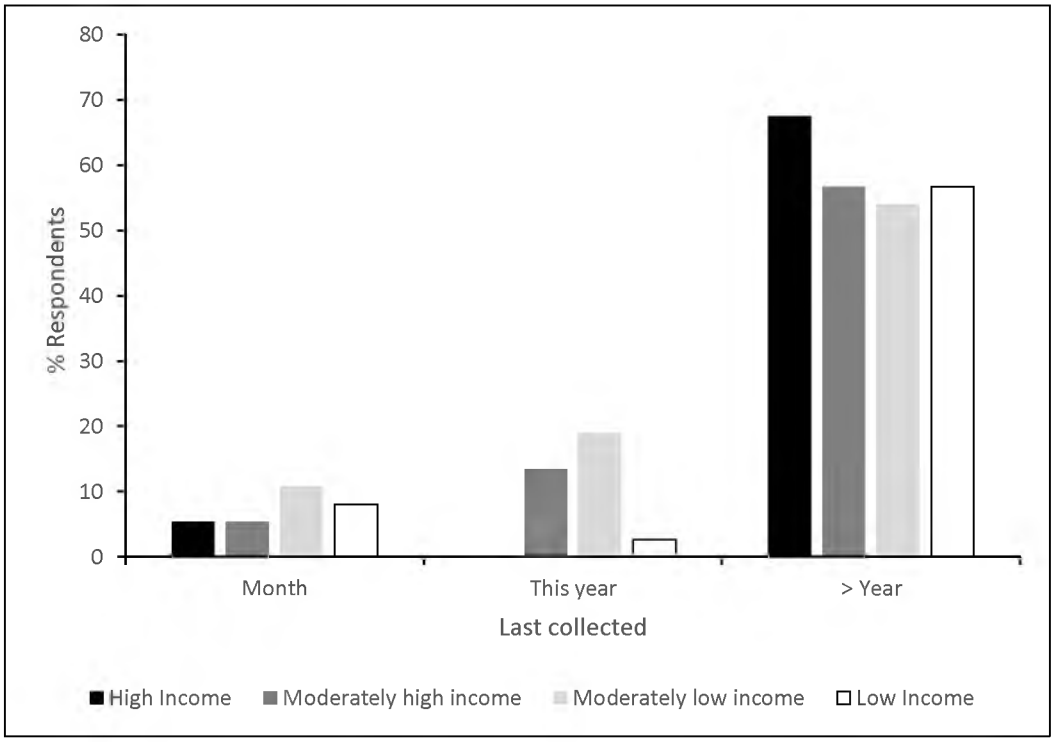


Figure 3.16. Last collection of Silver Wattle for tools per household wealth

Table 3.11. Resource value (± S.E) for Silver Wattle tools per annum and income quartiles

Income	Number of poles	Resource value (ZAR)
High	29 ± 3	289 ± 29
Moderately high	33 ± 2	327 ± 24
Moderately poor	36 ± 2	357 ± 22
Poor	33 ± 3	325 ± 29
Mean	33 ± 3	325 ± 26

3.5.2 Alternatives for Silver Wattle Tools

Of the respondents who used Silver Wattle to make tools, 81 % in Matatiele, 80 % in Mount Fletcher and 70 % in Maclear stated that they also used alternatives (Fig. 3.17). Nineteen percent in Matatiele, 20 % in Mount Fletcher and 30 % in Maclear of the respondents insisted that they only relied on Silver Wattle for tools.

The majority of the respondents stated that they use iron tools which they buy from neighbouring towns. A slight majority (57 % in Matatiele, 56 % in Mount Fletcher and 59 %

in Maclear) stated that they preferred iron tools. The main reason was that the iron tools are stronger than those made from Silver Wattle. When compared to *Eucalyptus* and *Populus canescens*, most of the respondents stated that they preferred tools from Silver Wattle because Silver Wattle is easily accessible, they also mentioned that tools from Silver Wattle are lighter to use than those from *Eucalyptus* or *Populus canescens*. Some respondents who stated that they preferred Silver Wattle tools to the iron tools was because Silver Wattle did not need to be bought and they could collect in their own time. Therefore, it was assisting in cash savings which they could use for other livelihood activities.

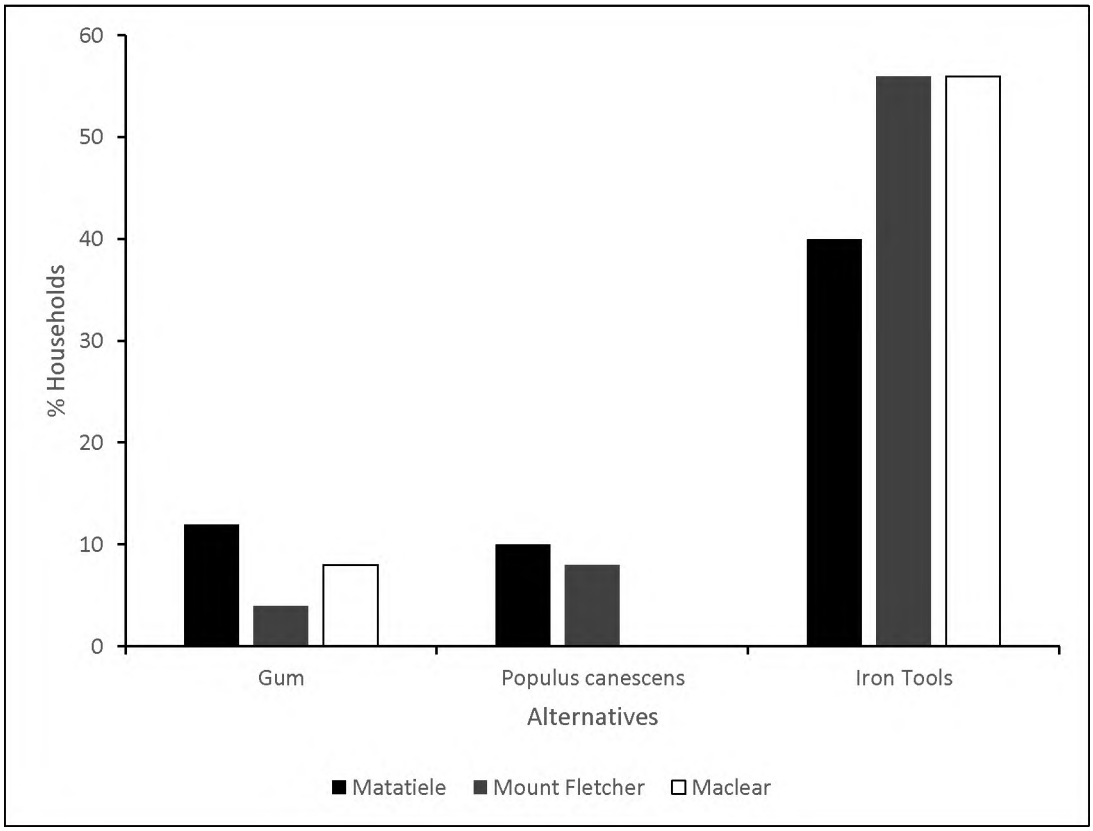


Figure 3.17. Alternatives for Silver Wattle tools and their relative uses

The majority of the respondents favoured alternative tool sources as compared to Silver Wattle (Figure 3.18). The most favoured tool source to be specific were the iron tools bought from the surrounding towns. More so, a higher number of respondents in Mount Fletcher preferred alternatives than in other sites. A few respondents stated that Silver Wattle tools were not as beautiful as compared to iron tools and respondents would not pride themselves in using them. Iron tools were also noted to be stronger and last longer than tools made from Silver Wattle.

The few respondents who preferred Silver Wattle tools mentioned that they were easily available and that they were not sold as they could easily procure for themselves.

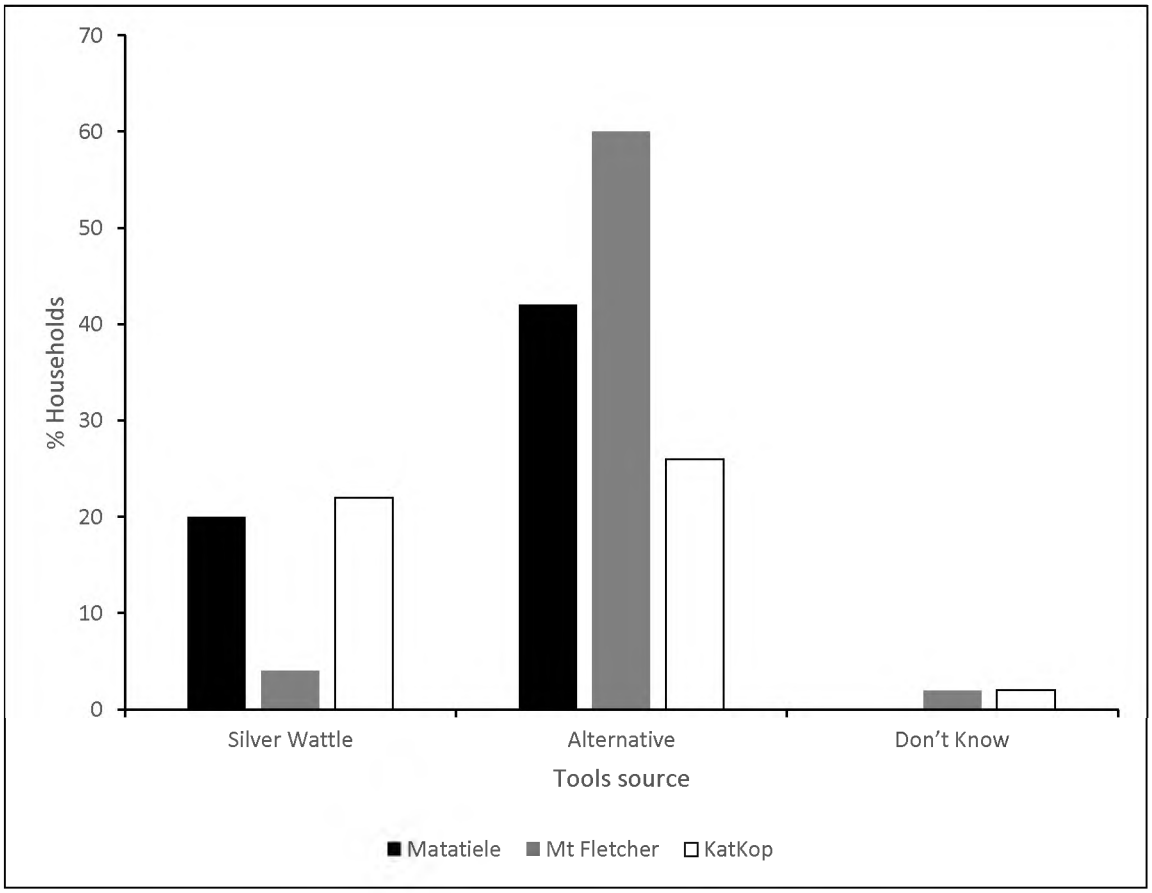


Figure 3.18. Favoured tool sources

3.6 Medicine

Silver Wattle was used for medicinal purposes by a small proportion of respondents, eight respondents in Matatiele, nine in Mount Fletcher and seven in Maclear. Use of Silver Wattle for medicinal purposes is not associated with site ($\chi^2 = 3.0$, df = 2, $p > 0.05$). The main part used was the bark to treat stomach-ache. They collected the bark closest to the ground and boiled it. The person suffering from stomach-ache drinks the boiled extract. The same is also done to treat chest pains. Roots of Silver Wattle are also used to treat stomach-ache. A few people stated that they use the bark to cover injured livestock to stop continuous bleeding. One respondent, who was a traditional healer, stated that she used leaves of Silver Wattle to treat

eye problems. She stated that she crushes the leaves and applies the residue of the leaves to the eyes.

3.6.1 Frequency of Use Silver Wattle for Medicine According to Wealth Classes

Silver Wattle is not frequently used for medicinal purposes. A few respondents within each quartile had last collected Silver Wattle for medicinal purposes over a year by the time the research was done (Fig. 3.19).

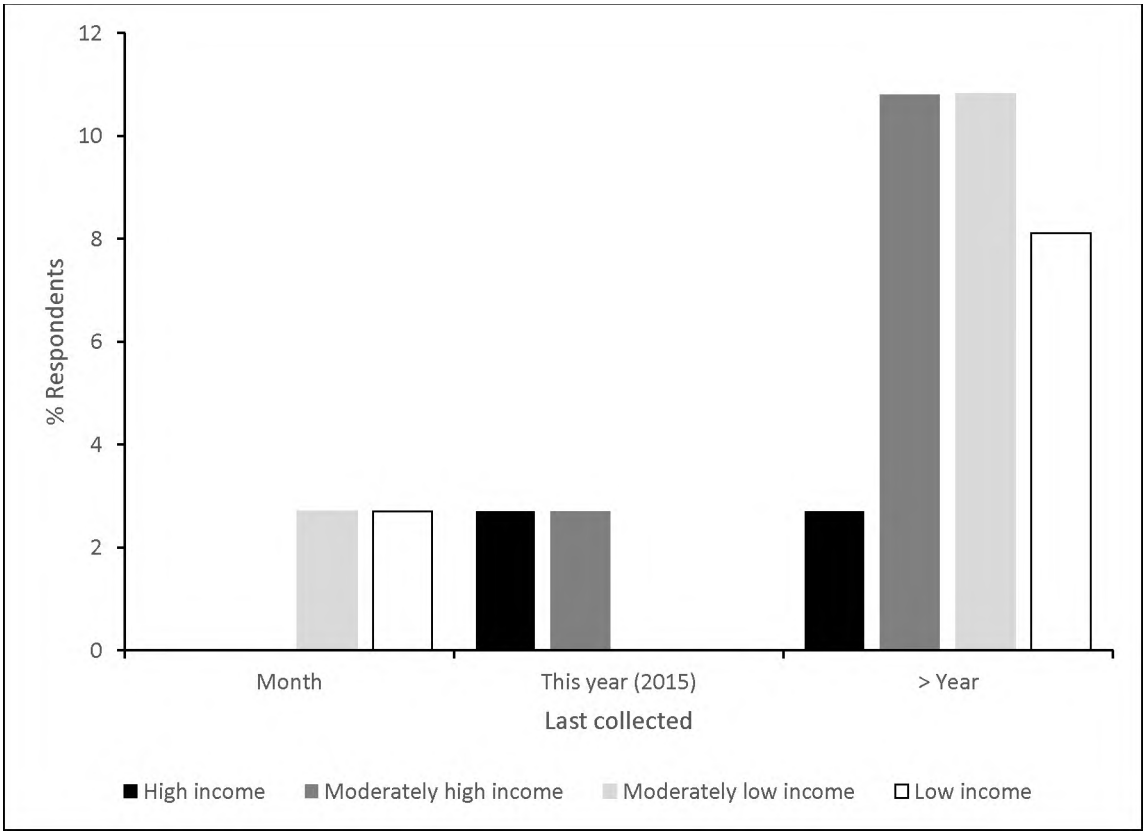


Figure 3.19. Last collection of Silver Wattle for medicinal purposes per wealth quartile

3.7 Fodder

The majority of respondents (78 % in Matatiele, 80 % in Mount Fletcher and 80 % in Maclear) own livestock. All the households owning livestock use Silver Wattle for fodder. Respondents in Mount Fletcher and Maclear use Silver Wattle for fodder more than in Matatiele though not significantly ($\chi^2 = 4.0$, df = 2, $p > 0.05$). Cattle and sheep feed on it but goats were reported as the animals with the highest affinity for the leaves of Silver Wattle (Figure 3.20). Respondents also noted that their livestock also feed on Silver Wattle pods during the fruiting season of

Silver Wattle. Almost every respondent who uses it for fodder stated that they herd their livestock daily in the areas where Silver Wattle occurs and observed that livestock ate the leaves almost every day. A few respondents stated that they occasionally collect Silver Wattle to bring to their households to feed either young or injured animals which are incapable of walking on their own. They would usually use livestock for transporting the fodder from the thickets to their houses. Respondents mentioned that often livestock would alternate between Silver Wattle and grass. A few respondents mentioned that they would buy livestock feed from urban hardware stores.

