# THE RELATIVE ROLES OF ECOSYSTEM SERVICES AND DISSERVICES IN RURAL LIVELIHOODS IN THE EASTERN CAPE, SOUTH AFRICA

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*Where leaders learn*

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**ABSTRACT**

Since the publication of the Millennium Ecosystem Assessment report there has been a marked increase in research into various aspects of ecosystem services (ES). While ES are essential to human wellbeing, the literature has overlooked that some ecosystem goods and services also undermine human wellbeing. These are known as Ecosystem Disservices (EDS). This study aims to counter this imbalance in research, specifically in the context of rural livelihoods which are frequently dependent on local ES but often ill-equipped to manage EDS. The objectives of this study, conducted in three rural villages along a gradient of habitat diversity, were to identify a range of ES and EDS, determine their perceived contributions to or effects on the wellbeing of respondents, and identify modifications in livelihood strategies in response to EDS. The research made use of household surveys in conjunction with participatory learning and action techniques, such as focus group discussions in which ranking and trendline exercises, timelines, and participatory mapping were conducted.

Findings indicated that although numerous participants were involved in the harvest of multiple ES, such as Non-Timber Forest Products (NTFPs), livestock outputs, crops and marine wildlife, they simultaneously experienced losses from EDS, such as ticks, unpalatable grass species, monkeys, and *Lantana camara* invasion which undermined livelihoods to varying degrees. The role of ES and EDS in livelihoods was expressed in economic terms, representing a common framework with which to illustrate the magnitude of their contribution or loss. For example, the average value of livestock goods and services, amongst those who owned and used outputs, was highest in the least biodiverse village at R9 753 per annum, while the corresponding value of potential livestock goods and services lost due to EDS, despite active implementation of prevention measures, totalled R22 426. Further, the average value of cultivated plots in the most biodiverse village could have totalled approximately R20 958, but because of EDS, represented less than 20% of this value. Further, the findings highlighted that the most biodiverse village also had the highest number of EDS, supporting Dunn (2010) who hypothesised that the number of EDS increases with the number of ES. Based on these findings, I propose that a comprehensive framework which systematically contextualises both the positive and negative contributions of ES is needed to grasp the full picture of how local people conceive and engage with nature to facilitate an understanding of the resulting practices and processes.

# DECLARATION

I, Shannon Herd-Hoare, 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.

Shannon Herd-Hoare

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# CHAPTER 1: INTRODUCTION - CONCEPTS AND APPROACHES

The idea that natural systems provide benefits which support human wellbeing, known as ecosystem services (ES), is a deep-rooted and well-documented concept. Seminal publications, such as the edited book by Daily (1997) and an article in *Nature* on the value of the world's ecosystems (Costanza et al., 1997), sparked a surge in research, applications of the idea, and policy development. Core areas of research have included validating and quantifying their links to human wellbeing (Santos-Martin et al., 2013), management needs and approaches to improve supplies of priority ES (Banerjee and Bark, 2013), and how to deal with trade-offs between different ES from the same area of land or under competing management objectives (Chrisholm, 2010, van Oudenhoven and de Groot, 2013). Whilst this wealth of literature has illustrated that ES are clearly essential for human wellbeing, it has overlooked that some ecosystem functions or processes may undermine human wellbeing, especially amongst the poorer and more vulnerable societies and people in the world. These have become known as ecosystem disservices (EDS). Yet, EDS are generally not considered alongside ES, and the prevalence and role of EDS in affecting human wellbeing has been little explored (Lele et al., 2013, Lyytimaki et al., 2008, Ninan and Inoue, 2013, Schaubroek, 2017, Shackleton et al., 2016). This study seeks to counter this imbalance in research, specifically in the context of rural livelihoods, where rural dwellers are frequently dependent on local ES and often ill-equipped to manage EDS (Folke et al., 2005, McMichael et al., 2005, Pereira et al., 2005, Shackleton et al., 2016). This chapter briefly examines the current understanding of ES and EDS and highlights the need to position them within a common framework. This is followed by an outline of a few pertinent attributes of rural livelihoods at both a national and local scale. Lastly, the Sustainable Livelihoods Framework (SLF) is presented as a useful conceptual framework to understand the contribution of ES and the effects of EDS on rural livelihoods.

## 1.1 Ecosystem services

Ecosystem services refer to the ecological characteristics, functions or processes, which occur in both natural and human-modified ecosystems, that are directly or indirectly enjoyed, consumed or used by humans to achieve or enhance human wellbeing (Boyd and Banzhaf, 2007, MA, 2005). It is important to distinguish between ecosystem processes and functions, and ES as they are related but not synonymous. Ecosystem processes and functions describe the biophysical relationships that exist regardless of whether humans benefit or not. In contrast, ES are those processes and functions that benefit people, directly or indirectly. In this sense, ES only exist if they contribute to human wellbeing and cannot be defined independently (Braat, 2013).

Classification systems have been developed to enhance understanding of ES, enable discussion, and contribute towards scientific analysis, economic valuation and policy making. One classification system, the Millennium Ecosystem Assessment which was launched in 2001 under the United Nations Environmental Programme, assumed a dynamic relationship between people and ecosystems and marked the first attempt to assess the state of the global environment at multiple scales (local, regional, global) (MA, 2005). It also developed a classification system which grouped the vast array of goods and services that ecosystems provide into four categories (Figure 1.1): a) material or *provisioning* services – these are the material benefits or products obtained from ecosystems and include fuel, fibre, food, building materials for shelter, natural product derivatives, wild plant foods, etc.; b) services that *regulate* ecosystem processes such as air quality regulation, climate regulation, maintenance of soil fertility, pollination, flood control, etc.; c) non-material benefits obtained from ecosystems which satisfy the *cultural* or spiritual needs of people and include aesthetic values, inspiration, knowledge systems, recreation and tourism, spiritual uses, etc. and, d) *supporting* services which underpin the other three types of services such as photosynthesis, soil formation, water cycling, etc. (Haines-Young and Potschin, 2010, Shackleton et al., 2010). This classification provides a particularly useful way of thinking in this study – while it acknowledges the inherent interdependency between categories (such as provisioning services affected by the condition of regulating services) and the importance of each category in contributing to human wellbeing – it also separates the tangible goods or services from the other ES. These provisioning ES, and the factors that undermine the provision of these tangible services (EDS), are the subject of this thesis and represent the only ES category investigated.

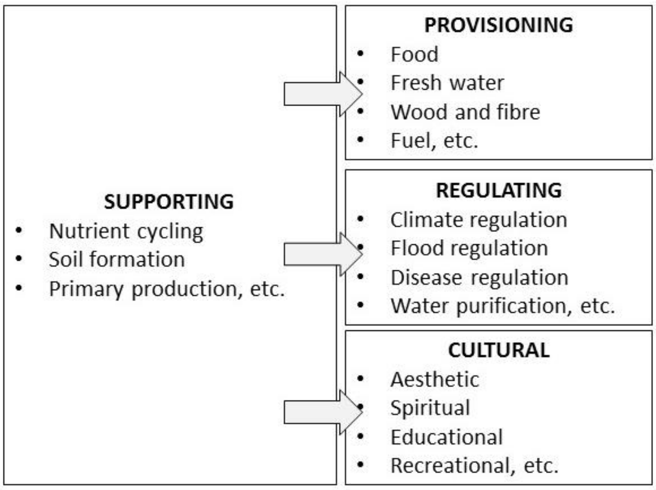



Figure 1.1: MA categories of ecosystem services (Source: MA (2005) Synthesis Report)

Even though listing services generated by ecological processes promotes their recognition and contributes to the development of policy and management, valuation of ES is a particularly useful tool in the analysis of ecological systems and ES. This is because many decisions involve trade-offs between various ES goods and services which affect human wellbeing differently. Conventional approaches to ES valuation involve inferring monetary value to ES (e.g. Obst et al., 2016). Yet, this conventional approach to valuation can only go part of the way, as it tends to overlook non-market values. However, headway is being made under the name of 'integrated valuation' where combinations of valuation methods are used to understand the value of ES, such as time units, labour units or in relative terms using a variety of indicators (Fioramonti, 2014). These indicators can be used to prioritise and compare ES on the basis of their contribution to individual or collective objectives. These indicators are outlined by Costanza et al. (2017) and may include the number of people benefiting from the service, their preferences, the cost of gaining access to the service and the availability or cost of substitutes.

While ES are indispensable to the wellbeing of all people in all places, ES play a particularly significant role in the livelihoods of rural dwellers because they frequently depend on local ES and are the most directly affected by changes in the composition and functioning of the ecosystem (Folke et al., 2005, McMichael et al., 2005, Pereira et al., 2005). Although the degree of dependency on ES varies across communities, households, individuals and regions – most rural households across the globe rely on provisioning ES to fulfil their subsistence needs, as a source of food security, as inputs for a variety of livelihood activities and as cash incomes (Shackleton et al., 2010). For example, multiple products which support rural survival are derived from forests and are collectively referred to as Non-Timber Forest Products (NTFPs)

(Shackleton and Shackleton, 2004). Kalaba et al. (2013), working in the Miombo woodlands of Zambia, highlighted that NTFPs contribute 43.9% to the average annual household income of local communities as they provide a source of food, fodder, medicine, fuelwood and construction material. Moreover, it is often the poorest and the most vulnerable members of society that are directly dependent on local ES for survival (Schreckenberg et al., 2018). For example, in Zimbabwe, Cavendish (2000) found that ‘environmental income’ made a significant contribution to the average rural incomes across wealth categories, with the highest proportional contribution to total household income among the poor of 40% in comparison to the more well-off households at 29%.

In this way it is evident that the wellbeing of present and future rural populations is dependent on the continuous flow of ES (Daily, 1997). Yet, human wellbeing is a multifaceted, dynamic, complex and context dependent concept and therefore requires additional insight (McMichael et al., 2005, Pereira et al., 2005, King et al., 2014, Summers et al., 2012). It comprises multiple constituents which fall within the objective and subjective dimensions of human wellbeing. More specifically, the objective dimensions refer to the material and social attributes of people’s circumstances such as physical resources, employment, education, health care, and housing (King et al., 2014) and the subjective dimensions incorporate an individual’s assessment of their own circumstances – what they think and how they feel about their life (Summers et al., 2012). These constituents are recognised as being situation dependent, as experienced and perceived by people across cultures and socio-economic gradients, reflecting culture and ecological circumstances. For example, in the Gariep Basin of southern Africa, the Sehlabathebe people identified ‘not being vulnerable’ as an important criterion, while in the Richtersveld and Great Fish River sites ‘self-determination’ was an important criterion (McMichael et al., 2005). Yet, in participatory workshops conducted in Sistelo, Portugal, local communities identified 40 different criteria for human wellbeing, with those most often repeated as cash income, access to goods and services, assets (house, cattle and fields), quantity of food, age, capacity to work, and amongst others a safe environment (Pereira et al., 2005). Given that different communities may identify different criteria for wellbeing, it is difficult to generate a ubiquitous definition for human wellbeing and, hence, is important to understand and work with local criteria.

The ES concept represents an important shift in discourse which asserts that healthy and productive ecosystems are fundamental to human wellbeing and as a result should not be compromised (Lele et al., 2013). However, the concept of ES is frequently understood in an unbalanced manner (Lyytimaki and Sipila, 2009). The positive framing of nature in the ES framework conceals that alongside the benefits, some ecosystem goods and services also undermine human wellbeing (Dunn, 2010, Lele et al., 2013, Lyytimaki and Sipila, 2009). These have become known as ecosystem disservices (EDS).

## 1.2 Ecosystem disservices

The notion that natural or ecological processes or phenomena may inflict harm on people is not new. A substantial body of literature exists across several disciplines including agriculture, natural disaster management, wildlife conservation and public health, providing detail on EDS such as agricultural pests or environmental diseases (von Dohren and Haase, 2015). However, these have scarcely been presented within ES frameworks, debates and studies. Failure to recognise EDS, alongside ES, has potentially important consequences, both for the sake of generating a complete picture of the relationship between ecosystems and human wellbeing and for ensuring successful natural resource management (Schaubroek, 2017). A more detailed look at motivations for considering EDS, alongside ES, is highlighted in section 1.3.

The number of studies which recognise EDS remains low, resulting in little debate, quantification or understanding of the dynamics and underlying processes of EDS and their ramifications for human wellbeing (Lyytimaki and Sipila, 2009, Ninan and Inoue, 2013, von Dohren and Haase, 2015). A cursory search of published literature by Campagne et al. (2018) in July 2017 showed an imbalance of 126 papers on EDS and 21 248 papers on ES, highlighting that 0.6% of published studies recognised EDS. Among the few studies that recognise EDS, the majority have been conducted within the agricultural and urban sectors (Lyytimaki et al., 2008), and there has been a strong research bias towards developed countries. An overwhelmingly high proportion of case-study research on EDS has been conducted in Europe, with few studies in Africa (von Dohren and Haase, 2015). Yet, Africa is perhaps the continent that suffers the most from EDS (Anderson, 2011). However, there has been an increase in the number of papers since 2009 on the adverse effects of ecosystems, reflecting increasing recognition of EDS (von Dohren and Haase, 2015). For example, Campagne et al. (2018), using an expert-based matrix approach, assessed the capacity of ecosystems in the Scarpe-Escautt Regional Natural Park in France to both provide ES and generate EDS, and Dorresteijn et al. (2017) assessed rural perceptions of ES and EDS in an agricultural-forest mosaic in south-western Ethiopia, paying particular attention to the effect of geographic and socioeconomic factors on residents' perceptions of ES and EDS.

Yet, the development of the EDS concept has not been without contestation (Barot et al., 2017, Saunders and Luck, 2016, Schaubroek, 2017, Villa et al., 2014). Villa et al. (2014) argue that the term disservice denotes the wrong message for science and society, hampering the development of a constructive dialogue around conservation. They further argue that discussions around EDS may economically justify the destruction of species considered harmful. However, Schaubroek (2017) provides multiple counter-arguments suggesting that those desiring information on the link between ecosystems and human wellbeing should be entitled to the full picture, both positive and negative, and science should not intentionally bias policy or society by not considering certain aspects of an assessment. Additional critiques include those by Saunders and Luck (2016) who argue that the black-and-white dichotomy created in the ES and EDS literature is too simplistic and rarely useful, calling for a renewed focus on the whole-of-ecosystem function and a new direction that recognises the relationships and changes that affect EDS and ES flow. Yet, I argue, against a backdrop of numerous studies that solely consider the positive ecosystem functions, incorporating EDS into ES research and analysis is a useful starting point. Therefore, in an effort to ensure transparency, the following section sets out the inherent characteristics of EDS, clearly setting out what EDS are and what they are not.

### 1.2.1 Defining EDS

A widely accepted definition of EDS does not exist, underscoring the low level of scientific inquiry directed to EDS so far, but it has generally been understood as an additional aspect of the ES approach, representing the negative effects of natural and ecosystem system processes on human wellbeing (von Dohren and Haase, 2015). Within the limited literature, various authors have put forward definitions to best describe an EDS and include: disturbed or missing services as consequences of the loss of biodiversity (Chapin et al., 2000); the negative effects of ecosystem change (Balmford and Bond, 2005); the functions of ecosystems that are perceived as negative for human wellbeing (Lyytimaki and Sipila, 2009); the absence or constrained supply of an ES (Power, 2010) and the functions or properties of ecosystems that cause effects that are perceived as harmful, unpleasant, or unwanted (Lyytimaki, 2015).

These varying interpretations are, from my perspective, both unsatisfactory and undeveloped. For example, those that view EDS as the absence of or diminishing ES fail to recognise that the cause of reduced ES might not be related to ecosystem attributes. Further, others who view EDS as the costs associated with harnessing or managing ES do not recognise that many costs associated with securing ES do not originate from the ecosystem. In light of these inadequacies, Shackleton et al. (2016: 4) developed a working definition of EDS, supported by this study, to include "the ecosystem generated functions, processes and attributes that result in perceived or actual negative impacts on human wellbeing". Importantly, this definition is based on two aspects, namely the ecosystem origin and the impact on human wellbeing. Ecosystem disservices can emerge from any ecosystem, regardless of the level of human activity within it (Shackleton et al., 2016). This is hinged on the recognition that human-modified systems also deliver ES and EDS. Examples of EDS in modified landscapes may include pollen from street trees causing health problems in urban spaces (Lyytimaki et al., 2008) or pest damage in the agricultural sector (Zhang et al., 2007). Further, the occurrence of EDS, and the associated relationship with human wellbeing, may be amplified by the expanding human footprint as human encroachment on ecosystems may place people at an increased proximity to natural ecosystem processes. For example, wild animals may move out from non-cultivated habitats to raid crops (Lemessa et al., 2013), and consequently, those cultivating crops closer to the forest edges become more susceptible to raiding than those further away from forest edges. Following this definition, Shackleton et al. (2016) highlight the three ways in which EDS manifest. The first is through the direct impact of an ecosystem process on human wellbeing such as a snake bite. The second is through the reduced flow of an ES as a result of an EDS, such as a crop pest. The third is through the loss or damage of a supporting or regulating service caused by an EDS, such as primary production loss following a wild fire.

Given that EDS are complex and diverse phenomena, it is useful to draw attention to and understand their inherent characteristics (Fisher et al., 2009). Despite sharing many characteristics with other phenomena, such as ES and social-ecological systems, they are best understood through elaboration or illustration from an EDS perspective. It is necessary to appreciate that ES and EDS are intimately linked and "can be viewed as opposite sides of the same coin" (Shackleton *et al.* 2016: 7), with the same natural process or component which delivers beneficial services to humans, also responsible for the provision of detrimental services (Lele et al., 2013, Vang Rasmussen et al., 2017). For example, wetlands provide many ES which contribute to human wellbeing such as flood regulation and erosion control, but they too may also support the incidence of diseases such as bilharzia or malaria (Malan et al., 2009). Similarly, the clearing of lands for agriculture may improve food supply, but at the same time may also increase pests, weeds and leaching of soil nutrients (Zhang et al., 2007). These examples illustrate that whether an ecological process is considered as an ES and EDS, or co-exist as both, is a matter of perception, which is closely related to contextual factors (Lyytimaki, 2015, Saunders and Luck, 2016, Vang Rasmussen et al., 2017, Vaz et al., 2017). This is further illustrated by Vang Rasmussen et al. (2017), in their study of agricultural communities in Laos, who showed how provisioning services of wild animals and plants could switch between ES and EDS. In one study site, government restrictions on land use and other economic and cultural changes, gave rise to perceptions of rodents and plants as EDS, while in another study site, which maintained shifting cultivation practices, the same taxa were perceived as ES. In this way, the study highlighted multiple factors linked to switches between ES and EDS and argued that the omission of EDS in ES research may lead to investment in inappropriate targets.

Perceptions are largely a matter of subjective valuation and may differ amongst different social groups according to gender, age, income, lifestyle, experiences, cultural background or knowledge level (Lyytimaki, 2015, Lyytimaki et al., 2008). This parallels some ES classes such as cultural ES. For example, elderly people or new-born babies are more susceptible to environmental diseases or sickness than young and fit people (Shackleton et al., 2016). Further, the degree of impact on human wellbeing is largely dependent on the context of the actors involved and varies according to socio-economic status and degree of reliance on ES. Naturally, those whose livelihoods are directly dependent on the productivity of the natural environment (farmers, fishers, pastoralists) are at a greater risk to a range of EDS than those who are less directly reliant on the immediate environment, such as city dwellers. The ability to cope with the negative impacts is harder for poorer societies and households than more affluent societies, because they typically have fewer assets. Further, location may also render some people more at risk than others, such as those living on a floodplain or on a steep slope. These elements are interlinked and often interact and exacerbate the situation (Vang Rasmussen et al., 2017).

Other pertinent EDS attributes, as components of complex systems, highlighted by Shackleton et al. (2016) include the potential for EDS to operate at various spatial scales such as a pest outbreak in a single field, or thousands of square kilometres affected by alien plant invasions. Additionally, they exist at various temporal scales, with some EDS occurring regularly, and others less frequently every few decades. Importantly, EDS are not only variable across time and space but may be highly irregular. For example, crop pests might exist as a permanent background presence, only being considered a nuisance, but may erupt as an outbreak under certain conditions. This illustrates that EDS have the potential to erupt suddenly, a consequence of surpassing a certain threshold and variable time scales, which result in the rapid onset of particular EDS, which is not characteristic of the supply of ES. This then requires early warning systems to avoid catching those involved unaware. The impacts of EDS are variable, with some short-term consequences, and others responsible for more serious long-term effects. For example, the loss of a breadwinner to malaria will have a major impact on the ability of the household to function. Therefore, EDS are responsible for negatively impacting human wellbeing, the degree of which is determined by perception and context, lifestyle, culture, age or experience. The type and intensity of EDS may also vary. As a result, the range of perceptions and impacts may give rise to sub-optimal management approaches, as each type requires different approaches. Therefore, much like ES literature, EDS have begun to be categorised as the basis for improved understanding measurement and management (Dunn, 2010, Lyytimaki et al., 2008). Various authors have proposed multiple typologies. For example, Shackleton et al. (2016) consider the inherent properties of an EDS and then classify them into six categories; and Vaz et al. (2017), considering a wide range of human wellbeing dimensions, propose five categories of EDS. Although a uniform classification framework does not exist, what is clear is the need to position ES and EDS in the same framework.

### 1.3 ES and EDS under the same framework

Despite a lack of attention in the literature, EDS are a reality, particularly for the rural poor who are greatly dependent on local provisioning services for survival. At the grass roots level, rural people attempt to harness the beneficial contributions that ES make to their livelihoods and mitigate any effects of EDS which may undermine their livelihoods. For example, Chikuni et al. (2004) highlight that the presence of *Prosopis glandulosa*, an invasive plant species, is both beneficial and a threat to the people of Swang'oma in the Lake Chilwa Plain, south-eastern Malawi. The predominantly poor local population view *P. glandulosa* as an important source of fuelwood which is used for household consumption and is sold to generate income (44% of households). To a lesser extent it is used for poles, timber and for fencing maize and rice fields which would otherwise be destroyed by livestock if left unprotected. However, *P. glandulosa* is also seen to present multiple threats to the local people such as limiting access to the shoreline (71%), the loss of grazing ground in the floodplain (54%), and the taking up of land usually used for growing maize and rice (19%). All respondents also identified that its spines puncture flesh, causing septic wounds to develop. In this way, both ES and EDS are woven into local dwellers' regular life patterns, attitudes and values.

A comprehensive framework that systemically contextualises both positive and negative effects as part of ecosystem structure and function is rarely discussed (Escobedo et al., 2011, Lyytimaki, 2015, Lyytimaki and Sipila, 2009, von Dohren and Haase, 2015, Zhang et al., 2007). This is problematic as it may be counterproductive for ecosystem management to frame ecosystem functions as benefits only, as various EDS, which ecosystems inevitably produce, may systemically undermine successful management operations or outcomes (Lyytimaki and Sipila, 2009). Moreover, the recognition and management of EDS may, in some instances, deliver better outcomes for human wellbeing at a lower investment than the management of ES (Shackleton et al., 2016). Therefore, the recognition of ES and EDS under a common assessment framework, may act as a better starting point for environmental management, conservation efforts and promoting sustainable rural livelihoods than a one-sided approach which focuses on the benefits only (Lyytimaki, 2015).