Figure 3.20. Livestock eating leaves of Silver Wattle (Photo by Agripa Ngorima)

3.8 Summary of Silver Wattle Resource Valuation

Extrapolating from the sampled households and using all the households within the sampled villages a total summary of the resource valuation per user households within the three sites (Table 3.12). From the local integrated development plans and headmen each village comprises of approximately 200 households and was used to calculate the total valuation. Firewood acquired from Silver Wattle represented a high resource value than other uses. A considerable

resource value is accrued for firewood according to hectares. The number of poles for fencing used per year are higher than for tools hence resource value of Silver Wattle for fencing is higher than value tools.

Table 3.12. Summary of resource valuation for Silver Wattle use (ZAR) per annum for the three sampled sites

Use	Value per user households	Value per household	Value per hectare	Total value per user households
Firewood	2 246	2 246	2 073	4 042 800
Poles	525	381	161	315 000
Tools	318	245	97	190 800

3.9 Cultural Uses

According to the respondents Silver Wattle does not have any cultural uses. One elderly respondent in Matatiele stated that they used Silver Wattle for death cleansing process. He stated that they take leaves of Silver Wattle to an accident scene and they would perform a ritual which would help the soul of the deceased to rest. However, Silver Wattle cannot be said to have significant cultural services to local communities.

3.10 Gender and Silver Wattle Use

Of the households sampled within the three sites, 50 % in Matatiele, 44 % in Mount Fletcher and 52 % in Maclear were female-headed households. Within the three sites there was no significant difference between the proportion of males and females who used Silver Wattle for firewood, fencing, tools, fodder and medicine purposes (Table 3.13).

Table 3.13. Comparisons of percentage uses of Silver Wattle and gender

Use	Gender of household head	Matatiele	Mount Fletcher	Maclear	χ^2 value	Significance
Firewood	Male	100	100	100	3.0	>0.05
	Female	100	100	100		
Fencing	Male	80	72	90	4.3	>0.05
	Female	78	78	80		
Tools	Male	82	77	83	3.2	>0.05
	Female	76	75	82		
Medicine	Male	20	10	11	6.2	>0.05
	Female	16	18	14		
Fodder	Male	80	81	82	4.7	>0.05
	Female	76	84	79		

3.11 Effects of Silver Wattle on Land Uses

The presence of Silver Wattle in the area has some negative effects on land use options by local communities. Of the respondents, 92 % in Matatiele, 98 % in Mount Fletcher and 90 % in Maclear stated that Silver Wattle grew in some landscapes in which they regarded as problematic (Figure 3.21). The majority of respondents 61 % stated that they did not want Silver Wattle near their homesteads. The reason was that the roots of Silver Wattle cause the foundations of their houses to crack which would destroy the houses. Consequently, this would force them to rebuild or repair the houses which would cost money. They also stated that Silver Wattle near their yards would attract criminals and would put their lives in danger. The presence of Silver Wattle near households was also said to attract dangerous animals such as snakes which could injure or even kill them.

A number of respondents (12 %) stated that they do not want Silver Wattle in and or near their fields. The majority noted that it was difficult for their crops to grow well when Silver Wattle is present. They also stated that they would find it difficult to do their farming activities due to the roots.

During the focus group discussions it was noted that before the commencement of the farming season, most households would engage in land preparation by removing Silver Wattle from their fields, mostly during August. This shows that they had already incorporated it into their seasonal calendar. Seventy-seven percent of the respondents stated that Silver Wattle was growing on their fields and it was causing problems, as they had to frequently remove it. A few respondents within the three sites stated that they did not want Silver Wattle anywhere near their communities as it would bring criminals to their areas. They stated that the presence of Silver Wattle allowed criminals to hide which would endanger the community. Forty-four percent of the respondents in Matatiele, 46 % in Mount Fletcher and 38 % in Maclear stated that Silver Wattle was found on culturally important sites. They noted that it was found at tribal council sites and graveyards. At the graveyards, they noted that due to the long roots of Silver Wattle graves were cracking and they were not happy with the situation.

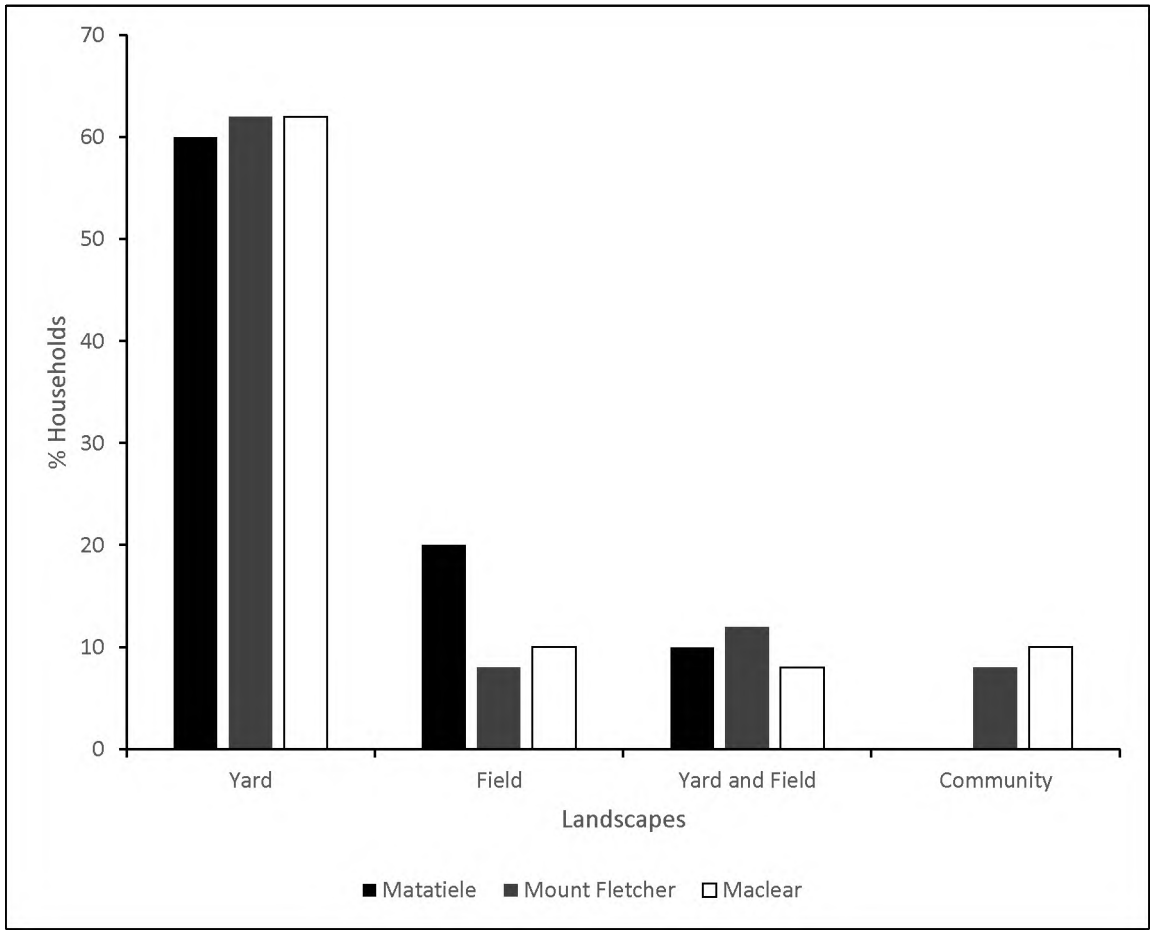


Figure 3.21. Landscapes where Silver Wattle is not wanted

There were mixed reactions due to the presence of Silver Wattle at tribal council sites; some noted that its presence was providing them with shade during the meetings which help them to relax, whilst others noted that it was too dense there and would affect their communication with ancestors. A number of respondents (28 % in Matatiele, 34 % in Mount Fletcher and 35 % in Maclear) expressed negative sentiments towards Silver Wattle because it consumed a lot of water. However, they could not mention how they could measure that, with most mentioning that most of their knowledge was gleaned from the Working for Water programme.

3.12 Costs Due to Silver Wattle Invasions

When asked if their livelihoods would improve or not if the current abundance of Silver Wattle was doubled, the majority of respondents 87 % felt that their livelihoods will be negatively impacted (Table 3.14).

Table 3.14. Will livelihoods improve if current Silver Wattle abundance is doubled?

Site	Yes (%)	No (%)	Do not know (%)
Matitiele	11	88	1
Mt Fletcher	12	84	4
Maclear	9	90	1
Mean	11	87	2

Furthermore, 88 % of the respondents in Matatiele, 90 % in Mount Fletcher and 86 % in Maclear stated that the current abundance was too much and it was a stress to them. They wished that it would be reduced as it was providing them with problems. The following villager's statement in Matatiele shows the peoples' concern about the high abundance, "*The high abundance of the tree is bringing criminals, high rate of rape and robbery especially us elderly people. Let us not talk about this tree because it gives me headaches*". The majority of the respondents stated that the current abundance attracted a lot of criminals in their areas. In Caba village near Matatiele, several households had had their livestock stolen and they put most of the blame on Silver Wattle in which they say thieves hide and monitor the activities of the people.

During the focus group discussion in the Fletcherville area, a concern was expressed about the abundance of Silver Wattle along the paths which lead from the Fletcherville Junior School and villagers feared that their children will be raped or murdered. They stated that they did not want any Silver Wattle near their households. In Chevy Chase village near Maclear, a recent burglary at the local school had happened and computers were stolen. In the village meeting attended by the researcher, villagers blamed the presence Silver Wattle because they said it was providing the thieves with places to hide. Women, who are usually the ones responsible for collecting firewood, also mentioned their fear in going to collect the firewood as criminals would hide in Silver Wattle patches.

The high abundance of Silver Wattle was affecting the activities of some people. The majority of the respondents (74 % in Matatiele, 76 % in Mount Fletcher and 84 % in Maclear) stated that they had to cut the trees near their fields to create land to cultivate. They noted that they were getting bad produce from the farms where Silver Wattle was and had to cut it down. A few respondents stated that Silver Wattle was consuming a lot of water and complained that

their area was dry. However, these respondents stated that information about water consumption of Silver Wattle they had heard it from Working for Water.

3.13 Silver Wattle Reducing Livelihood Vulnerability of Rural Communities

Despite the costs, the majority of the respondents (92 % in Matatiele, 84 % in Mount Fletcher and 92 % in Maclear) stated that their livelihoods would be difficult if Silver Wattle was absent. This is supported by a villager's response in Matatiele who said, "*We will struggle a lot, I cannot even imagine such a situation*". They stated that Silver Wattle cushions them from difficulties in life. The majority of the respondents mentioned that in their area there are not many alternative tree species which would provide them with firewood. Hence, they would have to buy firewood if Silver Wattle was no longer available, stretching their scarce cash resources. They stated that Silver Wattle cushions them from spending too much on electricity. On average households spent ZAR 95 in Matatiele, ZAR 93 in Mount Fletcher and ZAR 88 in Maclear on electricity monthly which is small for households averaging four people each household. Furthermore, there are two villages, namely Gabane village in Mount Fletcher and Chevy Chase village in Maclear, which do not have electricity and they relied most on Silver Wattle for firewood. They stated that they bought 2 kg of gas for ZAR 42. Respondents emphasised that they would have to spend cash to get the services that are provided by Silver Wattle if it was absent.

Very few respondents (6 % in Matatiele, 8 % in Mount Fletcher and 6 % in Maclear) stated that their lives would improve if Silver Wattle was absent as they would adapt and find other sources. They stated that they only use Silver Wattle because they did not have alternative tree species which they say have been outcompeted by Silver Wattle. They mentioned that Silver Wattle was responsible for the death of the indigenous species. Therefore, they argued that its removal would result in the native species returning. They also mentioned that the main notable use was firewood and most of their livelihood activities would not be affected by its absence.

Two respondents in Matatiele and one respondent in Mount Fletcher stated that they sold Silver Wattle for firewood. They did not frequently sell Silver Wattle firewood, usually when there were important occasions such as celebrations or funerals. The money they earned from selling firewood was used in buying food (66 %), paying school fees (66 %) and help in clothing their families (33 %). All the respondents who sold Silver Wattle firewood were males, who were unemployed and with low formal education. The highest education level of the sellers was

grade seven. They noted that though the money they earned was not significant, it was very vital sometimes as it helped them and with the current high unemployment rate it helped them to acquire income and complement other livelihood strategies. They also stated that acquiring cash from the surrounding forests made them happy and satisfied. The respondents mentioned that they got involved in selling Silver Wattle due to lack of employment and poverty. They also realised that other people at certain times required large amounts of firewood hence they were galvanised into the business. These few respondents involved in selling firewood mentioned that they all had been involved in Silver Wattle trade for a period of slightly more than a decade.

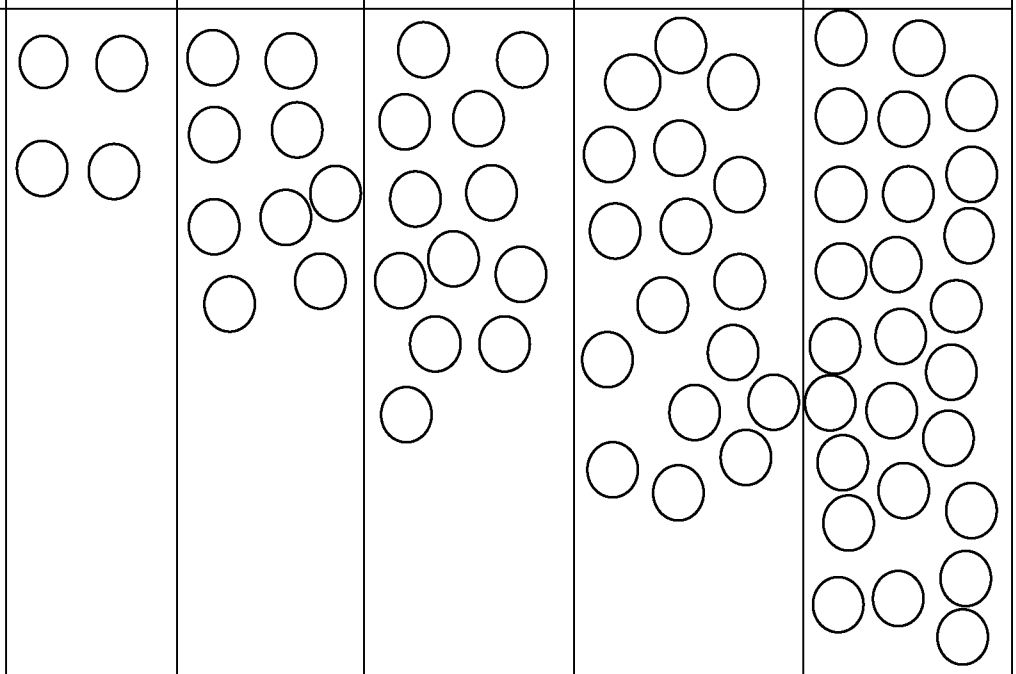
The main stress to which the rural communities are subjected were a high level of unemployment and poverty. Respondents showed that Silver Wattle was helpful in aiding communities in coping with these. Households save money through using Silver Wattle for free. The current unemployment rate is high, therefore, to those households which engage in selling Silver Wattle they will be able to earn extra income. Some of the respondents stated that they were getting employment due to the invasions as they were employed by contractors who had been given tenders to clear Silver Wattle in their area. Therefore, they stated that it was helping in providing income. A few respondents who were farmers and the headman in Caba Village pointed out that Silver Wattle had been helpful in arresting erosion in gullies that were in the area and that it was helping to reduce soil erosion as there were few other trees to cover the soil.

However, when asked to rank their livelihood strategies villagers within the three sites showed that social grants are the most important livelihood strategy. During the focus group discussions participants ranked key livelihood strategies according to importance as old-age pensions, child-support grants, employment, support from working children and use or selling of Silver Wattle.

3.14 Perceptions and Use of Silver Wattle in Relation to Abundance and Time

A historical timeline trend was conducted to determine how the abundance of Silver Wattle had changed over the given time period through community ranking by the local respondents (Table 3.15). The historical timeline trend started from 1930 as this was the year the oldest respondent was born. The historical timeline trend showed that the abundance of Silver Wattle has been increasing.

Table 3.15. Silver Wattle abundance changes with time

	1930-1950	1950-1970	1970-1990	1990-2010	2010-Present
Abundance					

To determine if the people's perceptions had changed with the increase in abundance or with time since the invasion, a historical timeline was constructed during the focus group discussions (Table 3.16). The people's perceptions grew negatively towards Silver Wattle as its abundance increased.