Operationalising ecosystem processes or components as both services and disservices will allow one to grasp the full picture of how local people conceive and engage with nature and facilitate an understanding of the resulting practices and processes (Schaubroek, 2017). This is illustrated by Ango et al. (2014) who describe how the tree management practices of small-scale farmers in agricultural landscapes in south-western Ethiopia are constructed according to perceptions of ES and EDS. Wild mammals, such as bush pigs, warthogs, and porcupines pose an agricultural threat to farmers, with the majority of farmers (63%) in the study site experiencing at least one crop pest in a cropping season. The level of damage caused by pests, however, was related to proximity to forest edges, as 85% of households close to the forest edges reported severe damage while only 22% of farmers located further away from forest edges reported similar levels of damage. As a result, crop raid experiences shaped farmers' actions which resulted in a) farmers migrating to areas with potential for forest clearing to distance crop fields from forests, b) farmers removing trees from crop fields to avoid the incidence of monkeys who find shelter in the trees, and c) community members allocating migrants to the forest edges. Conversely, in villages where a variety of benefits but only a few EDS were anticipated from trees, farmers retained or planted trees inside or along field boundaries as well as on other land uses such as arable, grazing fields, and home gardens. Further, the farmers' perceptions of ES and EDS and the various management strategies employed to balance them have contributed to shaping the "spatial pattern and the composition of trees in the agricultural landscape" (Ango *et al.* 2014: 10). This may allow for a more comprehensive assessment of the contribution of ecosystems to human wellbeing, as one cannot quantify or understand the value of ES without deducting the EDS experienced by local communities.

A one-sided focus on ES is inadequate, because optimising a particular service may also result in the increase in an EDS, and vice versa (Shackleton et al., 2016). For example, Lemessa et al. (2013) noted how common response strategies to crop raiding, which are intended to reduce the impact of crop raiding, may in fact lead to the modification of other ecosystem processes. For example, "the removal of natural habitats could limit pollination of crops, decrease natural pest control, cause losses in biodiversity or increase the risk of soil erosion and flooding" (Lemessa *et al.* 2013: 71). In this way, it is essential that ES are not viewed or managed in isolation, emphasising the need for wider recognition of the inherent complexity of ecosystem management and the connection between ES, biodiversity and EDS across multiple scales (Lyytimaki, 2015).

It is also argued that the ES framework oversimplifies the relationship between nature and society, as the positive depiction, which emphasises that more natural capital results in increased human wellbeing, does not always hold true (Lele et al., 2013). Dunn (2010) argues that regions of the world with high biodiversity have a high incidence of EDS, especially pests and diseases. Lyytimaki and Sipila (2009) support this by highlighting that a richness of goods and services in urban areas may also yield a richness of nuisances. However, there has not been any empirical quantification of the ratio of ES to EDS in different settings, nor in relation to biodiversity in the surroundings. This is explored in this thesis.

While previous examples have examined pests in agricultural systems and the threats which invasive species pose to rural populations, it is important to recognise the potential temporal or spatial sequential synergies that may exist between EDS. For example: a household may experience the death of a family member as the result of a snake bite while at the same time face the loss of agricultural crops due to crop pests. The effects of these EDS may work in tandem to erode the asset base of rural households and increase vulnerability. Therefore, EDS cannot be addressed by simply ignoring them or through post-hoc management. More research is required to understand the conditions under which EDS emerge, identification of key nuisances for rural communities, identification of the people most likely to suffer and current strategies used to mitigate EDS, or balance them against ES.

This next section details the inherent characteristics of rural livelihoods. This provides a key point of departure for understanding what ES and EDS, in the same framework, may look like in rural livelihoods in South Africa.

## 1.4 Rural livelihoods

The livelihoods of rural populations have been the object of research and policy for several decades (Carney, 1998, Chambers and Conway, 1992, de Haan and Zoomers, 2005, Ellis, 2000b, Scoones, 1998). While livelihood perspectives have several definitions and applications across disciplinary and sectoral boundaries, there is a general consensus that the construction of a livelihood involves several critical elements. Specifically, assets, social relations, institutions and access are identified as important variables to most livelihood analyses (King, 2011). Further, livelihood perspectives emphasise facets such as coping, adaptation, vulnerability, diversification and risk management (Scoones, 2009). In this way, an understanding of 'livelihoods' goes beyond the parameters of production, employment and cash income to depict a more holistic view of the way in which rural people are able to survive and maybe even thrive (Cousins, 1999, de Haan and Zoomers, 2005, Ellis, 2000b, Shackleton et al., 2000). Therefore, a livelihood can be seen as "the assets (natural, physical, human, financial and social capital), the activities, and the access to these (mediated by institutions and social relations) that together determine the living gained by the individual or household" (Ellis, 2000b:10).

Assets are considered to be the basic building blocks with which people construct their livelihood as they facilitate production, engagement in labour markets and participation in reciprocal exchanges with other households (Ellis, 2000b). Others argue, however, that assets are more than mere building blocks as they form the foundations of power and wealth and facilitate the ability 'to be' and 'to act' (Bebbington, 1999). A range of assets support livelihood objectives. These are typically divided into five main categories: natural, physical, human, financial and social capital. As noted by Ellis (2000b), natural capital refers to the natural resource base (land, water, biological resources) which yields products on which humans rely. Physical capital refers to assets generated by production activities such as housing, infrastructure, roads, tools and agricultural technologies. Human capital refers to the amount of skills and labour available to a household and is increased through investment in education and training and financial capital denotes the stock of cash and access to credit in the form of loans. Lastly, social capital refers to the social networks constructed between individuals and communities and from which they can derive support.

Access to assets and opportunities is regulated by endogenous social structures, such as institutions and social relations, and exogenous factors over which households have little control, such as economic trends or unforeseen shocks (e.g. drought, diseases, flood and pests). These exogenous and endogenous factors determine the differential ability of individuals or households to own, control or make use of assets (Ellis, 2000b). Institutions have been described as "rules of the game in society or humanly devised constraints that shape human interaction" (North, 1990:3). They are the informal and formal rules and norms that have developed over generations to facilitate or constrain interactions between people themselves and also their environment. Formal institutions consist of written or codified rules which are established through official channels such as the constitution or judicial laws, while informal institutions are socially shared rules that are created and enforced outside officially sanctioned channels (Torniainen and Saastamoninen, 2007). Local institutions fall into the second category and provide a means to monitor and control the rate of natural resource consumption and sanction any overuse (Muriaas, 2001), such as the land, livestock and labour sharing institutions which govern natural resource management in the highlands of Tanzania and Ethiopia (Mowo et al., 2011). Local institutions may also take the form of customs or rules which regulate access to land or resources (Ellis, 2000b).

Access to assets is also regulated by social relations such as gender, family, kin, class, caste, ethnicity, belief systems, etc. For example, while kinship networks are important in the facilitation and support of diverse income portfolios, gender prescriptions may limit access to land and other productive assets (Gladwin et al., 2001). It is equally important to recognise patterns of resource use and agency alongside rules and norms. Leach et al. (1999), drawing on the work of Sen (1981), use the concepts of 'endowments' and 'entitlements' to reveal the underlying power dynamics that shape access to capitals. This means that the realisation of assets for survival or potential upward mobility goes beyond individual motives and aims as they are bound within local institutional structures, social relations and configurations of power.

Yet, "very few people collect all their income from any one source, hold all their wealth in the form of a single asset, or use their assets in just one activity" (Barrett et al., 2001:315). Instead, diversification of assets, activities and income is the norm. It is a pervasive and enduring characteristic of rural livelihoods which reflects the entrenched precariousness of rural survival (Barrett et al., 2001, Ellis, 2000a). Livelihood diversification involves two key components which are usually related: a) multiplicity: an increase in the number of livelihood activities; b) change, transformation or adaptation: within the agricultural sector (e.g. trees and crops; subsistence crops and cash crops; different livestock types; irrigated and rain-fed production, etc.) or from the agricultural sector towards off-farm and non-farm activities (Linghor-Wolf, 2011). Off-farm income refers to income earned within the agricultural sector in the form of wage labour on other farms or farm support enterprises or services, while non-farm income refers to income earned outside the agricultural sector in the form of remittances, social grants, rental income from leasing land, wage labour in town, trading, etc. (Ellis, 2000b). Incomes from non-farm sources are growing in importance with more than 50% of the total income of many rural communities in many developing countries derived from non-farm sources (IFAD., 2010). Non-farm livelihood activities are typically positively correlated with household welfare indicators such as income, wealth, consumption and nutrition (Barrett et al., 2001). For example, Block and Webb (2001) illustrate that more income diversification results in increased income and greater nutritional value. Similar findings are highlighted by Babatunde and Qaim (2010) who found that off-farm income had a positive net effect on food security and nutrition among rural households in Nigeria. A large share of household income is also derived from off-farm income sources. For example, in Ecuador off-farm income (agricultural wage labour, non-farm wage labour, non-farm self-employment, transfers, other) contributes 87.5% of the total household income while on-farm income (crops and livestock) contributes 12.5%. Similar trends are seen in Bulgaria with off-farm income contributing 84.1% and on-farm income 15.9% to total household income (Davis et al., 2010). Davis et al. (2010) note that on-farm sources of income tend to be more important in African countries. This is evident in Nigerian rural households where on-farm income contributes 77.8% and off-farm income contributes 22.2% to the total household income.

Motivation for the diversification of assets, incomes and activities is commonly divided into two overarching categories: push and pull factors. Push factors are negative factors which push farm households to adopt additional livelihood activities out of necessity (Alobo Loison, 2015). Common push factors are related to different forms of risk management strategies in the presence of seasonality and climatic uncertainty, crises or high transaction costs (Alobo Loison, 2015, Barrett et al., 2001). As a result, households with limited risk-bearing capability may reduce risk by constructing an income portfolio out of components which are not equally affected by the same covariate risk (Ellis, 2000a). This means that factors that create risk for one livelihood strategy (e.g. climate) will not create risk for another (e.g. urban job insecurity) (Ellis, 2000b). However, household risk management strategies are often confused with coping behaviour. The distinction needs to be made as risk management is a deliberate strategy carried out in anticipation of failures in a household's income stream and involves the continuation of a range of income activities, while coping is a post-hoc response to disaster or unanticipated failure in sources of survival (Ellis, 2000b). In this way, risk can be interpreted as *ex-ante* income management and coping as *ex-post* consumption management in the face of disaster (Ellis, 1998). Following this distinction, coping strategies include those which seek to maintain consumption in the presence of a disaster, such as through drawing on savings, increasing food stocks, gifts from relatives, community transfers, sale of livestock, the sale of other assets, etc. (Ellis, 1998).

The second set of motives comprises pull factors. In this category diversification occurs voluntarily. Pull factors are positive and attract farming households to take part in additional livelihood strategies as a means to accumulate assets, wealth and increase the standard of living (Alobo Loison, 2015). Pull factors may include commercial agriculture or proximity to urban areas, which offer opportunities for diversification (Alobo Loison, 2015, Barrett et al., 2001).