The negative impacts associated with high Silver Wattle abundance prompted the people to prefer a moderately low abundance in landscapes which are not used intensively and considerable distances away from them (figure 3.22). The fundamental motivation why they required the low densities in the landscapes away from their yards was because they still wanted the services which are offered by Silver Wattle. They also stated that they do not need Silver Wattle at or near their yards, near or in the fields and along pathways they use to travel. Every respondent stated that they could not recollect a time when Silver Wattle was not available around their village. They also stated that they had incorporated it into their lifestyle and felt it was one of their own and part of them. A medium density of Silver Wattle was the second most favoured density by respondents, in landscapes that are away from their yards.

Table 3.16. Timeline on the uses and perceptions towards Silver Wattle

Period	Event	Impact
1930	Oldest member of focus group discussion was born	He is born when the trees are already there. He notes the tree is used as he grows but however, it is not abundant. Viewed as an important resource such that rules are placed to control access to the tree.
1930-1994	The local population increases.	Silver Wattle is cut to create land for settlement. However, it still grows in abundance.
1994	End of apartheid and attaining of independence.	Many people especially, young people, move to bigger cities to look for better opportunities. Population decreases and consequently the use of Silver Wattle is reduced.
1996 onwards	Working for Water activities become more popular in areas.	Information gets to them about the high consumption of water. That information exacerbates the negative perceptions that it has been receiving resulting due to its abundance.
2000 onwards	Road improvement.	Allows other people to move freely to come in and sell firewood in the area. During road construction, most locals are employed in the area and would cook with Silver Wattle firewood at their gatherings.
2005	Rules change; no need to seek permission.	No longer viewed as an important resource for them hence, it can be used as one pleases. However, the tree still belongs to the community and outsiders have to seek permission from the chief. In Chevy Chase rules only apply to use of poles for fencing as they would be cutting bigger trees.
2007 onwards	Economic hardships, unemployment soars.	Some unemployed youths resort to crime and they are hiding in the Wattle thickets and also outsiders use them as their hiding places for monitoring the activities of villagers. Resentment towards the tree increases.
2011 onwards	Electricity introduction.	Great reduction in the usage of Silver Wattle as an energy source as people revert to the usage of electricity. However, they note they still use for Silver wattle to complement electricity use.

Figure 3.22. Preferred densities of Silver Wattle by rural communities (Photo by Agripa Ngorima)

3.15 Perceptions towards Abundance of Silver Wattle and Household Wealth and Gender

To understand who within the community experiences constraints due to Silver Wattle invasions, the perceptions of the abundance of Silver Wattle in the area were examined within each wealth quartile. Respondents of all wealth quartiles suffer constraints due to high Silver Wattle abundance (Fig. 3.23). More respondents within the higher income quartile slightly experience constraints than in the low income quartiles though not significantly (χ^2 =12.00, df = 3, $p > 0.05$).

There were also no difference in who experienced constraints due to Silver Wattle invasion according to gender. Both males and females feared for their lives, however females especially those from the low income quartile were at more risk as they collected Silver Wattle for firewood were at more risk.

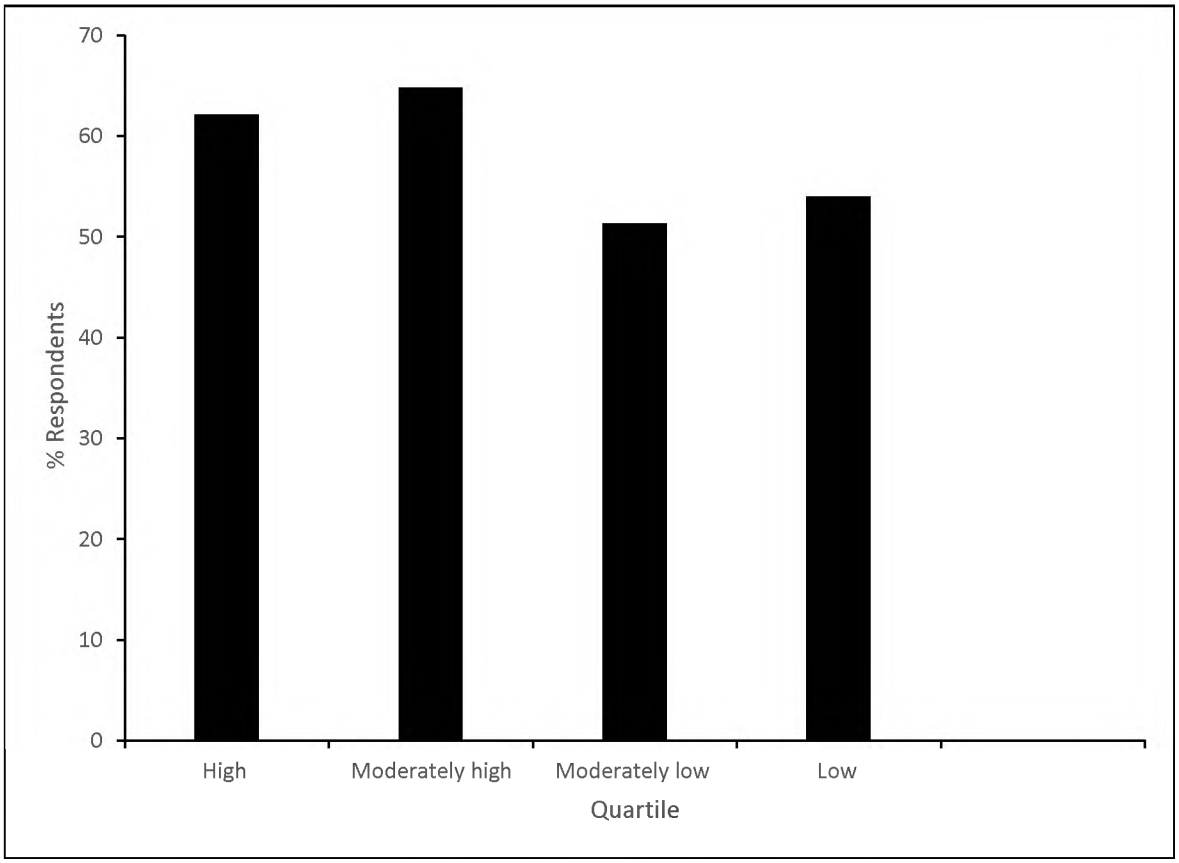


Figure 3.23. Respondents with negative perceptions of Silver Wattle abundance according to household wealth

CHAPTER FOUR: DISCUSSION

4.1 Perceptions of Invasion

For the communities in Matatiele, Mount Fletcher and Maclear, Silver Wattle was introduced before the current generation was born. The majority of people in these communities have, nonetheless noted an increase in the abundance of Silver Wattle within their areas over the decades including the last 10 years. This is similar with Shackleton *et al.* (2007) who found that the local communities in Catha district noted an increase in abundance of *Acacia mearnsii*. Approximately 70 % of South Africa is prone to more Australian *Acacia* invasions (Low, 2012). Hence the ongoing increase in abundance in many environments and locations. Similarly, Mwangi & Swallow (2008) reported that *Prosopis juliflora*'s abundance over the past decade was perceived to be on the increase by rural communities in Kenya. The abundance of seed produced by Silver Wattle and fertile soils were believed to be the main cause of its continous increase. Similar to studies by Shackleton *et al.* (2007) who found out in their study that abundant seeds, fertile soils and high rainfall were attributed to being the main drivers of the increase in Black Wattle. Le Maitre *et al.* (2011) accentuated the copious seed production as the main driver to invasions by several Australian *Acacias* and as such deemed it a primary barrier to control.

Consistent with findings by Shackleton *et al.* (2007) that Black Wattle favoured river banks and near water sources, the communities interviewed noted that Silver Wattle was more abundant near water sources, river banks and hilly areas. Local communities' incorporation of Silver Wattle within their livelihoods and the fact that everyone had grown up while Silver Wattle was present may have resulted in respondents not knowing that it is an alien species. Respondents expressed shock when it was mentioned that it is non-native which is similar to Shackleton & Shackleton (2016) majority of respondents had a poor knowledge of IAS. This echoes Shackleton *et al.* (2007) reports that the invasive *Opuntia-ficus indica* had received a local status, with people expressing shock when it was mentioned that it is alien. To the local communities in Matatiele, Mount Fletcher and Maclear, they viewed Silver Wattle as any other tree which is helpful to them and not as an invasive alien tree. dos Santos *et al.* (2014) agreed with this notion and stated that there is often no differentiation by local communities towards IAS and they view them as important livelihood resources. Therefore, to many rural

communities the status in being native or exotic does not influence local people's perceptions towards useful species. Silver Wattle has been part of the rural landscapes for many decades if not a century now and thus rural communities have adapted to its presence. Therefore, uses and perceptions towards Silver Wattle are no longer opportunistic or coincidental but adaptation and incorporation into their livelihoods. This study agrees with the notion of Shackleton *et al.* (2007) that some rural communities have adapted to the presence of IAS due to long periods of existence. Thus, any loss off Silver Wattle is likely to have some impact on local livelihoods.

3.2 Direct Use

Silver Wattle is used for various purposes such as firewood, fencing, tools, medicines and fodder. Kull *et al.* (2011) infer that Australian *Acacias*, despite being alien species, have a plethora of uses in rural livelihoods across the world. Silver Wattle is not the only IAS which is useful to villagers in close proximity with them. In Kenya, *Prosopis juliflora* also was used for a multiple purposes by rural dwellers (Mwangi & Swallow, 2008). In India, *Lantana camara* was used for various purposes including firewood, fencing, tool making and furniture production (Kannan *et al.*, 2014). Virtually everyone within the three sites stated that they use Silver Wattle for firewood. de Neergaard *et al.* (2005) found that in Madlangala, South Africa, almost every household used Silver and Black Wattle as an energy source. Silver Wattle is the primary energy source for the majority of residents in Matatiele, Mount Fletcher and Maclear. Similarly, Shackleton *et al.* (2007) showed that local communities in Catha used Black Wattle for firewood. The majority of rural respondents collected Silver Wattle which they used for firewood. Such findings are similar to those by Shackleton *et al.* (2007) in Catha South Africa, where 80 % of the respondents collected Black Wattle on their own. The lack of difference in use of Silver Wattle for firewood among the three sites underscores its importance to almost all the people where Silver Wattle have invaded. Furthermore, the importance of Silver Wattle for firewood is elaborated by its frequent collection by many respondents both the poor and wealthy.

Silver Wattle is regarded as producing good firewood because it lasts longer, produces little smoke compared to cow dung, and is a free, all year resource as compared to other alternatives, such as electricity and gas. Kull *et al.* (2011) agree with this notion stating that fuelwood produced by Silver Wattle is considered one of the best. dos Santos *et al.* (2014) found out that local communities in Brazil view several IAS as more useful and favoured than the indigenous

species. The IAS are favoured because they are useful for food, fiber, fuel wood and animal forage better than the indigenous species. Preferences for Silver Wattle over other alternative energy sources according to the respondents is influenced by easy access, unavailability of other tree species, a good firewood and charcoal production which lasts long and it is a free resource. Most Silver Wattle patches in the three sites were very close to households hence residents could easily access it for their uses. Shackleton *et al.* (2007) infered that nearness of a useful IAS to local people may influence positive perceptions by the people inhabiting the areas. Consistent to findings of Shackleton *et al.* (2007) that respondents used Black Wattle because it was reasonably close to them. Similarly, in Kenya, *Prosopis* is abundant and close to people. Therefore, they did not have to travel far to collect it (Mwangi & Swallow, 2008). Furthermore, there are some villages which are not yet electrified and almost completely rely on Silver Wattle as an energy source.

Collection of Silver Wattle for firewood is often daily or weekly by most villagers especially the poor households, mostly via headloads. Therefore, their bundles are limited in size hence requiring frequent collection visits. A considerable number of respondents also collect per month usually using cattle carts, which allows bigger bundles which last a lot longer, hence collection frequency is less. Collection of Silver Wattle for firewood increases during the winter period and occasions such as funerals and weddings. These findings are similar to those of Shackleton *et al.* (2007) in which collection of Black Wattle for firewood in Catha increased during the cold winter period. A report by Geldenhuys *et al.* (2016) showed that use of wattles in Ntabelanga for cooking and heating was more extensive during the winter period. From the amounts, collection frequency and values it can be argued that most important use of Silver Wattle is firewood.

Silver Wattle is important to some households for fencing yards, gardens and livestock kraals. This corroborates with Shackleton *et al.* (2007) in Catha, where Black Wattle was used for fencing and was favoured because it produced straight poles. Likewise, in Senegal, *Piper aduncum*, an invasive alien shrub, is used for fencing purposes (Siges *et al.*, 2005). *Prosopis juliflora* is used for fencing purposes in India, as it produces straight poles (Pasiecznik *et al.* 2001). In Matitiele, Mount Fletcher and Maclear, despite Silver Wattle being a free resource and easy to access, treated poles bought from surrounding towns were favoured for fencing by the majority. Creosote treated *Eucalyptus* poles were favoured because they lasted longer as they can resist attack by termites. Since Silver Wattle is not treated against any rotting agents, villagers have to continually replace them. However, Silver Wattle aided economically

marginalised households as they save cash by getting it for free for fencing. Even some well to do families use it for fencing to compliment the poles which they will have bought.

A. dealbata is also used to make various tools such as hoe handles, axe handles and ladders. Kull *et al.* (2011) also found that *A. dealbata* was used for making different tools by people in Madagascar. Similar to findings by Siges *et al.* (2005) in Senegal *Piper adancum* was also used to make hoe handles, axe handles and rake handles. Use of *A. dealbata* for tools increases during the commencement of the farming season. However, most local villagers favoured using iron tools which they buy. Iron tools are favoured because they are more durable and are more attractive.

A. dealbata has some medicinal properties used to treat stomach-ache, chest pains and eye ailments. de Neergaard *et al.* (2005) in Madlangala, South Africa, corroborates with such findings, as 45 % of respondents stated they used Black Wattle and Silver Wattle for medicinal purposes to treat stomach-aches and tooth-aches. The base of the tree is favoured as it has a thicker bark from which more extract is produced. Silver Wattle is not the only IAS used for medicinal purposes. *Prosopis* in Garrisa, Kenya, is also used for medicinal purposes by a small number of the community (Maundu *et al.*, 2009). Nayak *et al.* (2008) reported that *L. camara,* in India was used for animal wound healing. *L. camara* contains ethanol extract which aids in wound contraction (Nayak *et al.*, 2008). Local communities on the Wild Coast cultivate *A. sericifera* for medicinal purposes (Keirungi & Fabricius, 2005). Such intimate and specialised uses of IAS only occur after long and close interaction.

Silver Wattle is also used for fodder purposes, leaves of the plant are favoured for consumption. Studies by Griffin *et al.* (2011) in Australia, show that most Australian *Acacias* foliage is used for fodder purposes, whilst, Blanckaert *et al.* (2007) in Mexico, found that the majority (92 %) of the 161, IAS in Mexico were used mainly for forage purposes. The main plants represented by the IAS included Poaceae, Asteraceae, Malvaceae, Euphorbiaceae, Fabacea and Solanaceae (Blanckaert *et al.*, 2007). Similarly, In Brazil, Minquiriba area, the majority (82 %) of the invasive species were used for forage purposes. The pods which are produced seasonally by Silver Wattle are also consumed by livestock. Similarly, Wakie *et al.* (2016) reported that the pods of *P. juliflora* were consumed by livestock during droughts in Afar, East Africa. However, livestock which fed on the pods were susceptible to a nervous disease (Wakie *et al.*, 2016).

Local communities use Silver Wattle as firewood during important traditional gatherings, for cooking food which will be eaten at the ceremonies and keep people warm during the

ceremonies, especially those which occur overnight. Similarly Shackleton *et al.* (2007) reported that *A. mearnsii* was used as firewood during rituals. To underscore the importance of *A. dealbata* during, rituals respondents stated they often buy it to meet their needs. These findings corroborate to those by Shackleton *et al.* (2007) where villagers also bought *A. mearnsii* to be used during their ceremonies as they would require huge quantities. However, the respondents in Catha did not recognise Black Wattle as a traditional resource (Shackleton *et al.*, 2007). *A. dealbata* in Caba village, Matatiele, was being attributed to having helped in the rehabilitation of degraded landscapes, similar to reports by Kull *et al.* (2011) in Madagascar and Chile where it was used to restore degraded landscapes. *P. aduncum* in Senegal, has also been used to restore degraded lands by controlling soil erosion (Siges *et al.*, 2005).