Although assets, activities and income diversification are ubiquitous across rural livelihoods, households do not enjoy equal access to high return, off-farm livelihood strategies which provide a pathway for upward social and financial mobility (Barrett et al., 2001). Participation in high return, off-farm sectors, such as salaried jobs, shop keeping, trade, brick making, etc., are dependent on antecedent levels of human, social or financial capital (Ellis, 2006, Gautam and Anderson, 2016). This means that asset-poor households are often unable to overcome entry barriers and are restricted to low income, labour-intensive activities with limited contribution to wellbeing (Ellis, 2000a). This results in a positive feedback mechanism that reinforces levels of wellbeing, as households with access to higher capital are more likely to access higher return sectors and achieve higher wealth or wellbeing. This is evident in Humla, Nepal, where entry into high-return livelihood activities, identified as salaried jobs and trading, are dependent on high pre-existing levels of tangible and intangible assets (Gautam and Anderson, 2016). These included strong networks outside the district, household members who are politically active with affiliation in political parties or other locally important institutions, possession of educational qualifications, and access to bank credit. In this way, already rich households are able to accumulate more assets which underpin further lucrative diversification while poorer households are forced to engage in activities that do not require high investment or specialised skills such as wage labour and labour migration (Gautam and Anderson, 2016). This also highlights that diversification is not just an attribute of poor households as commonly portrayed. Despite this, a great interdependence between farm, non-farm and off-farm activities exists amongst rural households who draw on a range of activities and income sources as a risk management strategy, a coping mechanism and as a strategy to stabilise or increase household income (Johny et al., 2014). In this way, the ability to access various combinations of assets determines how vulnerable or robust a livelihood might be (Shackleton et al., 2000).

Vulnerability is related to aspects of exposure to risk or shock and the capacity to respond to its effects (Wiegers et al., 2006). In this sense, vulnerability is understood to comprise three main dimensions including a) exposure, b) sensitivity and, c) capacity to adapt (IPCC., 2001). Exposure deals with the degree to which a system or household is exposed to environmental or socio-political stress. Sensitivity is related to how at risk a household or community is to a threat and the degree to which a system is altered by perturbations. This is largely dependent on the stock of assets people have access to, dominant livelihood strategies (such as agriculture or brick making), as well as other contextual factors (Adger, 2006, Shackleton and Shackleton, 2010). Capacity to respond to shock refers to the ability of a system to accommodate shock or expand the range of variability with which it can cope (Adger, 2006). Therefore, vulnerability has an external dimension which includes external threats to livelihood security due to risk factors such as climate, markets or shocks and an internal dimension which is defenceless and unable to cope due to limited or no assets, food stores, support from social networks, etc. (Ellis, 2000b, O'Brien et al., 2009).

Levels of vulnerability differ between households due to differential exposure to risk as a result of geographic location and socio-economic context as well as the presence or absence of social support systems and other safety nets such as freely available wild resources (Shackleton and Shackleton, 2010). In this way, vulnerability is a product of the interaction between multiple stressors and is often articulated at the local level. It is also used to highlight specific contextual factors that influence exposure to risk and capacity to cope with risk and change and as an explanation as to why some groups and individuals experience negative outcomes from shocks and stressors while others do not (O'Brien et al., 2009).

## 1.5 Rural livelihoods in South Africa

Rural livelihoods in South Africa are diverse, dynamic and heterogeneous, and have, to a large extent, been shaped by discriminatory apartheid policies of the past (Hebinck and Lent, 2007, Neves and du Toit, 2013, Shackleton and Luckert, 2015). These policies allocated the majority of land to white commercial farmers and concentrated indigenous communities onto limited communal lands which eroded their agrarian base for rural existence and strengthened their dependency on the formal economy as migrant labourers (Kepe and Tessaro, 2014, Shackleton et al., 2000). Despite this history, land and natural resources within these communal systems play an important role in the livelihoods and household economies of rural dwellers (Shackleton et al., 2000). These include smallholder arable production, intensive cultivation of homestead plots, livestock husbandry and natural resource harvesting (e.g. collection of NTFPs for sale and household consumption) (Neves and du Toit, 2013, Shackleton et al., 2001). However, recent work in South Africa has suggested that farming in communal areas, particularly extensive arable production, is declining and moving towards more intensive cultivation of home gardens or being abandoned all together (Hebinck et al., 2018, Shackleton and Luckert, 2015). This unlinking from the productive use of land, or deagrarianisation of rural livelihoods, is a common trend in communal areas throughout South Africa. Hebinck and Lent (2007), working in two rural villages in the Eastern Cape, Guquka and Koloni, highlight that only 19% of households across the two villages were involved in agrarian activities and the number was declining. Hebinck et al. (2018) working in the same two villages found that even though most households were involved in some degree of cultivation, it occurred at a minor scale. Most households took part in home gardening rather than farming. Nobody in Koloni cultivated fields while only a few households did so in Guquka. Consequently, cropping contributed an insignificant amount to total household income with less than one percent across both sites. Further, Shackleton *et al.* (2015) showed the steady increase in abandoned arable lands near Willowvale. Despite this, the authors also note that agriculture remains a key livelihood activity for some as there was evidence of persistent agrarian activities by selected households across the two villages. Aliber and Hart (2009) support this, by claiming that agricultural production is crucial to rural dwellers with an estimated 1.25-3 million people (which constitutes <15% of the rural population) engaging in it to some degree across South Africa.

Externally derived income sources constitute a large proportion of the total household income of rural dwellers. Comparatively extensive for a developing country, social grants in South

Africa are an important source of externally derived income (Neves and du Toit, 2013). This takes the form of old age pensions, disability, child support, and foster grants – each of which has increased in value since the removal of racial differentiation (Hebinck and Lent, 2007). In total, social grants are received by more than 15.7 million individuals, i.e. over a quarter of the population (SASSA., 2012). Other important externally derived income sources are derived from migration and remittances and small-scale informal economic activities (farm and off-farm).

The core components that make up a typical livelihood portfolio of South African rural dwellers are illustrated by Shackleton and Luckert (2015) in Gatyana and Lesseyton, two rural villages in the Eastern Cape province. In Lesseyton the average income shares from different livelihood sources across households were as follows: crops (1%), livestock (4%), natural resources (10%), remittances (5%), casual labour (8%), small business (2%), formal employment (14%), and social grants (56%). Similar trends were noted in Gatyana: crops (1%), livestock (6%), natural resources (14%), remittances (5%), casual labour (4%), small business (2%), formal employment (14%), and social grants (60%). Therefore, the livelihoods of rural dwellers in South Africa are constructed out of a range of income sources and activities and access to each of these livelihood enabling activities shapes social differentiation and resulting vulnerability (Neves and du Toit, 2013). Important to mitigating against risk and vulnerability and in the building of livelihood resilience are ES (Shackleton et al., 2010).

### 1.6 Sustainable Livelihoods Framework as an analytical tool

In analysing the contributions of ES and the effects of EDS on rural livelihoods, a modified Sustainable Livelihoods Framework (SLF) presents a potentially useful analytical tool as it has successfully been used as an analytical approach in evaluating ES in rural livelihoods around the globe. Further, it highlights where EDS may be operational in local livelihoods and makes explicit the relationship with human wellbeing. Developed as a response to the inadequacies of conventional single sector analysis of rural livelihoods, the SLF assumes a 'people-centred' approach which seeks to understand the local realities of the poor (Scoones, 2009). In this way, the SLF is a holistic, dynamic and multi-scale framework that recognises the complexity and diversity which characterise rural lives. It is non-sectoral as it embraces the multiple influences and actors involved in livelihoods and acknowledges that households often pursue multiple livelihood strategies. It also facilitates an understanding of livelihood change, as livelihood portfolios shift in response to the capacity of households to generate new strategies.

The SLF illustrates the multiple actors, multiple strategies and multiple outcomes of livelihood production as well as the dynamic and complex 'iterative chain of events' (DfID, 2000). The arrows within the framework (Figure 1.2) illustrate a variety of different types of relationships, all of which are dynamic. None of the arrows imply direct causality, although all imply a certain level of influence. It makes explicit ES, EDS and human wellbeing as some of the primary drivers within the SLF. Further, it elevates the ecological context as a point of entry, dictating local people's vulnerability context, either contributing to their vulnerability or alleviating their vulnerability, which therefore affects their livelihood assets, and subsequently their livelihood outcomes and human wellbeing. This also has a causal relationship with the ecological context, because livelihood outcomes or human wellbeing dictate how the environment is used. Assets are also influenced by outside policies, institutions and processes. In this way, the livelihood strategies of households, which contribute to or undermine human wellbeing, are determined by their asset base and by the institutional context in which they operate.

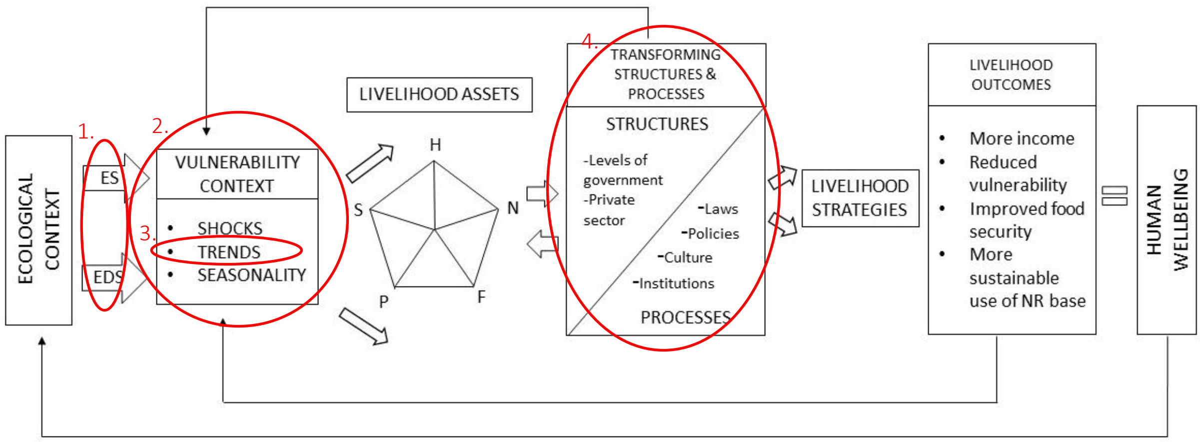



Figure 1.2: A modified Sustainable Livelihoods Framework. Red circles indicate the connection between the SLF and research objectives (Adapted from: DfID (2000))

It is however, also recognised that the SLF has certain weaknesses (Scoones, 2009). The first relates to the failure to engage with processes of economic globalisation (Scoones, 2009). Derived from a disciplinary parentage which emphasises the local, critics argue that the SLF does not address big shifts of global markets and politics. While these are incorporated in the 'context' box – it does not account for the possibility that contexts and the forces of capital and class may indeed be the most important factors, over-riding micro-negotiations around access to assets (Scoones, 2009). The second, highlights the lack of attention to power and politics in the SLF (Adato and Meinzan-Dick, 2002). Critics argue that the SLF requires a sixth capital asset, political capital, as political capital acts as a key capital asset and constraining factor, which cannot be captured though the transforming structures and processes (Baumann, 2000). The third is linked to the poor recognition of the long-term changes in environmental conditions such as those linked to climate change (Scoones, 2009). Despite recognition of the micro-scale shocks and stresses there is a lack of integration of local contexts and connections to global environmental change (Scoones, 2009). The last area of weakness is the failure to recognise long-term transformatory shifts in the rural economy and questions surrounding agrarian change (Scoones, 2009).

Despite this, the SLF is a useful tool which facilitates a more holistic and dynamic understanding of rural livelihoods. In this study, the SLF provides an important conceptual and analytical lens which allows one to pinpoint where ES and EDS may operate in rural livelihoods. For example: the ecological context may give rise to various ES and EDS, identified in objective 1 in this study, which could affect the vulnerability context of an individual or group. The function of an EDS as a shock may erode a household's asset base either directly (e.g. a flood may destroy a person's field) or indirectly (e.g. it applies pressure on the household to draw on financial savings or sell some of their cattle). This may subsequently decrease flexibility, diversification and local agency as well as exposure to increased risk, and may lock a household into desperate situations. EDS may also undermine an asset independently of the vulnerability context. At the same time, households may rely on ES to recover from shock, such as households drawing on the income from the sale of NTFP to recover from shock. These dynamics are explored in objective 2, which seeks to determine the perceived effects of ES and EDS on respondents' wellbeing. The ubiquity, frequency, seasonality, etc. of these ES or EDS were explored in objective 3, which sought to investigate the trends of ES and EDS through time.