From all the different uses, *A. dealbata* appears to make a positive contribution to the livelihoods of most of the local people irrespective of wealth status. This idea is supported by Kull *et al.* (2011) who stated that for the local villagers in Madagascar, *A. dealbata* made a vital contribution to the sustanence of their livelihood. Furthermore, Silver Wattle is a year round resource hence rural communities can use it any time. Findings by Shackleton *et al.* (2007) are similar in which respondents in Catha district, stated that Black Wattle is a whole year resource which they accessed at will. However, it should be noted that features which make Silver Wattle invasive such as high fecundity, good growth rate and high abundance are the features which make it useful to rural communities, also as they can find it all year for use.

Almost the same number of respondents in the wealth quartiles used Silver Wattle for firewood, fencing and carving tools. A higher number of respondents in well to do quartiles used it more for fodder than those in the poor quartiles. Some of the poor respondents do not have livestock to feed. There are no significant differences in use of Silver Wattle for firewood, fencing and carving tools shows that almost all the people experience benefits due to Silver Wattle invasion. Similar to Kannan *et al.* (2014) in India, wealth status did not significantly influence use of invasive *L. camara*. However, the low-income respondents collected Silver Wattle for firewood more frequently (daily and weekly) than the higher income respondents. This maybe because they do not have many alternatives for energy sources as compared to richer respondents. The few respondents who bought Silver Wattle for firewood, fencing and tools all belonged to the rich quartile. Shackleton & Shackleton (2006) revealed that more wealth gave households more freedom to buy resources which they desire as compared to the poorer households most of who would be restricted to self-collection.

Using the sustainable livelihood framework by DFID (1999) it can be shown that Silver Wattle is building financial capital through providing cash income and cash savings. Silver Wattle also provides natural assets through providing provisioning services which may assist towards providing a sustainable livelihood. Silver Wattle is also providing physical capital through building infrastructure. Shackleton *et al.* (2007) tried to unravel the social, cultural and economic factors which galvanise local communities to use IAS. An important result obtained was that IAS are of paramount importance to rural livelihoods, dependence is exacerbated by limited livelihood opportunities rural communities have (Kannan *et al.*, 2014). Given the evidence they went on to make an argument that removal of IAS would be detrimental to rural livelihoods in some instances as it would increase vulnerability (Shackleton & Gambiza, 2008). Shackleton *et al.* (2007) argued that any control methods need not only focus on ecological impacts but also how they impact livelihoods.

Of the few respondents involved in selling Silver Wattle firewood they were all found in the poor quartile. Similar to findings by Shackleton & Shackleton (2004) and Shackleton & Shackleton (2006) where the poorest sectors were more involved in trade of NTFPS either on full time or ad hoc basis to broaden their financial base. Silver Wattle benefitted to rural communities can be categorised as:

- Cash generation when households sell products from Silver Wattle such as firewood and poles. Additionally, some respondents obtain employment to remove Silver Wattle in some areas of the landscapes. Some of the money acquired by companies given tenders is channelled back to the communities through their chiefs for community development.
- Cash savings accrue when households acquire services and goods which they would have bought if Silver Wattle was not available. Just less that ZAR 1.5 million is saved per site per year for firewood. It also helps people during times of adversities such as funerals and in winter households have been noted to increase their Silver Wattle use for firewood.

3.3 Gender and Silver Wattle Use

Both male-headed and female-headed households used Silver Wattle in similar quantities and frequencies. Mwangi & Swallow (2005) reported that in Kenya, females benefitted more from *Prosopis juliflora* more than males for firewood. However, in male-headed houses females were responsible for fetching Silver Wattle for firewood. As found by de Neergaard *et al.*

(2005) in Madlangala South Africa, women were responsible for firewood collection. However, when transporting huge bundles by cattle, males would do the job, and also poles for fencing as they would be collecting bigger trees which would require more power. Cavendish (2000) states that physical nature of the type of work determines which gender type undertakes the work.

This study showed little evidence of gender differences of Silver Wattle on use of different purposes. Wunder *et al.* (2014) reports that men and women almost contribute similarly from forest related income. However, gender applies on who procures the resource for a particular purpose. Males were responsible for collecting Silver Wattle for fencing and tools while females were responsible for firewood collection. This corroborates to findings by Mwangi & Swallow (2005) where females were more responsible for firewood collection. Maundu *et al.* (2009) noted that males were responsible for collecting poles made from *Prosopis juliflora* in Kenya. When female-headed households needed Silver Wattle for fencing purposes they would have to send male children or look for it or employ other males to collect for them.

3.4 Economic uses of *A. dealbata*

A few households sold Silver Wattle for firewood, poles for fencing and tools which assists them to earn extra cash income. de Neergaard *et al.* (2005) found that 19 % of the respondents derived some cash from selling Silver Wattle firewood. Prices of Silver Wattle firewood depended on the size of the bundle, however the most common price was ZAR 250 for a full cattle-drawn cart of firewood. Similarly, in Kenya, the major use of *Prosopis juliflora* was firewood and it was also sold for firewood, aiding sellers to acquire cash (Mwangi & Swallow, 2005). Local communities in Baringo, Kenya, ranked charcoal making and selling from *Prosopis juliflora* highly as they sold a 40 kg bag of charcoal for US$ 2.7 (Maundu *et al.*, 2009). This business was carried out by the entire family (Maundu *et al.*, 2009). Cash acquired from the of Silver Wattle firewood sales aided in buying food, farming equipment and helped in sending children to school, as was the case for traders selling Prickly pear (Shackleton *et al.*, 2007).

However, few households are involved in buying and selling Silver Wattle firewood as most households accessed on their own due to its high abundance and proximity. Similarly, Mwangi & Swallow (2005) state that the high abundance of IAS in landscapes reduced the viability of the business of selling *Prosopis* for firewood as anyone could access it at any time. Males were involved in selling of Silver Wattle for fuelwood because selling usually requires huge bundles

which requires more energy. All the people involved in selling Silver Wattle firewood were unemployed and with poor formal education whose chances of acquiring formal employment were limited. Shackleton *et al.* (2011) also found that traders of *Opuntia-ficus indica* in Makana municipality, South Africa, were of low education levels. Despite only a few households being involved in commercial business regarding Silver Wattle but its use makes a significant contribution to their households. Rural communities also acquire income from selling of poles made from Silver Wattle. Each pole costs ZAR 10. Maundu *et al.* (2009) found out that a pole made from *Prosopis* cost US$ 1.1 each, helping local households to acquire cash.

Elderly people and younger women preferred to buy Silver Wattle fuelwood than collect it. Many elderly people have difficulties in walking and carrying bundles of firewood. Young women are not used to travelling and prefer electricity as it was easier to use and acquire. In Catha, elderly women paid men to collect firewood for them as they had difficulties in carrying large bundles and travelling long distances (Shackleton *et al.*, 2007).

On a yearly basis the monetary value of Silver Wattle used for firewood approximated to ZAR 2 300 in Matatiele, ZAR 2 284 in Mount Fletcher and ZAR 2 154 per household. Given that there are many households in each village the resource value of Silver Wattle is substantial when combined, amounting to slightly below ZAR 1.5 million per site each year. If the value per hectare (ZAR 2 330) is extrapolated across the area invaded in South Africa then the annual use nationally will be worth billions of rands.

Silver Wattle helps in cash savings because respondents spent little on electricity as they use Silver Wattle mainly for their energy requirements. Other energy sources they use such as gas costs ZAR 42 per 2 kg are deemed expensive and unsustainable to make it their primary energy source. Villagers who reside in communities which do not have electricity rely completely on Silver Wattle for firewood. When it comes to fencing Silver Wattle also aids with cash savings. A standard 2.1 meter treated pole costs ZAR 67 at the local hardware shops. Given that they will require approximately 40 poles to completely fence the whole yard or kraal, poles acquired from Silver Wattle compliments those acquired from town hence aiding in cash savings. By making tools from Silver Wattle, villagers are saving cash they would have used to purchase tools.

With the exception of areas which are of importance to the local people such as fields where they remove Silver Wattle before commencement of the farming season, local communities are not doing anything to remove Silver Wattle from other landscapes. This concurs with Geesing

et al. (2004) who argued that rural communities rarely engage themselves in activities to remove IAS within their communities. Shaanker *et al.* (2010) notes that attempted control of IAS in human dominated landscapes may not be tenable or accepted. Three suggestions exist why rural communities did not engage themselves in activities to control IAS. Firstly, it is a valuable asset to their livelihoods and some people derive benefits from Silver Wattle and efforts to control on their own would result in strong conflicts between those relying on it. Conflicts were noticed in meetings in Matatiele and Maclear about Silver Wattle where there were propositions to remove it. Secondly, some rural communities do not attempt to control IAS because that they do not have the required equipment or means to control it and given the lack of money they would rather engage themselves in other activities. Shackleton *et al.* (2007) agrees with the same suggestions of why communities may not engage in clearing IAS within their communities. Thirdly some think it is someone's responsibility, especially the government. For instance, in Matatiele, ward 4, once Environmental Rural Solutions consultancy tasked with controlling IAS stopped clearing Black and Silver Wattle the local people never continued with the work as they felt it was the consultancy's responsibility not theirs. The Conservation of Agricultural Resource Act (CARA) law in South Africa requires private land owners to control IAS within their areas. However, the law has not been enforced on community lands. Since the study was carried out on communal lands there was no enforcements to control IAS. Reasons why there has been no enforcements on communal lands to control IAS might be due to the lack of political clout of the act and also that the communal land is owned by the state itself.

Due to the benefits the rural communities acquired from Silver Wattle, the majority of the respondents mentioned that their livelihoods will be negatively affected and they will struggle if Silver Wattle were to be cleared without replacement trees planted which would provide them with the same resources. Therefore, despite Silver Wattle being an invasive species it is widely used and celebrated. Consistent with Kull *et al.* (2011) who found that in Madagascar Australian *Acacias* had been accepted, widely utilised and recognised despite often overtaking landscapes. Life without Silver Wattle would be difficult for the rural communities in the Eastern Cape as their resource base will have diminished. The situation is exacerbated by few natural alternatives within the area as this is a grassland biome. Benefits accrued by rural communities can be classified into three ways namely cash generation, cash savings, safety nets and culture.

However, of paramount importance is to note that due to the increase in abundance with time since invasion. Translating from the Shackleton *et al.* (2007) framework as abundance and time since invasion increases the costs which rural communities accrue due to IAS invasion have increased.

3.5 Vulnerability due to Silver Wattle Invasion

The high abundance of *A. dealbata* in the landscapes negatively affects some local communities. Silver Wattle grows fast, closing up the available free spaces and forming thickets. Silver Wattle thickets are perceived to provide criminals with hiding places from which they can monitor activities within the villages. Women and children who are mostly responsible for gathering firewood are at a higher risk of being raped and attacked (de Neegard *et al.*, 2005). A murder case of a school child was reported in Chevy Chase village in Maclear in which the murderers were believed to have hidden within the Silver Wattle thickets. Thieves also take advantage of the high Silver Wattle density and steal livestock and property within houses (Shackleton *et al.*, 2007). Most respondents in Caba village Matatiele, had their livestock stolen and implicated Silver Wattle for providing cover to the thieves. In Chevy Chase school in Maclear, surrounded by Silver Wattle, a break-in had been reported computers were stolen. Villagers blamed the high abundance of Silver Wattle thickets which allowed the thieves to monitor activities happening at the school and sneak away after the theft. The high abundance of *Prosopis* in Garrisa village, Kenya, was deemed to provide a hideout for criminals (Maundu *et al.*, 2009).

A. dealbata has long roots such that when it is situated near buildings they can cause foundations of to crack. Consequently, it pushes the people to rebuild their houses or renovate which requires money. By so doing the proximity of Silver Wattle near households will bring stress to the people. The situation is exacerbated by harsh economic conditions in which people cannot afford to rebuild or renovate their houses frequently. The presence of Silver Wattle near people's houses has also been implicated in attracting dangerous animals to the yards. Animals such as snakes may inhabit in the trees and endanger people. Sundaram *et al.* (2012) reported that in southwest India, since the invasion of *L. camara* the people's encounters with dangerous animals such as bears and elephants had increased.

According to the majority of the respondents the presence of Silver Wattle in their fields promoted food shortages. Silver Wattle grows in high densities which reduces the area which is available for farming. Silver Wattle displays allelophatic effects (Lorenzo *et al.*, 2010) which

hinders the growth of other plants, including crops, around it. Unsuccessful growth of crops near Silver Wattle may also be due to its high water demand. *A. dealbata* consumes large amounts of water and in South Africa, it is rated as the third-most water consumptive invasive species (de Neergaard *et al.* 2005). Jevon & Shackleton (2015) in Mazeppa Bay, showed that respondents did not like *L. camara* in their fields as it was competing with their crops. *L. camara* was also reducing grazing areas meant for livestock.

People often clear their arable lands of Silver Wattle especially before the commencement of the farming season. Such findings corroborate those by Shackleton *et al.* (2007) were residents in Catha endured extra costs of removing Black Wattle from their fields and grazing lands. The majority of respondents in Ngambo village, Kenya, uproot or clear *Prosopis* from their fields more as the farming season commences or approaches (Mwangi & Swallow, 2005). The invasion of fields near Lake Chad by *Prosopis juliflora* was increasing vulnerability of local people to food security such that the government had to look for support from FAO to help them clear it from the fields (Geesing *et al.,* 2004). Rai & Scarborough (2015) agree with such arguments and found that in Nepal, local communities cleared *Mikania* from their fields bearing extra costs as they are managing IAS which invaded their fields. Economically marginalised households are finding it hard to successfully clear their fields as they may not be able to hire labour to clear the fields. The presence of Silver Wattle in grazing areas is said to be reducing the area which is meant for grazing. This will affect livestock and consequently affect locals' livelihoods as most rural South African households view cattle as a source of family wealth.

Growth of *A. dealbata* on culturally important sites such as graveyards and tribunal council lands is perceived to be hindering of local people's communication with their ancestors. Similarly, Shackleton *et al.* (2007) described how where traditional healers in Catha, stated that the presence of *A. mearnsii* in cultural areas, such as scared pools, upset the ancestors. By outcompeting the important native species which by tradition are not supposed to be cut or removed, Silver Wattle is negatively affecting the local people's culture. Consistent with Wakie *et al.* (2016) in Afar, their culture prohibited the removal of native species but the impacts of *P. juliflora* on the native species was affecting their culture. It is also invading areas meant for Afar traditional sports (Wakie *et al.*, 2016).

Despite Silver Wattle being an appreciated resource, there were landscapes such as yards, fields, grazing lands and pathways, where Silver Wattle presence was unappreciated.

Consistent to findings also by Wakie *et al.* (2016) in Afar, East Africa, where *P. juliflora* an IAS invades grasslands meant for grazing purposes hence local communities had to clear the grazing lands on their own as they do not want it in their grazing areas. According to other respondents the presence of Silver Wattle in the forests resulted in indigenous vegetation dying. These findings are similar to those by Rai & Scarborough (2015) in Nepal, where respondents felt that invasion of *Mikania* was disrupting the abundance native species as it outcompeted them.

Shackleton *et al.* (2007) proposed a framework in which as the abundance of an IAS increases so does its cost to the local community. The results from my study matches the trajectory of the framework as all people, despite them utilising Silver Wattle for different purposes, noted that the high abundance of Silver Wattle was now providing them with problems. Similar to studies by Shackleton *et al.* (2007) where respondents, despite use of Black Wattle, acknowledged the costs brought by the increase in abundance of the species and that costs of control would increase as abundance increases. Kull *et al.* (2011) argued that time and abundance of Australian *Acacias* within an area will shape how it is perceived by local communities. Sundram *et al.* (2013) notes that in southwest India the high abundance of *L. camara* was making the lives of people difficult as it hindered access to NTFPs. As the abundance of an IAS increases so will its cost of management (Shackleton *et al.*, 2007). Rai & Scarborough (2015) concluded that in Nepal, whereas abundance of an IAS, *Mikania*, increased there was a proportional increase in vulnerability of livelihoods of forest dependant households.

There were no significant differences in who experiences constraints due to Silver Wattle invasion. Almost a similar number of respondents within the different wealth quartiles stated that they experience constraints due to Silver wattle invasion. Pasiecznik *et al.* (2001) in India, stated that affluent respondents felt that invasive *P. juliflora* was only a nuisance to them as compared to poor households who embraced it in high abundance as an energy source. The effects of high abundance of Silver Wattle are felt by almost all the people. Crime affects almost everyone even though the richer people who own many assets maybe at more risk. Any women not taking into cognisance their wealth levels can be raped due to the high abundance of Silver Wattle, although the women from poor households are at more risk since the self-collect more than women in wealth households. Therefore, constraints due to Silver Wattle invasion are felt by all the people within the communities. Similar to findings by Shackleton *et al.* (2007) where effects of invasion by Black Wattle in Catha were felt by anyone despite widespread use.

3.6 Desired Densities

The negative effects associated with Silver Wattle prompted respondents to choose a moderately low abundance at some distance away from their homesteads. Silver Wattle is not wanted near homesteads, fields and pathways. Geldenhuys *et al.* (2016) argue that not all wattle should be removed but should be removed from certain landscapes such as near households, along footpaths and grasslands. These findings are opposite to those by Shackleton *et al.* (2007) in Catha, where the majority of respondents desired the highest density of Black Wattle suggested. Perceptions due to IAS invasion are context specific, especially without available alternatives. Also the Shackleton *et al.* (2007) study was conducted ten years ago hence as already alluded to perceptions towards IAS are not stagnant but differ with time and extend in invasion.

Therefore, despite Silver Wattle being invasive and having negative impacts on the local people's livelihoods, respondents still require the services and goods which it provides. In as much as the majority of the respondents may have negative perceptions towards Silver Wattle they still regarded it as useful to them. It was frequently asked, *"What is the government going to plant which would provide us with the same services like Silver Wattle if they remove it?"* The argument that Silver Wattle covers crime was the main reason why many people preferred low density of Silver Wattle in the area.

3.7 Use and Perceptions Changing with Time and Extent of Invasion

The high abundance of Silver Wattle influenced the perception of local people about it. As the abundance of Silver Wattle increased so did the negative perceptions of the local people towards it grew. Shackleton *et al.* (2007) postulated that perceptions of local people towards IAS can be highly influenced by the abundance of the IAS. According to the Shackleton *et al.* (2007) framework, as the abundance of an IAS increases so do the costs which are related to it. In this case as Silver Wattle abundance increased so did the costs, such as providing more cover for criminals, being found everywhere which would local activities such as farming and grazing of livestock, and increased presence near homesteads which could cause buildings to crack. In its initial years of introduction Silver Wattle was a favoured resource in which local communities would derive benefits. Consistent to findings by Lemma & Mohammed (2016) in Ethopia, where in the initial years of introduction *P. juliflora* was perceived positively but as

abundance increased then villagers were no longer happy with it. Change with time also resulted in change of the rules regarding Silver Wattle access. In all the areas initially villagers would need permission to access it but with time they were no longer required to seek permission for its use. However, in Maclear to access Silver Wattle for fencing purposes residents still require permission from the chief as they would be harvesting bigger trees in size which were no longer abundant.

With an increase in time since invasion local people began to notice Silver Wattle as a resource and began to derive benefits for their livelihood activities. Living in an era of technological advancements, these advancements affected use of Silver Wattle by local communities. Road creation within the communities allowed better movement of people involved in selling of Silver Wattle. Also during the time of road constructions, most workers used Silver Wattle for cooking and their temporary house construction. The introduction of electricity resulted in a decrease in use of Silver Wattle for firewood as people found easier and cleaner. Similarly Mapako & Prasad (2007) found in Zimbabwe, that rural electrification programmes resulted in a reduction in use of natural resources by rural communities. As electricity becomes more widely available and young women grow up with it. The use of Silver Wattle for firewood is likely to decline. This may well then increase local abundance due to lower use.

The end of the apartheid brought a change in the intensity in use of Silver Wattle. The end of racial limits on where people could live and work resulted in many people moving to bigger cities to look for better employment opportunities. Therefore, the population reduced and consequently the amount of Silver Wattle used decreased.

3.8 Locally Available Alternatives

Matatiele, Mount Fletcher and Maclear areas do not have much indigenous forest and the alternatives for firewood which were used included exotic *Eucalyptus* species and *Populus canescens*, cow dung, electricity, and gas or paraffin. *Eucalyptus* species for firewood were mainly found in Matatiele where the people had created a plantation for their own use, access to which for any purposes required permission from the chief. The study sites are located within grasslands with very small patches of indigenous forest on scarp slopes and some valleys, hence the low abundance of other tree species which can be used as alternatives (Geldenhuys, et *al.*, 2016). Similarly, Geesing *et al.* (2004) found that due to lack of alternatives in Yemen local communities use *P. juliflora* for firewood even though the local communities did not favour it as it produced unpleasant smell. The most common energy alternative used by the respondents

in the three sites was electricity. However, respondents favoured fuelwood which they obtained from Silver Wattle. Similarly, in Catha, Shackleton *et al*. (2007) reported that the majority (60 %) of the respondents favoured firewood by Black Wattle as compared to other alternatives. Respondents stated that Silver Wattle is easily accessible as it was close to them. Shackleton *et al*. (2007) also state that easy access of an IAS for use by local people can influence their perceptions towards it. Silver Wattle access is free unlike other alternatives such as electricity, gas and paraffin which are pricey for most households to use as their primary energy source. Therefore, the money would now be used for other livelihood activities. Silver Wattle makes good firewood without smoke as compared to other alternatives as such as cow dung.

CHAPTER FIVE: SYNTHESIS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Silver Wattle as Livelihood Asset

Using the SLF framework by DFID (1999) and results in chapter three it can be shown that Silver Wattle can be a livelihood asset. The specific purpose of this thesis was to understand if Silver Wattle can be used as a livelihood asset which may reduce vulnerability and provide opportunities for better livelihoods. The study incorporated household surveys to understand idiosyncratic uses of Silver Wattle (chapter 2). Using the SLF framework the livelihood assets are defined by the different uses and services which are offered by Silver Wattle. It was evident that Silver Wattle is playing a pivotal role in reducing vulnerability.

Silver Wattle is providing natural capital to the rural communities through providing resources such as firewood, poles, wood for making tools, fodder and medicinal purposes. Due to a lack of freely available natural alternatives for firewood in the study areas, Silver Wattle is used for fuelwood by every household, with the majority of the households using it as their primary source of energy. Silver Wattle produces excellent fuelwood, as recorded elsewhere (Kull *et al.*, 2011). A considerable amount of Silver Wattle firewood is collected by households on a monthly basis. The amount and frequency of Silver Wattle collection for firewood increases in winter. When conducting their cultural practices, rural communities use Silver Wattle for firewood. Additionally, those villages that have not yet been electrified rely exclusively on Silver Wattle for their energy requirements.

The close proximity of Silver Wattle to local communities and households aids local communities to access it at any time. The close proximity of a useful IAS influences perceptions towards it (Shackleton *et al.*, 2007). Silver Wattle is a whole year round resource, therefore respondents can access it at any given time. To acquire Silver Wattle the majority of respondents collect Silver Wattle on their own.

Silver Wattle is also used for poles which are used for fencing and to provide timber for making tools. Silver Wattle trees with larger diameters are favoured for fencing. However, the majority of respondents favour creosote treated poles and iron tools for fencing and tool handles, respectively. Respondents use Silver Wattle for fencing and tools less frequently with the amounts collected also being low on a yearly basis. However, to the poor households Silver Wattle is important for fencing purposes as they have to use many poles (approximately 40) poles per yard which they could not afford to buy. Silver Wattle is also used for medicine and

fodder purposes. The bark of Silver Wattle is mainly used for medicinal purposes to treat stomach-ache. Livestock, especially goats, favour the leaves of Silver Wattle. Respondents noted that livestock eat the leaves on a daily basis.

All the wealth quartiles use Silver Wattle for firewood, fencing, tools, medicine and fodder purposes. For firewood purposes the low-income quartile collect more Silver Wattle frequently than the higher-income quartiles, who collected bigger bundles which lasted longer than the headloads collected by poor respondents. Increased wealth allows households to be flexible on their ways of procuring NTFPs (Shackleton & Shackleton, 2006). Use of Silver Wattle for fencing, tools, medicines and fodder are also not influenced by wealth.

Gender of the household head did not influence Silver Wattle use but it does influence the method of procuring Silver Wattle. Females are mostly responsible for collecting firewood headloads. However, if they need bigger bundles they will require males to help them. Males are more involved in collecting Silver Wattle for fencing and tools than females.

There are very few freely available alternatives which offer the same natural capital as Silver Wattle in the rural communities of Matatiele, Mount Fletcher and Maclear. The only notable ones, but in low abundances, were *Eucalyptus* and *P. canescens*. The latter alternative is also an IAS which invades riverine landscapes. These species are located a considerable distance from local households hence they are not favoured.

Silver Wattle also contributes to social capital; invasion by Silver Wattle has led to numerous meetings within the communities to discuss on how best they can solve the situation. Thus it can be argued that it brings people together and helps in decision making processes. In Chevy Chase, Maclear, such meetings have attracted investors in the form of contractors who are cutting it in some areas. This has provided the local people with employment and some of the money channelled back to the communities.

Physical capital in form of building structures are provided from Silver Wattle. In constructing livestock kraals households use Silver Wattle poles. During the creation of roads, respondents who were employed there noted that for cooking and warming themselves they used Silver Wattle. Silver Wattle was also used for construction of their temporary homes.

Silver Wattle invasion has provided rural communities with financial capital. A few households are involved in selling Silver Wattle firewood cash generation. The households involved in selling products from Silver Wattle are of poor education whose chances of getting formal

employment are minimum. The cash which they generate is used for different livelihood enhancing activities. In the communities where they have agreed to have Silver Wattle cut in certain landscapes by contractors local people are getting employment. Through using Silver Wattle, households are acquiring services for free which they otherwise would have bought. Therefore, they will save cash. The resource value for Silver Wattle firewood amounted to just below ZAR 1.5 million per site annually. Therefore, these livelihood assets will result in better livelihood outcomes such as more income, reduced vulnerability and increased well-being.

5.2 Silver Wattle and Vulnerability

Rural communities in Matatiele, Mount Fletcher and Maclear, South Africa, do not only derive livelihood assets from Silver Wattle but they also experience vulnerability due to Silver Wattle invasion. Using the SLF framework the vulnerability context is defined by the high abundance of Silver Wattle. The vulnerability context interacted and affected the livelihood asset portfolio which consequently affected the livelihood outcomes. Conceptualisations of vulnerability has been defined as the extent of dimensions of exposure to stresses and shocks rendering the people incapable of responding to the stress (Adger, 2006). For instance, Silver Wattle can affect multiple forms of capital or directly through the household on their safety and reducing productivity through depleting household assets which allow households to cope with stresses. This thesis attempted to understand how Silver Wattle invasion can make households vulnerable in the context of its high abundance and presence in different landscapes. This study incorporated timeline trends which assessed the changes in abundance and people's perceptions to those changes (chapter 2) and people's perceptions to the abundance of Silver Wattle (chapter 2).

A worrying trend to the rural communities due to Silver Wattle invasion is its high abundance. Using the impacts of IAS on rural livelihoods framework in chapter 1 as the abundance of an IAS and time since invasion increases, the costs due to the invasion increases also. Abundance of an IAS influence negative perceptions by rural people towards an IAS (Shackleton *et al.*, 2007).

The Silver Wattle thick forests reputedly provide criminals with places to hide and ambush people, especially women mainly responsible for collecting firewood and rape them. The majority of the women are afraid to collect firewood. The thickets arguably also provide criminals with places to monitor events happening within the communities and steal from the people. Rural communities in Matatiele have had their livestock stolen and blame Silver Wattle

for providing criminals with places to hide. If the history of Silver Wattle increase over the previous years is to be given precedence, the abundance of Silver Wattle will continue increasing and this consequently increases the vulnerability of the people, especially as firewood use declines with increasing adoption of electricity.

The presence of Silver Wattle in particular landscapes also increases vulnerability. Presence in is noted to reduce the people's harvest. Silver Wattle's high affinity for water (Lorenzo *et al.*, 2010) causes other crops to wilt and their long roots cause farming to be difficult. Silver Wattle occurs in high abundance hence it will consume some of the land which is intended for farming. Often people incur extra costs when they have to clear the fields so that they can farm in their areas. Furthermore, even if the people mechanically clear Silver Wattle, it will still have its long roots within the ground and this will negatively affect farming activities. The presence of Silver Wattle in in grazing lands is not favoured because it is reducing land intended for pastures. Silver Wattle's growth near households results in foundations cracking. Therefore, the people will have to repair the damage and will need money to do so. Silver Wattle near homesteads also regarded as attracting dangerous animals which end up endangering the people's lives.

Wealth does not significantly influence who experiences constraints due to Silver Wattle invasion, although the women from more poor households are prone to rape and murder as they collect Silver Wattle more on their own. The inability of this study to specifically differentiate vulnerability due to Silver Wattle invasion based on capital stocks may be an indication of the shortfall of basing it on a reductionist approach (focusing predominantly on assets). Perceptions and costs experienced by rural respondents due to Silver Wattle are influenced by time since invasion and extend of invasion by the species. Perceptions and use of an IAS by local people are not static.

Considering the abundance and impacts relationships (Figure 5.1) benefits from Silver Wattle are most accrued when the abundance is medium. It is during this stage when benefits exceed the costs, hence Silver Wattle would be helpful in reducing vulnerability of the local residents. Even though the use of Silver Wattle at high abundance is high, as they can easily access it at any time with ease, benefits are outweighed by the numerous costs associated with invasion. At low abundance though costs will be very minimum but the benefits accrued will be very few as the species will be low.

5.3 Conclusion

From the findings in chapter 4 and using the Shackleton *et al.* (2007) framework it can be concluded that

- Silver Wattle is useful.
- Silver Wattle invasion is in the last phase of invasion of the Shackleton IAS framework, within the three sites. It is too abundant and should be reduced.
- From the Shackleton *et al.* (2007) framework which incorporates the characteristics of the species (Figure 1.3), Silver Wattle is a useful and strongly competitive species.
- IAS are not uniformly problematic or uniformly useful. Evidence from this study also supports that IAS effects on people are spatially and temporally variable and context specific. Invasions are not uniform, the socio-economic and education status of households are not uniform. Therefore, how IAS impact people is influenced by a plethora of different factors.
- Very few households are involved in the trade of Silver Wattle. However, all of the respondents were involved in Silver Wattle use at household subsistence level.
- Extrapolating results from chapter 3, it can be concluded that rural communities makes extensive uses of Silver Wattle and depending on its abundance, rural people perceive it as beneficial to their livelihoods.
- Rural communities have shown adaptation and dependency on the presence of IAS. Hence, their use is not a mere matter of coincidence. However, to assume that rural communities only derive benefits from IAS invasion will be a misconception as they also experience constraints due to invasion. A high abundance of Silver Wattle is associated with negative impacts such as reduction in arable land, grazing land and a rise in crime rate.

The main finding of this research revealed that Silver Wattle was a useful resource to rural communities and is making a positive contribution to rural livelihoods. However, the current high abundance of Silver Wattle is now negatively affecting rural communities. This has prompted rural communities to prefer the current Silver Wattle abundance to be reduced.

5.4 Policy Recommendations

Recommendations from this study are that before any control on Silver Wattle commences on a larger scale, the same approach should be conducted to set a platform to determine the potential social consequences of any control. Removal of IAS which will leave the rural more communities vulnerable to shocks will only inflict more pressure on the environment as they will exploit more of the resources to compensate their livelihoods. The role of useful IAS should be communicated to policy developers and land-use planners not only for the purposes of poverty alleviation but also will help in promoting sustainable use of NTFPs. However, plans should always be in place to manage the abundance of Silver Wattle at acceptable levels which are not detrimental both to the environment and the people. DFID (1999) state that sustainable livelihoods are capable of recovering from shocks and improve assets without negatively affecting natural resources. Findings that a high proportion of households use Silver Wattle for several uses, recommends further research and suggests that valuation of the uses may contribute to sustainable use which may help in poverty reduction.

Prioritisation in invasion biology should be focused on attaining social and ecological sustainability through creation of a balance of the abundance of Silver Wattle which is required by rural respondents in landscapes which they deem will help in providing livelihood assets and at an abundance which is of limited detriment to the environment. If Silver Wattle is to be removed then there should be a contingency plan by the government to plant other trees which will provide the same services, preferably indigenous species which are not detrimental to the environment. The planting of such alternatives should be done several years in advance of any Silver Wattle clearing efforts to allow time for the trees to establish and grow. Silver Wattle should be reduced as its current abundance is high but it should be a gradual process which will allow villagers a chance to adapt to this reduction. Findings that a high proportion of households require of Silver Wattle to be reduced, indicates that the high abundance of IAS increases vulnerability to people as well as the environment. There was not much difference in the perceptions of the people and the proximity of Silver Wattle to their households, however the distance was not measured. Therefore, for future studies distance between the houses and proximity to patches of vegetation should be measured and tested to determine if they do not influence perceptions.