Further, EDS may also erode the nature or efficacy of the transforming and institutional structures (e.g. a snake bite might result in the death of a chief which results in a leadership vacuum or leadership struggle). Despite this, it has been widely noted that rural people actively prepare for shocks which may undermine livelihood assets and transforming structures and processes. These dynamics were explored in objective 4, which sought to understand whether people modified their behaviours and livelihood strategies in preparation or response to EDS. In this way, EDS may operate across all the core components of the SLF and shape livelihood strategies and possible resulting livelihood outcomes.

## 1.7. Aim and objectives

This thesis seeks to contribute both theoretically and empirically toward the growing literature on the links between rural livelihoods, ES, and EDS. The aim of this study was to investigate the relative roles of ES and EDS in rural livelihoods in the Eastern Cape province, South Africa. To adequately address this aim, the objectives of this study were to:

1. Identify ES and EDS that respondents recognise in more biodiverse and less biodiverse environments.
2. Determine the perceived effects of ES and EDS and their relationship to respondents' wellbeing.
3. Investigate and interrogate trends in ES and EDS through time and why?
4. Determine whether people modify their behaviours and livelihood strategies in preparation for or in response to EDS.

Empirical chapters, chapters 3-5, have been constructed according to land-based livelihood activity i.e. chapter 3 – arable agriculture, chapter 4 – livestock husbandry, and chapter 5 – non-timber forest products. Each objective has been addressed within each empirical chapter.

## CHAPTER TWO: STUDY AREA AND METHODOLOGY

This chapter bridges the gap between the first chapter – the introduction and the conceptual framework – and the empirical chapters that form the core of this thesis. It presents a detailed description of the study area and the methodology on which the empirical chapters are based. In particular, it outlines the bio-physical and socio-economic characteristics of the study area as well as the foundational epistemologies which guided the researcher and the qualitative and quantitative methods of data collection. It also highlights the ethical considerations adhered to when conducting the research.

### 2.1 Study area

This study was conducted in three rural villages situated along a gradient of decreasing habitat diversity (from the coast inland) in the north-eastern part of the Eastern Cape province, South Africa (Figure 2.1). The coastal village Njela (31°44'16"S; 29°22'26"E) lies approximately 18 km from the R61 road that links Mthatha to Port St Johns, the closest hub of shops and supermarkets, government offices, fuel stations and fast food outlets. It is also situated a short distance from Isilimela Rural Hospital, one of the few rural hospitals in the district. Gogogo (31°43'11"S; 29°17'00"E) and Ludaka (31°39'21"S; 29°08'09"E) are situated further inland from the coast towards Libode, roughly 15 km and 56 km from Njela, respectively. Under the apartheid system, the area formed part of the Transkei homeland but under the new dispensation, falls within the O.R. Tambo district municipality, one of the seven district municipalities that make up the Eastern Cape province. A district municipality has a municipal executive and legislative authority over an area, with its primary responsibility being district-planning. Located within a district municipality are individual local municipalities which share their municipal authority with the district municipality. These villages fall within two different local municipalities: Njela and Gogogo form part of Port St Johns local municipality (area 1 291 $km^2$ and 31 715 households) and Ludaka is in Nyandeni local municipality (area 4 231 $km^2$ and 61 647 households) (Statistics South Africa, 2011).

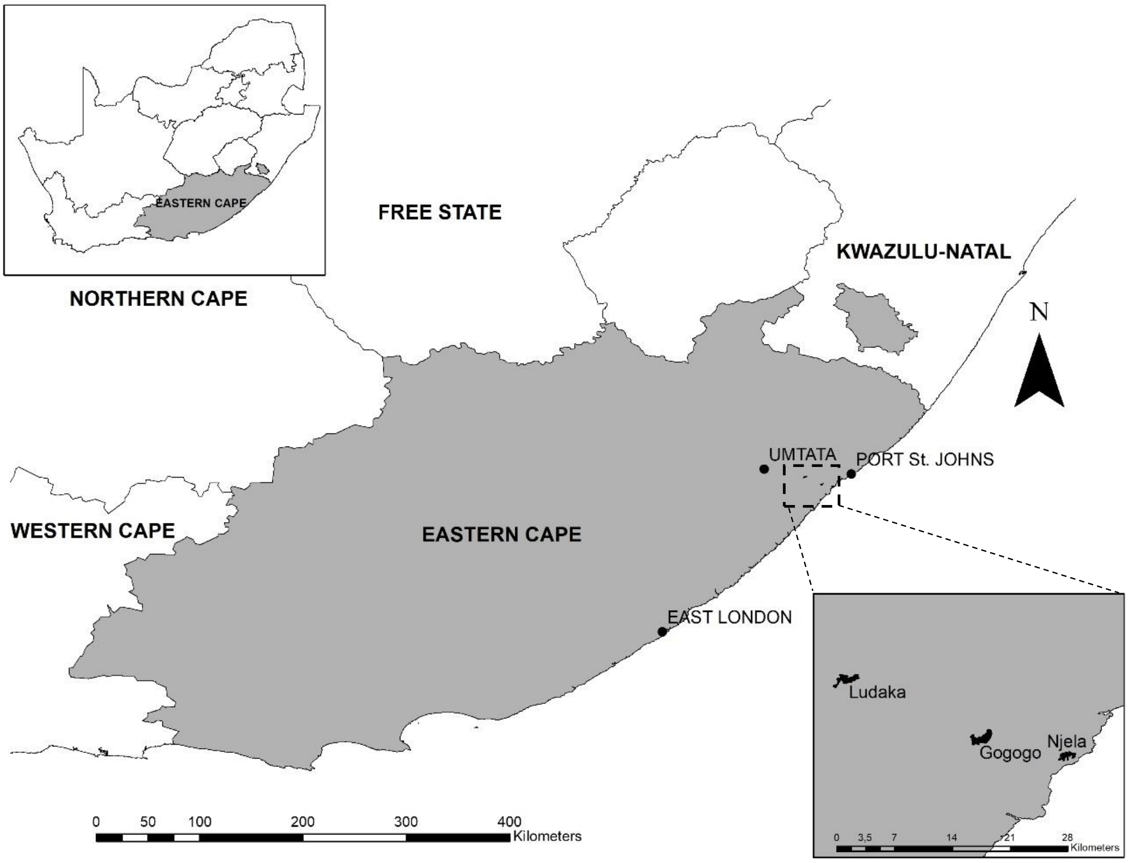



Figure 2.1: Location of Njela, Gogogo and Ludaka (Source: ArcGIS 15/11/2017)

### 2.1.1 Bio-physical factors

The landscape consists of rolling hills and valleys, with an altitude ranging from sea level at Njela to 600 m for Ludaka. The mean annual rainfall ranges between 1 015 mm at Njela on the coast and 717 mm further inland at Ludaka and is concentrated in summer (October – April), although some rain in winter is also common. Mean temperatures range from highs of 30 ˚C in summer, to lows of 10 ˚C in winter (Mucina and Rutherford, 2006).

The Transkei falls within the Maputaland-Pondoland-Albany Biodiversity Hotspot, a meeting point of six of the country's eight major biomes and boasts high levels of endemism and threatened species (CEPF, 2010). Each village was selected based on their proximity to decreasing landscape diversity and vegetation units from Njela through to Ludaka. This selection criterion was informed by Dunn (2010) who suggested that areas of higher biodiversity have a high incidence of ES and EDS.

Njela falls within a floristic region known as Transkei Coastal Belt, a hilly coastal strip along the Wild Coast of the Transkei (Mucina et al., 2006). The vegetation can best be described as a grassland-woodland-forest mosaic. The grassland generally occurs on the higher lying areas, with forests in the valleys and an uninterrupted belt of coastal dune thicket on the seaward border. These forests are considered the most species rich, non-tropical forests in the world (CEPF, 2010). This made it appropriate for selection as the most biodiverse study site as it consisted of diverse habitats that support livelihoods such as extensive rangeland for livestock husbandry, pockets of indigenous forests for NTFP collection and it bordered onto the coastline providing access to marine ES. Gogogo falls within the Ngongoni Veld vegetation type. This is characterised by dense, tall, grassland dominated by wiry *Aristida junciformis* and low species diversity. Wooded patches are present in the valleys at lower altitudes (Rutherford et al., 2006). Therefore, habitats in Gogogo consisted of indigenous forest patches and extensive rangeland, a decrease in habitat diversity from Njela, which made it suitable for selection as the intermediate village along the biodiversity gradient. Ludaka is primarily situated in Bisho Thornveld, characterised by open savanna punctuated by small trees, such as *Acacia natalitia,* with a short to medium, dense, sour grass understorey (Rutherford et al., 2006). Therefore, the homogenous landscape of grassland in Ludaka rendered it suitable for selection as the least biodiverse village.

### 2.1.2 Socio-economic factors

To understand the current socio-economic dynamics of the region, it is instructive to briefly consider its political history. The origins of the former Transkei can be traced back to the Native Land Act (No. 27 of 1913) implemented by the apartheid government. This act served to formalise the Native Reserve system which demarcated just over 13% of the land area in the country for separate occupation by the majority black population (Haysom, 1983). The establishment of these reserves, or homelands, was to ensure the separate development of black and white populations. This saw the consolidation of white interests as it provided a means to secure a supply of cheap labour for the mining industry and a way to govern the majority black population. This was achieved through the renewal of power amongst traditional political structures such as chieftain rule and village headmen (Westaway, 2012).

The changes that took place in South Africa at the dawn of democracy in the early 1990s saw the dismantling of the homelands geopolitical designation and governing institutions and their reintegration into South Africa, but implemented few broader socio-economic changes. Instead, the high levels of chronic poverty, low levels of economic activity, dearth of employment opportunities, high levels of dependency on welfare, poor service delivery and low levels of development, characteristic of the apartheid homeland system, have stubbornly remained, especially in rural areas (Westaway, 2012). Exceptions pertain to massive programmes in electrification and bulk water supply, along with housing in urban areas.

These aforementioned socio-economic conditions are reflected across the three study sites. Gogogo is the largest village with a population of 951 in 206 households, followed by Ludaka with 685 people in 144 households and then Njela with a population of 460 in 85 households (Statistics South Africa, 2011). In Njela, the population consists of a high proportion of children and youth, with about 59.3% between the ages of 0-19. Only about 4.3% fall into the pension group (age 65+) whilst 36.4% is of an economically active age (age 20-64). Similar trends are reflected in Gogogo and Ludaka, with the majority of the population occurring within the youth age bracket at 60.7% and 59.8%, respectively, and 33.6% and 37.3%, respectively, amongst the working age group, and 5.7% and 2.9%, amongst the pensionable age group (Statistics South Africa, 2011). Further, each village has a higher female to male ratio.

Each village is under communal tenure, where land is categorised into arable land, residential plots with neighbouring home gardens and communal rangeland which is used for grazing and for the extraction of natural resources such as fuelwood, thatch grass, construction materials, fruits and reeds. While land is state owned, the authority to allocate land lies with the traditional leadership structure i.e. chiefs and headmen. Once a family has been allocated land for settlement or cultivation, it is defacto theirs and is retained by them whether used or not. Houses were formally scattered across the landscape but were consolidated around 1969, under the Betterment Planning regime, a government attempt to better control the use of resources. Each village has limited infrastructure with no households having potable water or sewage reticulation, but most households have electricity which was introduced around 1995/6. The entire population in Gogogo and Ludaka relies on river or rainwater, and people in Njela rely on a stagnant, dammed pool for water. In some cases, households have made use of makeshift roof water harvesting systems and gutters, collected in storage tanks. Fuelwood is the dominant source of energy for cooking and heating, while lighting is primarily electricity derived.