5.5 Closing remarks

This study highlighted the complexity inherent in understanding the conflict of interest which exists in invasion biology, emanates from the difficulty to balance benefits, trade-offs and costs due to the invasions. Being able to breakdown these conflicts of interest is of paramount importance in social and ecological systems.

Silver Wattle is a useful species to local people as it is used for several livelihood activities. Perceptions of locals towards Silver Wattle invasion are influenced by its usefulness, abundance and time it has been available. The current perceptions of local people towards Silver Wattle can be best described as in 'dilemma'. Positive perceptions are due to its usefulness whereas the negative perceptions are due to its high abundance.

References

Achigan–Dako, E., N'Danikou, S., Assogba–Komlan, F., Ambrose–Oji, B., Ahanchede, A., & Pasquini, M. (2011). Diversity, geographical, and consumption patterns of traditional vegetables in sociolinguistic communities in Benin: Implications for domestication and utilization. *Economic Botany*, 65: 129-145.

Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16: 268-281.

Agrawal, A., Chatre, A., & Hardin, R. (2008). Changing governance of the world's forests. *Science,* 320: 1460-1462.

Aitken, M., Rangan, H., & Kull, C. (2009). Living with alien invasives: The political ecology of Wattle in the eastern Highveld Mpumalanga, South Africa. *Études Océan Indien*, 42: 115–142.

Angelsen, A., Jagger, P., Babigumira, R., Belcher, B., Hogarth, N. J., & Bauch, S. (2014). Environmental income and rural livelihoods: A global-comparative analysis. *World Development*, 64: S12-S28.

Arnold, J. E. M., & Ruiz-Pe'rez, M. (2001). Can non-timber forest products match tropical forest conservation and development objectives? *Ecological Economics*, 39: 437-447.

Beinart, W., & Wotshela, L. (2003). Prickly pear in the Eastern Cape since the 1950s: Perspectives from interviews. *Journal of Cape History,* 39*:* 191-209.

Berkes, F., Colding, J., & Folke, C. (2002). *Navigating social-ecological systems: Building resilience for complexity and change*. Cambridge University Press, Cambridge, London, UK.

Binggeli, P. (2001). *The human dimensions of invasive woody plants. The Great Reshuffling: Human Dimensions of Invasive Alien Species*. Gland (Switzerland): IUCN.

Birkmann, J., & Fernando, N. (2008). Measuring revealed and emergent vulnerabilities of coastal communities to tsunami in Sri Lanka. *Disasters*, 32: 82-105.

Blanckaert, I. K., Vancraeynest, R. L., Swennen, F. J., Espinosa García, D., Piñero, D., & Lira Saade, R. (2007). Non crop resources and the role of indigenous knowledge in semi–arid production of Mexico. *Agriculture, Ecosystems and Environment*, 119: 39–48.

Branch, G. M., & Nina Steffani, C. (2004). Can we predict the effects of alien species? A case-history of the invasion of South Africa by *Mytilus galloprovincialis* (lamarck). *Journal of Experimental Marine Biology and Ecology,* 300: 189-215.

Brocklesby, M.A., & Hinshelwood, E. (2001). *Poverty and the environment: What the poor say – an assessment of poverty-environment linkages in participatory poverty assessments. CDS*, University of Wales, Swansea.

Brockwell, J., Searle, S. D., Jeavons, A. C., & Waayers, M. (2005). *Nitrogen fixation in Acacias: An untapped resource for sustainable plantations, farm forestry and land reclamation.* Australian Centre for International Agricultural Research (ACIAR).

Cavendish, W. (2000). Empirical regularities in the poverty-environment relationship of rural households: Evidence from Zimbabwe. *World Development*, 28: 1979-2003.

Chambers, R. (2007). *From PRA to PLA and pluralism: Practice and theory. IDS Working Paper 286*, Institute of Development Studies. Brighton, UK.

Chambers, R., & Conway, G. (1992). *Sustainable rural livelihoods: Practical concepts for the 21st century*. Institute of Development Studies. Brighton, UK.

Coates, P. (2007). *American perceptions of immigrant and invasive species: Strangers on the land.* University of California Press, California, USA.

Cossalter, C. (1986). Introducing Australian Acacias in dry, tropical Africa. *Australian Acacias in Developing Countries.* Proceedings of an International Workshop at the Forestry Training Centre, 21: 118-122.

Danthu, P., Ndongo, M., Diaou, M., Thiam, O., Sarr, A., & Dedhiou, B. (2003). Impact of bush fire on germination of some West African Acacias. *Forest Ecology and Management*, 173: 1-10.

Davidson, D. W., & Morton, S. R. (1984). Dispersal adaptations of some Acacia species in the Australian arid zone. *Ecology,* 65: 1038–1051.

de Neergaard, A., Saarnak, C., Hill, T., Khanyile, M., Berzosa, A. M., & Birch-Thomsen, T. (2005). Australian wattle species in the Drakensberg region of South Africa: An invasive alien or a natural resource? *Agricultural Systems*, 85: 216-233.

Dennill, G. B., & Donnelly, D. (1991). Biological control of *Acacia longifolia* and related weed species (Fabaceae) in South Africa. *Agriculture, Ecosystems and Environment*, 37: 115-135.

DFID, U. (1999). *Sustainable livelihoods guidance sheets*. London. DFID.

Dickie, I. A., Bennett, B. M., Burrows, L. E., Nuñez, M. A., Peltzer, D. A. B., & Porté, A. (2014). Conflicting values: Ecosystem services and invasive tree management. *Biological Invasions*, 16: 705-719.

dos Santos, L. L., do Nascimento, A. L. B., Vieira, F. J., da Silva, V. A., Voeks, R., & Albuquerque, U. P. (2014). The cultural value of invasive species: A case study from semi–arid north eastern Brazil. *Economic Botany*, 68: 283-300.

Drimie, S., & Casale, M. (2009). Multiple stressors in Southern Africa: The link between HIV/AIDS, food insecurity, poverty and children's vulnerability now and in the future. *AIDS Care*, 21: 28-33.

Dunlop, R., & MacLennan, L. (2002). *Black wattle: The South African research experience.* Institute for Commercial Forestry Research, South Africa.

Department of Water Affairs and Forestry, South Africa. (2005). Groundwater Resource Assessment. Phase II. Methodology. *Ground water-surface water interactions*. Department of Water Affairs and Forestry, Pretoria.

Edwards, W., & Westoby, M. (1996). Reserve mass and dispersal investment in relation to geographic range of plant species: Phylogenetically independent contrasts. *Journal of Biogeography*, 23: 329-338.

Folke, C. (2006). Resilience: The emergence of a perspective for social–ecological systems analyses. *Global Environmental Change*, 16: 253-267.

Geesing, D., Al Khawlani, M., & Abba, M. L. (2004). Management of introduced *Prosopis* species: Can economic exploitation control an invasive species? *Unasylva*, 217: 36-44.

Geldenhuys, C. J. (1999). Requirements for improved and sustainable use of forest biodiversity: examples of multiple use forest in South Africa. In: Poker, J., Stein, I., Werder, U. (Eds.). *Proceedings Forum: Biodiversity Treasures in the World's Forests*. Alfred Toepfer Akademie, Germany.

Geldenhuys C. J, Funda, O., Aromaye, T., & Mugure, M. W. (2016). *Evaluation of selected quaternary catchments to guide management of the use, rehabilitation and conservation of natural woodlands and forests.* Department of Forest and Wood Science, Stellenbosch University, South Africa.

Gorgens, A., & van Wilgen, B. (2004). Invasive alien plants and water resources in South Africa: Current understanding, predictive ability and research challenges. Working for Water. *South African Journal of Science*, 100: 27-33.

Griffin, A., Midgley, S., Bush, D., Cunningham, P., & Rinaudo, A. (2011). Global uses of Australian acacias–recent trends and future prospects. *Diversity and Distributions*, 17: 837-847.

Hennink, M. M. (2013). *Focus group discussions.* Oxford University Press, UK.

Herlihy, P., & Knapp, G. (2003). Maps of, by, and for the peoples of Latin America. *Human Organization*, 62: 303-314.

Hirsh Hadorn, G., Bradley, D., Pohl, C., & Rist, S. (2006). Implications of transdisciplinarity for sustainability research. *Ecological economics*, 10: 119-128.

Holmes, T. P., Aukema, J. E., Holle, B.V., Liebhold, A., & Sills, E. (2009). Economic impacts of invasive species in Forests. Ann New York. *Academy of Science*, 1162: 18-38.

Hussein, K., & Nelson, J. (2016). *Sustainable livelihoods and livelihood diversification.* College of Agriculture and Life Sciences, Virginia, U.S.

Jackson, R. B., Jobbagy, E. G., Avissar, R., Baidya, R. S., Barrett, D., Cook, C. W., Farley, K. A., Le Maitre, D. C., McCarl, B. A., & Murray B. C. (2005). Trading water for carbon with biological carbon sequestration. *Science*, 310: 1944-1947.

Jevon, T., & Shackleton, C. M. (2015). Integrating local knowledge and forest surveys to assess *Lantana camara* impacts on indigenous species recruitment in Mazeppa bay, South Africa. *Human Ecology,* 43: 247-254.

Kannan, R., Shackleton, C. M., Krishnan, S., & Shaanker, R. U. (2016). Can local use assist in controlling invasive alien species in tropical forests? The case of *Lantana camara* in Southern India. *Forest Ecology and Management,* 376: 166-173.

Kannan, R., Shackleton, C. M., & Shaanker, R. U. (2014). Invasive alien species as drivers in socio-ecological systems: Local adaptations towards use of *Lantana* in Southern India. *Environment, Development and Sustainability*, 16: 649-669.

Kaoma, H., & Shackleton, C. M. (2015). The direct-use value of urban tree non-timber forest products to household income in poorer suburbs in South African towns. *Forest Policy and Economics*, 61: 104-112.

Kaufman, S. (2013). Invasive and introduced plants and animals: Human perceptions and approaches to management ed. by Ian D. Rotherham (review). *Ecological Restoration*, 31: 98-99.

Keirungi, J., & Fabricius, C. (2005). Selecting medicinal plants for cultivation at Nqabara on the Eastern Cape Wild Coast, South Africa. *South African Journal of Science*, 101: 497-501.

Kenrick, J. (2003). Review of pollen-pistil interactions and their relevance to reproductive biology of Acacia. *Australian System Botany*, 16: 119-130.

Kull, C. A., Shackleton, C. M., Cunningham, P. J., Ducatillon, C., Dufour-Dror, J., & Esler, K. J. (2011). Adoption, use and perception of Australian Acacias around the world. *Diversity and Distributions,* 17: 822-836.

Kull, C., Tassin, J., Rambeloarisoa, G., & Sarrailh, J. (2008). Invasive Australian Acacias on Western Indian Ocean islands: A historical and ecological perspective. *African Journal of Ecology,* 46: 684-689.

Kumschick, S., Gaertner, M., Vilà, M., Essl, F., Jeschke, J. M., & Pyšek, P. (2015). Ecological impacts of alien species: Quantification, scope, caveats, and recommendations. *Bioscience*, 65: 55-63.

Kunwar, R. M. (2003). Invasive alien plants and *Eupatorium*: Biodiversity and livelihood. *Himalayan Journal of Sciences*, 1: 129-133.

Larson, D. L., Phillips-Mao, L., Quiram, G., Sharpe, L., Stark, R., & Sugita, S. (2011). A framework for sustainable invasive species management: Environmental, social, and economic objectives. *Journal of Environmental Management*, 92: 14-22.

Leak, S. G. A. (1999). *Tsetse biology and ecology: Their role in the epidemiology and control of Trypanosmosis*. CABI publishing Wallingford, UK.

Le Maitre, D., De Lange, W., Richardson, D., Wise, R., & van Wilgen, B. (2011). The economic consequences of the environmental impacts of alien plant invasions in South Africa. *Biological Invasions: Economic and Environmental Costs of Alien Plant, Animal and Microbe Species.* CRC Press, Boca Raton, 295-323.

Le Maitre, D. C., Krug, R. M., Hoffmann, J. H., Gordon, A. J., & Mgidi T. N. (2008). *Hakea sericea*: Development of a model of the impacts of biological control on population dynamics and rates of spread of an invasive species. *Ecological Modelling*, 212: 342-358.

Le Maitre, D. C., Richardson, D. M., & Chapman, R. A. (2004). Alien plant invasions in South Africa: Driving forces and the human dimension. *Southern African Journal of Science*, 100: 103-112.

Le Maitre, D. C., Versfeld D. B., & Chapman, R. A. (2000). The impact of invading alien plants on surface water resources in South Africa: a preliminary assessment. *Water South Africa*, 26: 397-408.

Lemma, B., & Mohammed, N. (2016). Distribution and socio-economic impacts of *Prosopis juliflora* in Gamo Gofa, Segen area people and South Omo zones, Southern Ethiopia. *International Journal of Agricultural Science and Technology*, 2: 101-115.

Lorenzo, P., González, L., & Reigosa, M. J. (2010a). The genus Acacia as invader: The characteristic case of *Acacia dealbata* link in Europe. *Annals of Forest Science*, 67: 101-105.

Lorenzo, P., Rodríguez-Echeverría, S., González, L., & Freitas, H. (2010b). Effects of invasive *Acacia dealbata* link on soil microorganisms as determined by PCR-DGGE. *Applied Soil Ecology*, 44: 245-251.

Low, T. (2012). Australian Acacias: Weeds or useful trees? *Biological Invasions*, 14: 2217-2227.

Mahdi, S., Shivakoti, G., & Schmidt-Vogt, D. (2009). Livelihood change and livelihood sustainability in the uplands of Lembang subwatershed, West Sumatra, Indonesia, in a changing natural resource management context. *Environmental Management*, 43: 84-99.

Makiwane, M., & Chimere-Dan, D. (2010). *The people matter: The state of the population in the Eastern Cape*. Research and Population Unit, Eastern Cape Department of Social Development, South Africa.

Mapako, M., & Prasad, G. (2007). Rural electrification in Zimbabwe reduces poverty by targeting income-generating activities. *CSIR Natural Resources and the Environment,* 1: 1-6.

Marais, C., van Wilgen, B., & Stevens, D. (2004). The clearing of invasive alien plants in South Africa: A preliminary assessment of costs and progress: Working for Water. *South African Journal of Science,* 100: 97-103.

Maslin, R., & McDonald, M. (2004). *Acacia search. Evaluation of Acacia as a woody crop option for Southern Australia, RIRDC.* Union Offset Printers, Canberra, Australia.

Maundu, P., Kibet, S., Morimoto, Y., Imbumi, M., & Adeka, R. (2009). Impact of *Prosopis juliflora* on Kenya's semi-arid and arid ecosystems and local livelihoods. *Biodiversity*, 10: 33-50.

May, B. M., & Attiwill P. M. (2003). Nitrogen-fixation by *Acacia dealbata* and changes in soil properties 5 years after mechanical disturbance or slash-burning following timber harvest. *Ecology Management*, 181: 339-355.

McNeely, J. A. (2001a). *An introduction to human dimensions of invasive alien species. The Great Reshuffling: Human Dimensions of Invasive Alien Species*. IUCN, Gland, Switzerland.

McNeely, J. A. (2001b). *Global strategy on invasive alien species*. IUCN, Gland, Switzerland.

McNeely, J., Rotherham, I., & Lambert, R. (2011). Xenophobia or conservation: Some human dimensions of invasive alien species. *Invasive and introduced plants and animals: Human perceptions, attitudes, and approaches to management.* IUCN, Gland, Switzerland.

Meyerson, L. A., & Mooney, H. A. (2007). Invasive alien species in an era of globalization. *Frontiers in Ecology and the Environment*, 5: 199-208.

Mooney, H. A. (2005). *Invasive alien species: A new synthesis.* Island press. London, UK.

Mugasi, S., Sabiiti, E., & Tayebwa, B. (2000). The economic implications of bush encroachment on livestock farming in rangelands of Uganda. *African Journal of Range and Forage Science,* 3: 64-69.

Mwangi, E., & Swallow, B. (2008). *Prosopis juliflora* invasion and rural livelihoods in the Lake Baringo area of Kenya. *Conservation and Society*, 6: 130-137.

Nayak, B., Raju, S., & Ramsubhag, A. (2008). Investigation of wound healing activity of *Lantana camara* in Sprague dawley rats using a burn wound model. *International Journal of Applied Research in Natural Products*, 1: 15-19.

Niehof, A. (2004). The significance of diversification for rural livelihood systems. *Food Policy*, 29, 321-338.

Newing, H. (2010). *Conducting research in conservation: Social science methods and practice* Routledge. New York, USA.

Novoa, A., Kaplan, H., Wilson, J. R., & Richardson, D. M. (2016). Resolving a prickly situation: Involving stakeholders in invasive cactus management in South Africa. *Environmental Management,* 57: 998-1008.

Nuñez, M. A., & Simberloff, D. (2005). Invasive species and the cultural keystone species concept. *Ecology Social*, 10: 1-4.

Oelofse, M., Birch-Thomsen, T., Magid, J., de Neergaard, A., van Deventer, R., & Bruun, S. (2016). The impact of Black Wattle encroachment of indigenous grasslands on soil carbon, Eastern Cape, South Africa. *Biological Invasions*, 18: 445-456.

Pasiecznik, N. M., Felker, P., & Henry Doubleday Research Association. (2001). *The 'Prosopis juliflora'-'Prosopis pallida'complex. A monograph* HDRA Coventry.

Paumgarten, F., & Shackleton, C. M. (2011). The role of non-timber forest products in household coping strategies in South Africa: The influence of household wealth and gender. *Population and Environment,* 33: 108-131.

Pejchar, L., & Mooney, H. A. (2009). Invasive species, ecosystem services and human well-being. *Trends in Ecology and Evolution,* 24: 497-504.

Pfeiffer, J. M., & Ortiz, E. H. (2007). Invasive plants impact California native plants used in traditional basketry. *Fremontia,* 1: 7–13.

Pfeiffer, J. M., & Voeks, R. A. (2008). Biological invasions and biocultural diversity: linking ecological and cultural systems. *Environmental Conservation*, 35: 281-293.

Pimentel, D., Lach, L., Zuniga, R., & Morrison, D. (2000). Environmental and economic costs of non-indigenous species in the United States. *Bioscience*, 50: 53-65.

Perera, A., Pasiecznik, N., Smith, S., Harris, P., Perera, E., & Premalal, G. (2005). *Turning invasive Prosopis to improving livelihoods in Sri Lanka.* Proceedings of the 17th Commonwealth Forestry Conference, Colombo, Sri Lanka.

Pretty, J. (2002). Landscapes lost and found. *Agriculture: Reconnecting People, Land and Nature*. Earthscan, Routledge, London.

Rai, R. K., & Scarborough, H. (2015). Understanding the effects of the invasive plants on rural forest-dependent communities. *Small-Scale Forestry*. 14: 59-72.

Rai, R. K., Scarborough, H., Subedi, N., & Lamichhane, B. (2012). Invasive plants: Do they devastate or diversify rural livelihoods? Rural farmers' perceptions of three invasive plants in Nepal. *Journal of Nature Conservation*, 20: 170-176.

Rama Devi, S., & Prasad, M. N. V. (1991). Tannins and related polyphenols from ten common Acacia species of India. *Bioresources Technology*, 36: 189-192.

Rango, A., Huenneke, L., Buonopane, M., Herrick, J. E., & Havstad, K. M. (2005). Using historic data to assess effectiveness of shrub removal in southern New Mexico. *Journal of Arid Environments*, 62: 75-91.

Reid, P., & Vogel, C. (2006). Living and responding to multiple stressors in South Africa: Glimpses from KwaZulu-Natal. *Global Environmental Change*, 16: 195-206.

Richardson, D. M., Pyšek, P., Rejmánek, M., Barbour, M. G., Panetta, F. D., & West, C. J. (2000). Naturalization and invasion of alien plants: Concepts and definitions. *Diversity and Distributions*, 6: 93-107.

Richardson, D. M., & van Wilgen, B. W. (2004). Invasive alien plants in South Africa: How well do we understand the ecological impacts? Working for Water. *South African Journal of Science*, 100: 45-52.

Robin, L., & Carruthers, J. (2012). National identity and international science: the case of Acacia. *History Records Australian Science*, 23: 34-54.

Scoones, I. (1998). Sustainable rural livelihoods: A framework for analysis. *Institute of Developmental Studies*, 72: 2-19.

Searle, S. (1997). *Acacia mearnsii* de wild. (Black wattle) in Australia. Black Wattle and its utilizations. *Barton, ACT: Rural Industries Research and Development Corporation,* 1: 1-10.

Serrat, O. (2008). *The Sustainable Livelihoods Approach*. Asian Development Bank. Philippines

Semenya, S. S., Tshisikhawe, M. P., & Potgieter, M. (2012). Invasive alien plant species: A case study of their use in the Thulamela local municipality, Limpopo province, South Africa. *Scientific Research and Essays*, 7: 2363-2369.

Shaanker, U., Joseph, G., Aravind, N., Kannan, R., & Ganeshaiah, K. (2010). Invasive plants in tropical human-dominated landscapes: Need for an inclusive management strategy. *Bioinvasions and Globalization: Ecology, Economics, Management and Policy*, 13: 202-219.

Shackleton, C., & Gambiza, J. (2008). Social and ecological trade-offs in combating land degradation: The case of invasion by a woody shrub (*Euryops floribundus*) at Macubeni, South Africa. *Land Degradation and Development*, 19: 454-464.

Shackleton, C. M., McGarry, D., Fourie, S., Gambiza, J., Shackleton, S. E., & Fabricius, C. (2007). Assessing the effects of invasive alien species on rural livelihoods: Case examples and a framework from South Africa. *Human Ecology*, 35: 113-127.

Shackleton, C. M., & Shackleton, R. T. (2016). Knowledge, perceptions and willingness to control designated invasive tree species in urban household gardens in South Africa. *Biological Invasions,* 10:1-11.

Shackleton, C. M., & Shackleton, S. E. (2004). The importance of non-timber forest products in rural livelihood security and as safety-nets: Evidence from South Africa. *South African Journal of Science,* 100: 658-64.

Shackleton, C. M., & Shackleton, S. E. (2006). Household wealth status and natural resource use in the Kat River valley, South Africa. *Ecological Economics,* 57: 306-317.

Shackleton, C. M., Shackleton, S. E., Buiten, E., & Bird, N. (2007). The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in South Africa. *Forest Policy and Economics*, 9: 558-577.

Shackleton, C. M., Shackleton, S. E., Gambiza, J., Nel, E., Rowntree, K., & Urquhart, P. (2010). *Livelihoods and vulnerability in the arid and semi-arid lands of Southern Africa: Exploring the links between ecosystem services and poverty alleviation*. Nova publishers, New York, USA.

Shackleton, C. M., Willis, C. B., & Scholes, R. J. (2001). Woodlands or wastelands: examining the value of South Africa's woodlands. *Southern African Forestry Journal*, 19: 65-72.

Shackleton, R. T., Le Maitre, D. C., & Richardson, D. M. (2014). Stakeholder perceptions and practices regarding Prosopis (mesquite) invasions and management in South Africa. *Ambio*, 44: 569-581.

Shackleton, R. T., Le Maitre, D. C., & Richardson, D. M. (2015). Prosopis invasions in South Africa: Population structures and impacts on native tree population stability. *Journal of Arid Environments*, 114: 70-78.

Shackleton, S. E. (2005). *The significance of local level trade in natural resource products for livelihoods and poverty alleviation in South Africa*. PhD thesis. Rhodes University, Grahamstown.

Shackleton, S. E., Kirby, D., & Gambiza, J. (2011). Invasive plants: friends or foes? Contribution of prickly pear (*Opuntia ficus-indica*) to livelihoods in Makana municipality, Eastern Cape, South Africa. *Development Southern Africa*, 28: 177-193.

Sharma, I. (1981). Ecological and economic importance of *Prosopis juliflora* (swartz) DC., in the Indian Thar desert. *Journal of Taxonomy and Botany*, 2: 245-248.

Sharp, K. (2007). Squaring the "Q's"? Methodological Reflections on a study of destitution in Ethiopia. *World Development*, 2: 264-280.

Sheppard, A. W., Shaw, R. H., & Sforza, R. (2006). Top 20 environmental weeds for classical biological control in Europe: A review of opportunities, regulations and other barriers to adoption. *Weed Research*, 46: 93-117.

Siges, T. H., Hartemink, A. E., Hebinck, P., & Allen, B. (2005). The invasive shrub *Piper aduncum* and rural livelihoods in the Finschhafen area of Papua New Guinea. *Human Ecology,* 33: 875-893.

Steenkamp, H. E., & Chown, S. L. (1996). Influence of dense stands of an exotic tree, *Prosopis glandulosa*, on savannah dung beetle (Coleoptera: Scarabaeinae) assemblage in Southern Africa. *Biological Conservation*, 78: 305-311.

Sundaram, B., Krishnan, S., Hiremath, A. J., & Joseph, G. (2012). Ecology and impacts of the invasive species, *Lantana camara*, in a social-ecological system in South India: Perspectives from local knowledge. *Human Ecology*, 40: 931-942.

Thondhlana, G., Vedeld, P., & Shackleton S. E. (2013). Natural resource use, income and dependence among San and Mier communities bordering Kgalagadi Transfrontier Park, southern Kalahari, South Africa. *International Journal of Sustainable Development and World Ecology*, 19: 460-470

Turner, I. I., Matson, B. L., McCarthy, P. A., Corell, J. J., Christensen, R. W., Eckley, L., Hovelsrud-Broda, N., Kasperson, G., Kasperson, J. X., Luers, R. E., Martello, A., Mathiesen, S., Naylor, M. L., Polsky, R., Pulsipher, C., Schiller, A., Selin, H., & Tyler, N. (2003). Illustrating the coupled human–environment system for vulnerability analysis: Three case studies. *Proceedings of National Academy of Science*, 100: 8080-8085.

Turpie, J. K., Marais, C., & Blignaut, J. N. (2008). The working for water programme: Evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. *Ecological Economics*, 65: 788-798.

Twine, W., Moshe, D., Netshiluvhi, T., & Siphugu, V. (2003). Consumption and direct-use values of savanna bio-resources used by rural households in Mametja, a semi-arid area of Limpopo province, South Africa. *South African Journal of Science*, 99: 467-472.

UNEP/IISD. (2004). *Exploring the links: Human well-being, poverty and ecosystem services*. UNEP/IISD, Canada.

Uy, N., Takeuchi, Y., & Shaw, R. (2011). Local adaptation for livelihood resilience in Albay, Philippines. *Environmental Hazards*, 10: 139-153.

van Wilgen, B. (2012). Evidence, perceptions, and trade-offs associated with invasive alien plant control in the table mountain national park, South Africa. *Ecology and Society*, 17: 23-26.

van Wilgen, B. W., De Wit, M., Anderson, H., Le Maitre, D., Kotze, I., & Ndala, S. (2004). Costs and benefits of biological control of invasive alien plants: Case studies from South Africa: Working for Water. *South African Journal of Science*, 100: 113-122.

van Wilgen, B. W., Forsyth, G. G., Le Maitre, D. C., Wannenburgh, A., Kotzé, J. D. F., & van den Berg, E. (2012). An assessment of the effectiveness of a large, national-scale invasive alien plant control strategy in South Africa. *Biological Conservation*, 148: 28-38.

van Wilgen, B. W., & Richardson, D. M. (2014). Challenges and trade-offs in the management of invasive alien trees. *Biological Invasions,* 16: 721-734.

Vedeld, P., Angelsen, A., Bojö, J., Sjaastad, E., & Berg, G. K. (2007). Forest environmental incomes and the rural poor. *Forest Policy and Economics*, 9: 869-879.

Wakie, T. T., Laituri, M., & Evangelista, P. H. (2016). Assessing the distribution and impacts of *Prosopis juliflora* through participatory approaches. *Applied Geography*, 66: 132-143.

Walker, B., Holling, C. S., Carpenter, S. R., & Kinzig, A. (2004). Resilience, adaptability and transformability in social-ecological systems. *Ecology and Society*, 9: 5-10.

Walter, K. J., & Armstrong, K. V. (2014). Benefits, threats and potential of *Prosopis* in South India. *Forests Trees and Livelihoods*, 23: 232-247.

WCED, U. (1987). *Our common future*. World Commission on Environment and Development Oxford University Press. Oxford, UK.

Wiegers, E., Curry, J., Garbero, A., & Hourihan, J. (2006). Patterns of vulnerability to AIDS impacts in Zambian households. *Development and Change,* 37: 1073-1092.

Williams, A., & Shackleton, C. M. (2002). Fuelwood use in South Africa: where to in the 21st century? *Southern African Forestry Journal,* 196: 1-7.

Witt, H. (2005). Clothing the once bare hills of Natal. The origin and development of wattle growing in Natal, 1860-1960. *South African Historical Journal,* 53: 99-122.

World Bank, (2004). *Sustaining Forests: a Development Strategy*. World Bank, Washington D.C, USA.

Wunder, S., Angelsen, A., & Belcher, B. (2014). Forests, livelihoods, and conservation: Broadening the empirical base. *World Development*, 64: S1-S11.

Xego, S., Kambizi, L., & Nchu, F. (2016). Threatened medicinal plants of South Africa: Case of the family hyacinthaceae. *African Journal of Traditional, Complementary & Alternative Medicines,* 13: 45-56.

Appendix 1.
Interview Schedule Used
HOUSEHOLD INTERVIEW

Date: Village: Household number from aerial photograph: Interview schedule number:

A. DYNAMICS OF INVASION

1. How many years have you been living here? _____

2. Do you know this species? Y [ ] N [ ]

3. What do you call it? _____

4. Does it 'mean anything'? Y [ ] N [ ] D/K [ ]

5. If yes, what does it mean? _____

6. Does it have any other names? _____

7. For how long has the Silver Wattle been here? _____

8. Was it here when you were young? Y [ ] N [ ] D/K [ ]

9. If no, when did you begin to notice Silver Wattle? _____

10. Have you noticed any change in the IAS abundance over the last 5-10 years? Y [ ] N [ ]
11. If yes, how has it changed? : Increased [ ] decreased [ ]

12. What might be the reason for that change?

_____

B. FIREWOOD

13. Do you use Silver Wattle for firewood Y [ ] N [ ]

14. Do you collect/ buy/ both? _____

15. If you collect, how often do you collect? _____

16. When did you last collect? _____

17. Approximately how long does a trip take?_____

18. How many bundles do you collect per trip?_____

19. Who in the family is responsible for collecting the firewood? _____

20. Are there months when you collect more than usual? Y [ ] N [ ]

21. If yes which ones and why? _____

Buying

22. Do you buy Silver Wattle firewood? Y [ ] N [ ]

23. How often do you buy? _____

24. When did you last buy some? _____

25. How much per time? _____

26. What is the cost per unit?_____

27. What was the price last year? _____

28. From where/who do you buy it from? _____

29. Do you pay for transport? Y [ ] N [ ]

30. If yes how much? _____

31. Are there any months you where you buy the species more than usual? Y [ ] N [ ]

32. If yes which and why? _____

Selling

33. Do you sell any firewood from the species? Y [ ] N [ ]

34. If yes: How often do you sell?_____

35. When did you last sell? _____

36. How much do you sell a unit for?

37. How much do you sell per week/month? _____

38. Where do you get the firewood that you sell?_____

39. Do you pay for transport? Y [ ] N [ ]

40. If yes, how much? _____

41. Where do you sell and/or to who are your customers?_____

42. What do you use the money acquired from selling the firewood from the species for?

Food	
Sent children to school	
Clothing	
Buy farming materials	
Savings	
Other: Specify	

C. FENCING

43. Do you use the Silver Wattle for fencing? Y [ ] N [ ]

44. Do you collect/buy/both? _____

45. If you collect, how often do you collect silver wattle for fencing?

46. When was the last you collected poles? _____

47.Who in the household is responsible for collecting poles? _____

48. Approximately how long does a trip take? _____

49. How much do you collect per interval? _____

50. Are there months when you collect more than others? Y [ ] N [ ]

51. If yes which ones and why? _____

Buying

52. Do you buy Silver Wattle poles for fencing? Y [ ] N [ ]

53. If yes, what is the cost per pole? _____

54. How often do you buy? _____

55. How much do you buy per time?_____

56.When did you buy it last? _____

57. What was the price last year? _____

58. From where do you buy it? _____

59. Do you pay for transport? Y [ ] N [ ] if yes how much? _____

60. Are there any months you where you buy the species more than usual? Y [ ] N [ ]

61. If yes why? _____

Selling

62. Do you sell any Silver Wattle poles for construction? Y [ ] N [ ]

63. If yes, how often do you sell? _____

64. How much do you sell a pole for? _____

65. When did you sell last? _____

66. How much do you sell per week/month? _____

67. Where do you get the poles that you sell? _____

68. Do you pay for transport? If yes, how much? _____

69. Where do you sell and/or to who are your customers?

_____

70. What do you use the money acquired from selling poles from the species?

Food	
Sent children to school	
Clothing	
Buy farming materials	
Savings	
Other: Specify	