General economic activity in each village is low. The modal household income bracket in each village is R9 601-19 600 per annum, with more than a quarter of households in each village falling within the "no income" bracket (Statistics South Africa, 2011) (Table 2.1). Most households rely on state social grants, cultivation of crops, and natural resources harvested from the wild. Household surveys revealed that 98% of the sampled households in Njela and

Gogogo and 95% in Ludaka received at least one government social grant per month. Low levels of education are pervasive with the modal level being primary school and less than 2% of sampled households had a member with any tertiary education (Statistics South Africa, 2011). Furthermore, permanent employment is low with only 31% of households in Njela, 15% in Gogogo and 8% in Ludaka having any member involved in full-time employment.

Table 2.1: Socio-economic profile across the three villages (From: Statistics South Africa (2011) and baseline data from household surveys)

| Category | Njela | Gogogo | Luduka |
|---|---|---|---|
| Population (people) | 460 | 951 | 685 |
| Households | 85 | 206 | 144 |
| Average household size (people) | 8±4 | 7±5 | 6±3 |
| % HH with livestock | 29 | 53 | 70 |
| Mean size of home garden (ha) | 0.13±0.10 | 0.12±0.02 | 0.21±0.06 |
| % female headed households | 59 | 58 | 58 |
| Modal level of education | Primary | Primary | Secondary |
| Modal household income bracket (Rand per year) | 9 600 – 19 600 | 9 600 – 19 600 | 9 600 – 19 600 |
| Main source of water | Dam/stagnant pool | River/stream | River/stream |

## 2.2 Methodology

### 2.2.1 Approach

The research was conducted within a mixed methods framework with the use of qualitative and quantitative methods. Described as a ‘third research paradigm’ (Johnson and Onwuegbuzie, 2004), a mixed methods approach draws on both qualitative and quantitative methods in all phases of the research process, such as philosophy, research design orientation, data collection and data analysis (Creswell and Plano Clark, 2011). In this way, it combines the best of both approaches to provide complementary insights into research objectives. This fosters a better understanding of the research problem than each approach in isolation. A mixed methods approach is also well suited for the combined worldviews (understood as “a basic set of beliefs that guide action” (Guba, 1990:17), which underpin this study, namely pragmatism with some elements of social constructivism (Table 2.2) (Creswell, 2009).

Pragmatism, in its simplest sense, is a practical approach to a problem (Cameron, 2011, Feilzer, 2010, Morgan, 2007). As a worldview, it arises out of actions, situations and consequences, rather than antecedent conditions. Pragmatism is not committed to any one system of philosophy and reality (Feilzer, 2010, Baskarada and Koronios, 2018). Rather, emphasis is placed on the research problem, and various approaches, both qualitative and quantitative, are used to derive knowledge about the problem. Therefore, pragmatists do not see the world in absolute unity. For a mixed methods researcher pragmatism opens the door to multiple methods, different world views, and different assumptions, as well as different forms of data collection and analysis (Creswell, 2009). On the other hand, a social constructivist approach holds that individuals develop subjective meanings of their experiences. These meanings "are varied and multiple, leading the researcher to look for the complexity of views rather than narrowing meanings into a few categories or ideas" (Creswell, 2009: 8). The questions are broad and general so as to allow the participants to construct meaning of a situation, which is generally created in discussions or interactions with other participants. In this approach, researchers rely as much as possible on the views of the research participants but also recognise how their interpretation is affected by their own personal, cultural and historical experiences (Morgan, 2014).

Table 2.2: Worldviews that underpin this study (Adapted from: Creswell 2009: 6)

| **Pragmatism** | **Social constructivism** |
| --- | --- |
| • Consequences of actions | • Understanding |
| • Problem-centred | • Multiple participant meanings |
| • Pluralistic | • Social and historical construction |
| • Real-world practice orientated | • Theory generation |

In this study, learning and memory were considered to occur at the level of the group and the individual (social constructivist approach). Therefore, useful methods to communicate between knowledge systems, namely scientific (researcher) and local (research participants), were participatory in nature. Interactive and participatory research approaches, or other forms of research collaboration between various groups which transcend disciplinary boundaries, are seen as an appropriate means to ensure that constructive input from all relevant disciplines related to the problem are incorporated (Lang et al., 2012). Collaborative efforts between academics and non-academic stakeholders is also believed to increase the legitimacy, ownership and accountability for the problem, as well as solution options (Lang et al., 2012, Spangenberg, 2011, Talwar et al., 2011).

In this study, participatory methods such as Participatory Learning and Action (PLA) tools, dominated. These include a combination of visual, verbal and interactive techniques and have frequently been used to garner local information on the contribution of ES in rural livelihoods (e.g. Dovie et al., 2005, Kar and Jacobson, 2012, Shackleton et al., 2002a, Twine et al., 2003). Noting the success of participatory methods in ES research, this study adopted a similar approach in investigating EDS in rural livelihoods. The overall approach involved a combination of separate focus group discussions, using a range of PLA activities, with multiple groups within the community, structured household surveys, transect walks with natural resource users, and mapping of land use change using Geographic Information Systems (GIS).

Due to its dominance in this research, PLA deserves additional attention. PLA is a term used to refer to a range of similar approaches, including Participatory Rural Appraisal (PRA) and Rapid Rural Appraisal (RRA) (Chambers, 2006). All operate under a common framework to promote active participation of research participants in identifying their own needs and opportunities and the subsequent actions required to address them (Chambers, 1994). Unlike traditional research methods, researchers hand over 'the stick of authority' to local people and act as mere facilitators as local people gather, express and analyse much of the information (Puri, 2011). This method consists of a growing toolkit of participatory and visual methods that facilitate discussion, collective analysis and learning as well as uncover issues that can be followed up later. However, it is important to highlight weaknesses of participatory methods as some researchers argue that despite the emphasis on community empowerment, in some cases there is still a lack of overt community empowerment, yet that is not to belittle individual learning, understanding and communication which can be empowering at that level (Puri, 2011).

### 2.2.2 Data collection

Field work was conducted between late 2016 up to March 2017 assisted by a translator. Interviews and discussions were conducted in isiXhosa and interpreted simultaneously. The various quotes scattered throughout the text are the English translations of conversations in isiXhosa.

Empirical chapters, chapters 3-5, have been constructed according to land-based livelihood activity, each of which address objective 1-4. There was a large degree of overlap in the type of method used to collect data for each chapter, therefore the following data collection section has been constructed according to the method of data collection. Table 2.3 provides a summary of specific methods relevant to the data requirements of each objective.

Table 2.3: A summary of objectives and corresponding data collection methods in this study

| Objective | Data collection method | Chapter and associated method |
|---|---|---|
| 1. Identify ES and EDS that respondents recognise | - Focus group discussion with natural resource user groups: *using listing, ranking and participatory mapping* | Chapters 3, 4, 5 |
| | - Key informant interviews (e.g. vet, headmen) | Chapters 3, 4, 5 |
| | - Transect walks | Chapters 3, 4, 5 |
| 2. Determine the perceived effects of ES and EDS on respondents' wellbeing | - Focus group discussion with human wellbeing group: *constructed matrices* | Chapters 3, 4, 5 |
| | - Household survey | Chapters 3, 4, 5 |
| 3. Investigate perceived trends in ES and EDS through time and why | - Focus group discussions with natural resource user groups, elderly and youth: *construction of trendlines and seasonal calendars* | Chapters 3, 4, 5 |
| | -Focus group discussion with elderly and youth: *development of timeline* | Chapters 3, 4, 5 |
| | - Land use change mapping with GIS | Chapter 4 only |
| 4. Determine whether people modify their behaviours and livelihood strategies in preparation for or in response to EDS | - Focus group discussion with natural resource user group: *construction of matrices* | Chapters 3, 4, 5 |

#### 2.2.2.1 Focus group discussions

A series of focus group discussions was held with separate groups within each village including a) various natural resource user groups, b) the elderly, c) a mixed group to determine local indicators of human wellbeing, and d) the youth. Each focus group, labelled a-d, was conducted in all three villages, although the number of natural resource groups varied between villages according to habitat diversity. Table 2.4 provides further detail on the range of focus groups in each village, the number of participants and the range of PLA activities conducted in each focus group discussion. The findings from each of these focus groups are discussed in empirical chapters 3,4 and 5. What follows is further detail on the PLA activities conducted in each focus group.

Each group consisted of between six and 12 members who represented a cross-section of the community such as between wealth groups (well-off and very poor), gender (men and women), ages (old and young) and geographical profile (residents living in different parts of the village). Participants for each focus group were selected and organised by the headman or a traditional leader due to their in-depth knowledge of local residents.

Prior to the engagement in PLA activities, focus group participants were introduced to the concept of ES. These were described as benefits from nature that support people's livelihoods and daily practices through the provision of various resources, such as firewood for cooking and sale or river water for irrigation. Participants were also made aware that natural resources not only provide benefits but also generate negative impacts, known as EDS, such as snake bites, crop destruction by crop pests or malaria from mosquitos. Each focus group generated two lists, the first detailed ES that underpinned local productive activities, domestic practices and wellbeing and the second detailed EDS which eroded asset bases and undermined that particular livelihood strategy. Lists were augmented with identification of specific community members who relied on the identified ES or those who were most vulnerable to the EDS.

Table 2.4: Range of focus groups and associated method of data collection and number of participants in each group

| Village | No. of focus groups | No. of participants | Method of data collection in each focus group |
|---|---|---|---|
| **Njela** | 1. Natural resource user groups: | | |
| | 1.1 Home garden owners | 13 | Ranking, trendlines, seasonal calendars, matrices, participatory mapping |
| | 1.2 Livestock owners | 7 | |
| | 1.3 NTFP collectors | 8 | |
| | 1.4 Marine resource collectors | 8 | |
| | 2. Youth focus group | 7 | Ranking, trendlines, seasonal calendars, matrices, participatory mapping |
| | 3. Elderly focus group | 9 | Historical timeline |
| | 4. Human wellbeing focus group | 7 | Matrices |
| | **Total no. focus group: 7** | **Total: 59** | |
| **Gogogo** | 1. Natural resource user groups: | | |
| | 1.1 Home garden owners | 9 | Ranking, trendlines, seasonal calendars, matrices, participatory mapping |
| | 1.2 Livestock owners | 7 | |
| | 1.3 NTFP collectors | 9 | |
| | 2. Youth focus group | 6 | Ranking, trendlines, seasonal calendars, matrices, participatory mapping |
| | 3. Elderly focus group | 8 | Historical timeline |
| | 4. Human wellbeing focus group | 9 | Matrices |
| | **Total no. focus group: 6** | **Total: 48** | |
| **Ludaka** | 1. Natural resource user groups: | | |
| | 1.1 Home garden owners | 12 | Ranking, trendlines, seasonal calendars, matrices, participatory mapping |
| | 1.2 Livestock owners | 8 | |
| | 2. Youth focus group | 12 | Ranking, trendlines, seasonal calendars, matrices, participatory mapping |
| | 3. Elderly focus group | 11 | Historical timeline |
| | 4. Human wellbeing focus group | 8 | Matrices |
| | **Total no. focus group: 5** | **Total: 51** | |

- Natural resource user and youth focus groups

Focus group discussions with separate natural resource user groups in each village identified provisioning ES that contribute to livelihoods and EDS which eroded assets or undermined livelihood activities. Natural resource user groups were constructed according to primary livelihood activity, as each group relied on and experienced a different suit of ES and EDS, although there was some overlap. Primary livelihood activities included a) on-farm activities, such as cultivators and livestock rearing (in separate groups), and b) natural resource collecting groups such as NTFP and marine resource collectors. The environmental circumstances of each village determined the range of livelihood activities in each village. This impacted the number of natural resource focus groups in each village. More specifically, four natural resource focus groups took place in Njela: NTFP collectors, marine resource collectors, livestock and home garden owners, three took place in Gogogo: livestock and home garden owners and NTFP collectors and in Ludaka only two natural resource focus groups occurred with livestock and home garden owners (Table 2.4). Participatory sessions with natural resource users revealed that, in some instances, the youth had contrasting opinions to elder members of the community. This led to the development of youth focus group discussions where the same PLA activities were performed.