D. WOOD FOR TOOLS/ TOOLS

71. Do you use the Silver Wattle to carve tools? Y [ ] N [ ]

72. Do you collect/buy/ both? _____

73. If you collect, how often do you collect wood for carving? _____

74. When did you last collect? _____

75. Who is responsible for collecting wood for carving? _____

76. Approximately how long does a trip take? _____

77. How much do you collect per interval? _____

78. Are there months when you collect more than usual? Y [ ] N [ ]

79. If yes which ones and why? _____

Buying

80. Do you buy wood for carving tools from Silver Wattle? Y [ ] N [ ]

81. If yes, what is the cost pert tool? _____

82. How often do you buy? _____

83.How much do you buy per time?_____

84.When did you last buy? _____

85. What was the price last year? _____

86. From where do you buy it? _____

87. Do you pay for transport? Y [ ] N [ ]

88. If yes how much? _____

89. Are there any months you where you buy more than usual? Y [ ] N [ ]

90. If yes why? _____

Selling

91. Do you sell any tools made from Silver Wattle? Y [ ] N [ ]

92. How often do you sell?_____

93. When did you last sell? _____

94. How much do you sell the tools for? _____

95. How much do you sell per week/month? _____

96. Where do you get the wood for carving from? _____

97. Do you pay for transport? Y [ ] N [ ]

98. If yes, how much? _____

99. What do you use the money acquired from selling the tools curved from the species for

Food	
Sent children to school	
Clothing	
Buy farming materials	
Savings	

E. MEDICINES

100. Do you use Silver Wattle for medicinal purposes? Y [ ] N [ ]

101. Do you collect/buy/ both? _____

102. When did you collect last? _____

103. If they collect, how often do you collect? _____

104. Which parts do you use for medical purposes? _____

105. Approximately how long does a trip take? _____

106. Are there months when you collect more than others? Y [ ] N [ ]

107. If yes which ones and why? _____

Buying

108. Do you buy any medicines made from Silver Wattle? Y [ ] N [ ]

109. If yes, how often do you buy it? _____

110. How much do you buy per time? _____

111. If yes what is the cost of medicine? _____

112. What was the price last year? _____

113. Where do you buy it from? _____

114. When did you buy it last? _____

115. Do you pay for transport? Y [ ] N [ ]

116. If yes how much? _____

117. Are there any months you where you buy it more than usual? Y [ ] N [ ]

118. If yes which are they and why? _____

Selling

119. Do you sell any medicines made from the IAS? Y [ ] N [ ]

120. If yes, how often do you sell? _____

121. How much do you sell the medicine for? _____

122. How much do you sell per day/week/month? _____

123. When was the last time you sold?_____

124. Where do you get the medicine from? _____

125. Do you pay for transport? Y [ ] N [ ]

126. If yes, how much? _____

127. Where do you sell and/or to who are your customers? _____

128. What do you use the money acquired from selling medicine acquired form the species for?

Food	
Sent children to school	
Clothing	
Buy farming materials	
Savings	
Other	

F. FODDER

129. Do you use Silver Wattle for fodder? Y [ ] N [ ]

130. If yes, which parts do you use as fodder? _____

131. Do you collect/buy/both? _____

132. If they collect, how often do you collect? _____

133. When did you collect last? _____

134. How long does a trip take? _____

135. Are there months when you collect more than usual? Y [ ] N [ ]

136. If yes which ones and why? _____

Buying

137. Do you buy Silver Wattle fodder? Y [ ] N [ ]

138. How often do you buy? _____

139. How much do you buy per time? _____

140. When did you last buy some? _____

141. What is the cost of fodder from Silver Wattle? _____

142. What was the price last year? _____

143. Where do you buy it from? _____

144. Do you pay for transport? Y [ ] N [ ]

145. If yes how much? _____

146. Are there any months when you buy Silver Wattle fodder more than usual? Y [ ] N [ ]

147. If yes why? _____

Selling

148. Do you sell any fodder made from Silver Wattle? Y [ ] N [ ]

149. If yes, how often do you sell? _____

150. How much do you sell the fodder for? _____

151. How much do you sell per week/month? _____

152. When was the last time you sold? _____

153. Where do you get the fodder/ pods from? _____

154. Do you pay for transport? Y [ ] N [ ]

155. If yes, how much? _____

156. Where do you sell and/or to who are your customers? _____

157. What do you use the money acquired from selling acquired from Silver Wattle fodder?

Food	
Sent children to school	
Clothing	
Buy farming materials	
Savings	
Other	

G. ALTERNATIVES

158. Do you remember a time when this species was absent? Y [ ] N [ ]

159. If yes: What alternative species where you using to get the below services as from the Silver Wattle?_____

Use	Alternative Species	Frequency of use	Time taken for a trip
Firewood			
Fencing			
Wood for carving tools and handles			
Medicines			
Fodder			

160. Which one did you prefer for the below services? Please tick in a box

Purpose/ Use	Silver Wattle	Alternative species	Why do you prefer it?
Firewood			
Fencing			
Wood for carving tools and handles			
Medicines			
Fodder			

161. Do you still use those alternative species? Y [ ] N [ ]

162. Do you collect/buy/ both the alternative species?

_____

163. Are there any products or goods from Silver Wattle which are impossible to make from the alternative species? Y [ ] N [ ] D/K [ ]

164. If yes what?

_____

165. If Silver Wattle is reduced in abundance or removed are there any species available to offer the same services?

166. Will your livelihoods improve if it was not here? Y [ ] N [ ] D/K [ ]

167. Why? _____

168. Will your livelihoods improve if it increased to double the current amount? Y [ ] N [ ] D/K [ ]

169. Why? _____

170. What do you like about Silver Wattle? _____

171. What don't you like about Silver Wattle? _____

E. EFFECTS ON LAND USES

172. Are there any specific areas where this species is most common? Y [ ] N [ ] D/K [ ]

173. If yes, what are those areas? _____

174. Are there any areas in the landscape where you wouldn't want Silver Wattle to grow? Y [ ] N [ ]

D/K [ ]

175. If yes, what are those areas? _____

176. Why don't you want it to grow there?

_____

177. Are there any problems associated with the species to your household? Y [ ] N [ ]

178. If yes, what are those problems? _____

179. Are there other problems that the species causes to other households? Y [ ] N [ ] D/K[ ]

180. If yes what are these? _____

181. Does the tree grow on any arable agricultural land or on grazing areas?

_____

F. CULTURAL SIGNIFICANCE

182. Are there any cultural or ritual uses for the species? Y [ ] N [ ] DK [ ]

183. If yes, what? _____

184. How is it used? _____

185. Is the species found on any culturally important sites? Y [ ] N [ ] DK [ ]

186. If yes, where? _____

187. Are there rules to use of Silver Wattle? Y [ ] N [ ] DK [ ]

188. If yes, what are the rules?

_____

189. Are there any taboos, beliefs and stories about Silver Wattle? Y [ ] N [ ] DK [ ]

190. If yes, what are they? _____

191. Other comments about Silver Wattle?

_____

_____

_____

_____

_____

_____

G. HOUSEHOLD ATTRIBUTES

Age	**Gender**	**Marital status**	**Occupation**	**Education (yrs)**	**Grants**

192. How many livestock do you own?

Cattle		Goats/sheep		Pigs		Donkeys		Poultry	

193. What is the household's main source of income?

_____

194. What is the second most important source of income? _____

195. Does this household have electricity? Y [ ] N [ ]

196. If yes, approximately how much do you spend per month? _____

Appendix 2. Participatory Learning Action Schedule

1. TIME TREND ANALYSIS

- To identify any in(direct) contributions of *A.dealbata* towards local livelihoods and how it has changed with time.

With who?

- Work with 7-8 senior members of the community.

Instruments used

- Use a spacious room.
- Seeds, coloured seeds or pebbles to signal scores.
- Writing or drawing tools (e.g., chalk, coloured powder, or pencil).
- A video to capture the activities.
- A voice recorder to record the session.
- A notebook to capture notes.

How?

- Initiate the discussion on situation of *Acacia dealbata* invasion.
- Facilitate the discussion to reach perceptions and livelihood uses of the species whose changes will be analysed. Some of the aspects that will be analysed include:
  - Changes in the livelihood uses of *A.dealbata*.
  - Changes in perceptions towards the species.
  - Changes in the rules towards access to *A.dealbata*.
- Facilitate the selection of time landmarks across which the trends could be studied. Done through identifying certain years that had significant effects on the perceptions and uses of *A. dealbata.*
- With the help of participants construct a matrix. One side consisting of attributes discussed and the other times

- Take on one attribute and put it a matrix and ask the participants to state its present scenario and go with it backwards.
- Where necessary drawings will be done or symbols (markers and seeds)
- Give some minutes to participants to review its content and make any amendments necessary.
- Discuss the diagram with participants. Encourage them to discuss their finding. Some
  - If they perceive any pattern in trends.
  - Major causes of trends.
  - Effects of *A.dealbata* invasion at different times.
  - Effects on sustainability of livelihoods and food security.
- Review your notes with the participants.

2. SEASONAL CALENDARS

What for?

- To identify seasonal changes in (in)direct contributions of *A.dealbata.*

With who?

- Work with 7-8 senior members of the community.

Instruments

- Large and spacious room.
- Seeds, coloured cards, or pebbles to signal information.
- Writing and drawing materials.
- A camera to capture the activities.
- A voice recorder to record the session.
- A notebook to capture notes.

How?

- Discuss the different seasons of the year with participants.
- Draw a table with the seasons/ months in the top row, starting with the month stated by the participants as 'beginning' of the year as specified.

- Then discuss about the activities done by the community in each month.
- Ask the participant to list their activities focusing on the most important activities. If Silver Wattle related activities are not mentioned, ask whether they can be added to the list.
- Draw a separate row on the table for each activity and places the beans in months box for each activity and ask the relative importance of each.
- Ask who does which activity and how many do each activity and place beans to indicate the labour.

3. PREFERRED DENSITIES

With who?

- One male and one female group comprising of 7-8 people each.

Instruments

- Large and spacious room.
- Pictures at different densities.
- Writing and drawing materials.
- A video recorder to capture the activities.
- A voice recorder to record the session.
- A notebook to capture notes.

How?

- Community to create a participatory landscape map.
- Provide people with pictures consisting of different densities.
- Ask them to pick up their preferred densities per landscape type or position.
- Discuss about the reasons for the preferred decisions.

4. TRANSECT WALKS

What for?

- To identify the (in)direct contributions of Silver Wattle towards sustainable livelihoods.
- To identify perceived effects over Silver Wattle invasions.

With Who?

- Approximately 5-7 senior members of the village

Instruments

- Video to take visual records.
- Notebooks to take notes.
- Portable drawing materials if possible.

How?

- Choose a direction randomly
- During the way questions will be asked, mainly about the following attributes:
  - Main land use in the area.
  - People in the area mainly concerned with collecting Silver Wattle.
  - Who owns Silver Wattle?
  - Are there any conflicts regarding Silver Wattle on a community level?
  - Are there any laws which affect access to Silver Wattle?

Transect Walks Outcomes

Main land uses

- Farming
- Cattle rearing
- Trade to raise capital

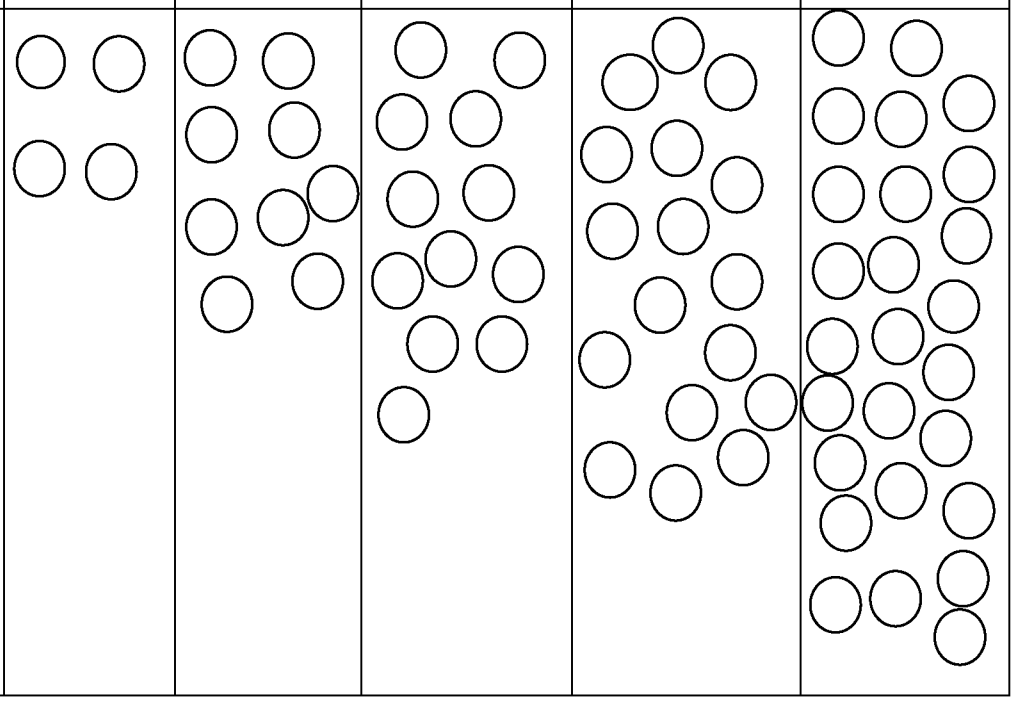
Concerns regarding Silver Wattle invasion

- High abundance
- Providing criminals with places to hide in
- Proximity to important landscapes such as fields, houses and important cultural sites
- Jurisdiction of Silver Wattle is under the Chief but the villagers can access at any time

Conflicts regarding Silver Wattle

- Some want Silver Wattle removed especially those who stay in close proximity with the Silver Wattle thickets. Others do not want it removed because it is useful to them and they do not receive much costs due to its invasion.

Time trend and abundance analysis outcome

	1930-1950	1950-1970	1970-1990	1990-2010	2010-Present
Abundance					

Preferred densities and participatory mapping

No Silver Wattle is required at productive landscapes such as the people's fields, personal gardens, and near their yards. No Silver Wattle is required by people along ways which they use to travel. Majority of the respondents required low density of Silver Wattle at landscapes which are far away from the houses so that they could access different resources

Time trend change and changes in perceptions towards Silver Wattle

Period	Event	Impact
1930	Oldest member of focus group discussion was born	He is born when the trees are already there. He notes the tree is used as he grows but however, it is not abundant. Viewed as an important resource such that rules are placed to control access to the tree.
1930-1994	The local population increases.	Silver Wattle is cut to create land for settlement. However, it still grows in abundance.
1994	End of apartheid and attaining of independence.	Many people especially, young people, move to bigger cities to look for better opportunities. Population decreases and consequently the use of Silver Wattle is reduced.
1996 onwards	Working for Water activities become more popular in areas.	Information gets to them about the high consumption of water. That information exacerbates the negative perceptions that it has been receiving resulting due to its abundance.
2000 onwards	Road improvement.	Allows other people to move freely to come in and sell firewood in the area. During road construction, most locals are employed in the area and would cook with Silver Wattle firewood at their gatherings.
2005	Rules change; no need to seek permission.	No longer viewed as an important resource for them hence, it can be used as one pleases. However, the tree still belongs to the community and outsiders have to seek permission from the chief. In Chevy Chase rules only apply to use of poles for fencing as they would be cutting bigger trees.
2007 onwards	Economic hardships, unemployment soars.	Some unemployed youths resort to crime and they are hiding in the Wattle thickets and also outsiders use them as their hiding places for monitoring the activities of villagers. Resentment towards the tree increases.
2011 onwards	Electricity introduction.	Great reduction in the usage of Silver Wattle as an energy source as people revert to the usage of electricity. However, they note they still use for Silver wattle to complement electricity use.