Various PLA activities were conducted within each focus group discussion to establish the types and amounts of natural resources used, the frequency and seasonality of use, and change over time as well as the EDS which effected natural resources, their frequency and severity, and coping or adaptive mechanisms to minimise damage. What follows is a more detailed description of PLA activities conducted within natural resource user and youth focus group discussions, which were adapted from Schreckenberg et al. (2016) PLA manual.

*Ranking exercises*

Ranking is a means of prioritising or ranking prepared lists in order of significance (Theis and Grady, 1991). Ranking can be used to determine the relative importance attached to various species, activities, environmental attributes and stakeholders (DfID, 2000). In this study, focus group participants were asked to list ES/EDS within that specific land-based livelihood sector, e.g. livestock owners listed ES associated with livestock such as manure, milk, draught power, etc. Lists of ES/EDS were then revisited and ranked according to various criteria such as: a) frequency of use, and b) amount used. Criteria for ranking EDS included: a) frequency of occurrence, b) the ability to cope with the EDS, and c) EDS severity. Numerous questions such as “which item on the list is considered to be used most frequently” or “do you use/collect item one less frequently than item two, etc.” were used to stimulate discussion amongst participants. Once participants had reached consensus, items were placed in order from first to last, according to the specific criteria. When ranked, the same ES/EDS may have occupied different positions according to the different criteria. This provided deeper insight into the underlying opinions, beliefs, concerns or priorities within the community and generated an understanding of the preferences of natural resource use within the community. As a consensus-based activity, discussion regarding the placement of items on the list was also noted as it unveiled nuanced individual sentiments within the group (Appel et al., 2012).

*Trendlines*

Trendlines provide an understanding of people’s perception of change over time. They can be used to discuss varying issues such as ecological histories, changes in land use, customs and practices, populations, and migration (Chambers, 1992). In this case, trendlines were used to demonstrate the perceived change in the production or use of selected ES and the occurrence of selected EDS since the 1950s. Dates, increasing in ten year increments from 1950, were written on individual cards and placed on the floor. Participants then engaged in discussion on how to distribute a set number of stones, usually 40 stones, across the dates to illustrate change, with many stones indicating a greater number or magnitude of ES and visa versa. One participant was elected, and through ongoing discussion with other focus group participants, distributed the stones across the date cards. On numerous occasions the distributed stones had to be reshuffled across date cards as the participants did not have the desired amount left to be allocated to the last date card. Once finished, the number of stones on each date card was recorded, thus demonstrating change of ES/EDS over time.

*Seasonal Calendars*

Seasonal variations may have a great influence on the livelihoods of rural people. Certain months bring more work, income and food while others bring the opposite and the combinations thereof. Drawn by local people, seasonal calendars depict variations in the main activities, problems and opportunities of a community throughout the annual cycle (Narayanasamy, 2009). In this case, seasonal calendars were constructed in focus groups to identify seasonal variations in the presence or supply of selected ES and EDS. Calendar construction began by identifying whether residents were more comfortable talking about months or if they preferred talking about particular ‘marker seasons’ (e.g. harvest season).

Once identified, a table was constructed with seasons/month in the top row and selected ES/EDS in separate rows below. For each ES/EDS participants were asked to draw on a piece of paper which part of the year they experience the specific ES/EDS. Lines or bars were used to indicate the period in which they occur. Thicker/thinner bars indicated intensity (e.g. a thicker/taller bar during more intense period).

*Matrices*

Presented in the form of simple checklists or complex tables with rows and columns, matrices are useful tools for summarising large amounts of information regarding a range of issues (Newing, 2011). In this case, participants constructed a matrix identifying different adaptive strategies or coping mechanisms to selected EDS. More specifically, participants provided further detail on the possible short-term and long-term coping or adaptive strategies, who was responsible for administration of the strategy within the household, and any possible government intervention, cultural norms or traditions that had been developed to minimise occurrence of the specific EDS.

*Participatory mapping*

Participatory mapping provides a means to gather information about natural resources, special sites, and local perceptions in a common geographical framework (Puri, 2011). This activity requires the collation and plotting of spatial information on a base map according to the perceptions of their territory (Chambers, 2008). In this study, focus group participants identified the harvest locations of the top ranked ES and points of EDS origin onto a projected Google Earth image of their village. This tool was used to stimulate discussion rather than a means to generate a visual map. Participatory mapping was also used to delineate the village boundary, used later in the mapping of land use change in section 2.2.2.5.

- Focus groups with elderly

A focus group discussion with elderly members of each community was conducted to better understand what historical natural and human events (e.g. perceived differences in resource availabilities, democracy, weather related events, health changes in livestock, etc.) had influenced the livelihoods and wellbeing of the community. In these sessions, a historical timeline was constructed by looking back to the 1950s and identifying important critical events, with an emphasis on ecological events and changes that have occurred since then. The construction of a timeline began in a neutral and informal manner as a conversation between the researcher and participants. The researcher explained that this was an unfamiliar area and would like to understand the past significant events or perhaps how things have changed over time. Events or changes were recorded on timeline drawn on long sheets of paper as they were remembered and not necessarily in chronological order. The event was noted above the line and a brief description below the line. If there was difficulty in remembering specific dates, they were related to more well known events such as democracy, death of an important person, etc. (Shreckenberg *et al.* 2016).

- Human wellbeing focus groups

Wellbeing extends beyond material bases for livelihoods and includes intangibles, such as social or other subjective or culturally constructed experiences, goals or needs (White and Pettit, 2004). Participatory approaches provide an important opportunity to define wellbeing in a way that genuinely reflects local people's own perspectives. These perceptions of wellbeing are diverse and often context specific (Agarwala et al., 2014), and were therefore explored separately in each village in this study.

Local perceptions, definitions and indicators of wellbeing were generated in the form of a matrix. This involved identification of common wellbeing indicators (e.g. quality of house, ownership of livestock, land ownership, type of job, etc.) which were recorded in the first column of the matrix. The different number of wellbeing groups identified in the community, such as better-off, poor, or very poor, were inserted in the neighbouring columns. Details of the value of the different indicators pertaining to each wellbeing group were captured. This provided insight into how people made a living in the area, how people gauged whether a family had a high or low wellbeing, or the way in which ES/EDS affected the manner in which people made a living. It also provided insight into what aspects other than money or material possessions were associated with wellbeing (e.g. education, membership of a specific organisation, participation in local traditional events, etc.).

#### 2.2.2.2 Key informant interviews

Key informant interviews are structured or semi-structured interviews with individuals who are considered knowledgeable about a particular issue (Borrini-Feyerabend, 1997). In this study, semi-structured key informant interviews were conducted with village headmen, members of the village committee, key individuals who specialised in the use or harvest of a particular ES and a state vet. These were used to gain additional understanding of natural resource use and the effects of EDS in the community. Interviews were conducted in a quiet, neutral space to allow for ease of conversation and the researcher posed questions which clarified any uncertainties that came out of focus group discussions, or asked for additional expert-based knowledge on the subject. Key informants were also encouraged to ask the researcher questions (Schreckenberg et al., 2016).

#### 2.2.2.3 Transect walks

Transect walks involve engagement between the researcher and study participants beyond the confines of the focus group discussion location (Schreckenberg et al., 2016). Involving walks with one or two participants along a pre-defined transect within the community, transect walks serve to collect information on a range of issues and stimulate discussion. An important part of the method is active listening, identification of problems and local level solutions. In this study, transect walks were conducted with participants in each village who were deemed knowledgeable on each land-based livelihood sector. This allowed for collection of key plant species for identification mentioned in focus group discussions, clarification of particular uncertainties and a more accurate understanding of spatial layout of the village.

#### 2.2.2.4 Household survey

When conducted on a random sample, household surveys are a well-known technique that enable researchers to make inferences regarding the population in question (Christiaensen et al., 2001). In this study, household surveys (appendix 1) were used to a) triangulate the information from the PLA focus groups, b) calculate the gross, direct-use value of natural resources at the household level, and c) calculate the financial cost of EDS related losses.

Household surveys were modified in each village to include resources locally available for collection within the village boundaries. For example, ocean resources were not included in Ludaka which was primarily grassland. Although some information on resource trading was gathered, the focus of the survey was on the value of resources for domestic use or direct household provisioning.

A sample of 35 households in Njela and 40 households in Gogogo and Ludaka were selected, representing a sampling intensity of 41% of households in Njela, 20% in Gogogo and 28% in Ludaka. A smaller sample size for Njela was the result of a) smaller village size and b) considerably longer interviews per household due to the extensive use of a diversity of ocean resources which were not available in other villages. Households were randomly selected with an aerial photo and random number table, which is underpinned by the principle that each unit should have the same probability of being selected. Household heads were the primary source of information but often delegated another member as the respondent for specific resources of activities. In households where it was difficult to isolate a respondent, a collective household interview was conducted. In this study ‘a household’ was seen to be a person or group of persons who live together and make common provision for food or other essentials for living (United Nations., 2008). It is important to note that ‘households’, which represent domestic and economic social units (i.e. people jointly generating and/or managing resources), differ from ‘families’, which allude to social relationships, bonds of blood and matrimony (Schreckenberg et al., 2016).

The household survey was divided into three parts. The first section was designed to collect data required to calculate the direct-use values of all ES used per household. This included a checklist of all the natural resources collected, followed by a section for details of each. Details included the frequency of harvest (number of times a week/month/or annually) over the number of months (to account for the natural production period or seasonality), and the typical volume of the harvest. Data on resource harvest or consumption was often expressed in the dimensions of local units such as ‘headloads’, ‘packets’, ‘sacks’ or ‘cups’. In most cases, consumption was reported in the same local units but in a few select cases, such as in the reporting of maize, it was converted to conventional units of measurement. The average weight of a maize sack, the local measurement used to report harvest of maize, was 25 kg. Local farm gate prices of each resource were noted in the household survey, and the average price of the resource was used to calculate the direct-use value. Taking into account the production period, the mean annual direct-use value for each resource was calculated by multiplying the annual household consumption of a household by the average local price. However, the economic value of livestock services, such as slaughter or sale, was calculated by multiplication of the number of services harnessed per annum and the average local value of the livestock type. The direct-use value of each resource was calculated per household and then averaged across all sampled households to calculate the mean, annual, direct-use value per resource. This was also calculated on a per household basis for user households i.e. excluding those households who do not use a specific resource. The annual direct-use value of all resources in a natural resource category (i.e. home gardens, livestock, NTFPs) was calculated per household and then averaged across all households in the sample and also among user households. All values are gross values as no costs, such as opportunity costs of labour or input costs, were deducted. However, they are low in the context of unemployment and limited employment opportunities.

The second section collected data on EDS. This included a) a checklist of selected EDS mentioned in natural resource user focus groups, such as chicks snatched by birds of prey, tick-related livestock deaths, loss of crops to invertebrate pests or monkeys, etc., b) the financial cost of EDS related losses and, c) the presence of coping or adaptive mechanisms and the financial implications in implementing them.

Financial cost calculations differed across natural resource user groups. The cost of livestock EDS to households was represented by the loss of potential consumptive services, i.e. the average economic value of services that would have accrued per household if not for the disservices. This was calculated as the sum of the direct-use and trade value per household and the potential consumptive services lost as a result of the EDS. The total potential economic value of home gardens, representing 100% of home garden value if not for EDS, was calculated as the sum of the direct use value of the home garden (yield in Rands) and the economic value of crop loss (calculated from the average percentage loss). Further details around economic loss calculations are outlined in each specific results section. Lastly, the financial costs of coping or adaptive mechanisms were primarily calculated as the cost of prevention or treatment medication per annum. The quantity of medication per annum was multiplied by the price of the medication per user household and then averaged across all user households.

Lastly, socio-economic characteristics of the household were captured in the third part of the survey. This included local human wellbeing indicators such as type of house, number of appliances, sources of income from the formal, casual or self-employment sectors and social grants, as well as other questions such as household size and structure, and age, level of education and number of years spent in the village of the household head.

#### 2.2.2.5 Mapping of land use change with GIS

Bush encroachment and other broad trends in land use and cover, were recorded at three different time periods in each village through the classification, analysis and interpretation of aerial photographs in ArcGIS 10.3. Historical aerial photographs of each study site were obtained from the Chief Directorate of Surveys and Mapping (Department of Land Affairs, Republic of South Africa). For 1974 (Job no. 733) and 1995 (Job no. 983) aerial photographs at 1:50 000 were acquired. Georeferenced, orthorectified 1: 10 000 (Job 560) were obtained for 2013.

All historical aerial photographs were georeferenced to the 2013 images. A 30 x 30 m grid was then generated within each village boundary drawn by villagers in focus groups on Google

Earth. A random selection of 5% of cells was sampled three times for each time period in each village and was then classified according to dominant land use or cover (Table 2.5). In some villages, certain land use categories were not applicable.

Table 2.5: Land use or cover categories allocated to grid cells on aerial photographs (Njela n=2 304, Gogogo n=3 474, Ludaka n=2 340)

| **Land use or cover** | **Description** |
|---|---|
| Burnt landscape | Distinctly blackened area of landscape |
| Coastal | Beach sand, coastal rock, river or ocean |
| Reed beds | Moderate to fully inundated areas, marked by reed or rush-like vegetation, presumably from the Cyperaceae or Juncaceae family |
| Dense Bush Encroachment | More than two-thirds of the cell dominated by lighter shaded woody vegetation with a discontinuous canopy. Usually located at the perimeter of the intact indigenous forest. |
| Field | Cultivated land, marked by dark plough lines, detached from the homestead |
| Grassland | At least 65% of the cell dominated by grassland |
| Home garden | Cultivated land, usually surrounded by a hedge, located immediately next to the homestead |
| Indigenous forest | Dark shaded woody vegetation, with a canopy cover greater than 90% |
| Infrastructure | Human made structures including buildings or dirt roads |
| Invasion within the settlement | Invasive alien vegetation in and around settlement area. Presumably *Solanum chrysostichum*, *Plectranthus comosus* or *Lantana camara* |
| Sparse bush encroachment | Up to two-thirds of the cell dominated by lighter shaded woody vegetation with a discontinuous canopy. Usually located between grassland or previously cultivated areas and intact indigenous forest |
| Woodlot | In- or near-settlement patch of trees, defined by a distinct boundary |

### 2.2.3 Data analysis

Data were expressed in descriptive statistics, and in some cases augmented with analysis in R version 3.4 (R Core Team, 2013). For example, a one-way ANOVA was employed amongst normally distributed data to test the significance between the means of the three study sites. For non-normal data a Kruskal Wallis test was conducted. In particular, an ANOVA was employed to test for significance between the economic value of a land-based livelihood option, such as home gardens, livestock or NTFPs, and villages. It too was used to test for significance between the means of different time-steps of a particular land cover. A regression was carried out to test the strength of a relationship between two continuous variables such as human wellbeing and NTFP/livestock or home garden economic value, as well as the relationship between the number of NTFPs harvested or crops grown and human wellbeing. A p value of less than 0.05 was regarded as significant.

### 2.2.4 Ethical considerations

It is acknowledged that, because this study involved human subjects, there were certain ethical aspects which were considered and accounted for. The ethical guidelines, as laid out in the Rhodes University Ethics Policy (Rhodes University, 2014), were strictly adhered to through all phases of research. The research proposal and survey questionnaires were approved by the university ethics committee.

A preliminary trip to each field site took place prior to data collection. During this trip the researcher, assisted by an isiXhosa translator and facilitator, met with the traditional authorities in each village. In these meetings the purpose and nature of the proposed research was outlined, confidentiality and anonymity of the research participants assured, the anticipated benefits derived from participating in the research highlighted, the procedures that participants would be asked to participate in described, and the ability of participants to withdraw from the study at any time guaranteed. An official hard copy outlining the aforementioned points and additional contact numbers to affiliated parties at the university was handed to traditional leadership. Privacy was also ensured, by acknowledging that participants had the right to withhold or reveal any information they pleased, asking permission before entering a private residence, and the use of a camera and voice recorder only with respondents' permission. During official fieldwork, the above points were outlined at the beginning of focus groups and household surveys. This was followed by verbal consent from each of these groups to participate in the research.

Feedback of the research findings to each community took place in June 2018. This took the form of a workshop where an open invitation was extended to all community members that took part in focus group discussions or household surveys, as well as community leaders or any other interested members of the community. During this workshop, research findings were presented to the community who then had the opportunity to highlight any misconceptions or conclusions drawn in the research. A hard copy of key research findings was also provided to local leaders in each village.

### 2.2.5 Limitations

The following limitations are acknowledged in this research:

#### 2.2.5.1 Unidimensional value vs pluralistic value

The economic contribution of ES and the economic losses caused by EDS, are only one proxy for the importance of ES/EDS in rural livelihoods. Pascual et al. (2017) calls researchers to look beyond the unidimensional value lens of a utilitarian economic perspective and embrace a more integrated approach that embraces value pluralism by acknowledging a diversity of values. Groups or individuals perceive or judge ES/EDS in numerous ways, which cannot be measured using the same yardstick. For example, livestock provide an important economic contribution or saving to the household. However, they also extend beyond the instrumental value, as they are inextricably linked to rural people's sense of identity and perception of a meaningful or good life. Although relational and intrinsic values are explored in some detail in this study, instrumental values still dominated. This was due to the novelty of research and the need for a starting point, coupled with the large tracts of data and time limitations. In future research, value pluralism when investigating ES and EDS would enable a more nuanced calculation of the gains, losses, values, etc. as it would link the non-material services which are strongly linked to certain decisions.

#### 2.2.5.2 Sample selection

In most cases, participants for focus group discussions were selected by village leaders. This was to ensure that participants which fitted the desired profile of the focus group attended the focus group. However, this method of selection might have introduced bias into the study because village leaders may have only selected participants within their good graces or those who would represent village affairs in a desired way.

#### 2.2.5.3 Language and translation

Almost all methods of data collection, including focus group discussions, household surveys, key information interviews and transect walks, were conducted with the assistance of a translator. The question or direction was initially posed by the researcher in English and then interpreted and translated into isiXhosa with the assistance of a translator. Responses from the participants were then interpreted and translated from isiXhosa back into English. This process may have allowed for incorrect interpretation as well as limited the opportunity for the researcher to pick up on subtle nuances in responses.

# CHAPTER 3: ARABLE AGRICULTURE

## 3.1 Introduction

Smallholder food production, in the form of small home gardens and larger field plots, represents humankind's largest engineered ecosystem (Zhang et al., 2007). Relying on various ES, agricultural ecosystems are primarily managed to optimise food production, which contributes to the nutritional status, health and food security of local households (Mayori, 2009, Rogan, 2018, Tesfamariam et al., 2018). Cultivation also aids self-sufficiency, as plants grown in cultivated plots can generate income through sale in local and regional markets, or reduce household expenses through provision of nutritious vegetables and fruit and animal feed or staple cereals (Galhena et al., 2013). In this way, agroecological systems form an integral part of most rural livelihoods, and their significance has been appreciated throughout the world, including in South Africa (Adekunle, 2013, Connor and Mtwana, 2017, Dovie et al., 2003). However, EDS, in the form of crop pests, have for centuries undermined crop production through a reduction in yields and an increase in production costs (Zhang et al., 2007). What this study highlights, is the necessity to analyse both crop production and the impact of crop pests in tandem rather than in separate disciplinary silos, in order to arrive at a balanced view of the contribution of crop production in rural households (Schaubroek, 2017).

In South Africa, an estimated four million people are engaged in subsistence agriculture to varying degrees, the majority of whom are in the former homelands (Baiphethi and Jacobs, 2009). In these areas, cultivation primarily occurs in small home gardens located next to the homestead where several species of crops are grown and involve minimal direct costs and marginal labour costs to the household in comparison to other major economic activities within the household. In some cases cultivation also occurs in fields which are disconnected from the homestead, however their use is declining, especially in the Eastern Cape (Hebinck and Lent, 2007, Shackleton et al., 2013, Shackleton and Luckert, 2015). In this way, cultivated plots are often taken-for-granted contributors to household wellbeing, and used as a remedy to alleviate hunger and malnutrition in the face of a growing global food crisis. For example, Tesfamariam et al. (2018), in their investigation of the role of home gardens in rural households in Gauteng province, showed that participation in home garden cultivation reduced food insecurity in participating rural households by as much as 42% and in a number of other studies (Faber and Benada, 2003, Faber and van Jaarsveld, 2007, Faber et al., 2002) analysis of a home-garden-based intervention to address vitamin A deficiencies in South Africa found positive associations between home gardens and nutrition. With a wealth of literature pointing towards similar findings, there is a broad consensus that households possessing home gardens tend to eat better than those who don't (Pritchard et al., 2018).

Subsistence production has the potential to increase food supply and reduce dependence on purchased food in the face of rising food prices which can exacerbate poverty, inequality and food insecurity. Recent studies have shown a rise in dependence on cash incomes for food purchases (D'Haese and Van Huylenbroeck, 2005), which in the context of high unemployment, is largely from social grants. In South Africa between 2014 and 2015, the cost of a basic food basket increased from R485 to R514, representing an increase from 45% to 48% of the average monthly income of the poor (Faber and Drimie, 2016). In response to rising food prices, home gardens may act as coping mechanisms. This was emphasised by Mkhawani et al. (2016) in their study analysing the short- and long-term coping mechanisms for rising food prices in Mopani District, Limpopo Province, where approximately 50% of participants began cultivating home gardens for food availability and subsistence in response to rising food prices, which echoes what happened in Zimbabwe following hyperinflation (Masvaure, 2016).

However, biodiversity which supports agroecological processes and the provision of crops also generates a suit of EDS which impact crop productivity, often resulting in production and economic losses, and which compromise food security (Oerke, 2006). The effects of vertebrate and invertebrate pests are widely acknowledged throughout the globe. For example, Marchal and Hill (2009) perceived wildlife-crop damage by pests, such as primates, squirrels, long-tail macaques, pigs, porcupines, elephants, etc., as the most significant limitation to agricultural production in four villages in North Sumatra, Indonesia; and in three villages in northern Laos rats were responsible for the loss of 8-12% of rice production (Vang Rasmussen et al., 2017). Similar findings were reported by Sharma et al. (2017) who indicated that arthropods destroy an estimated 18-20% of annual crop production worldwide. Furthermore, despite the implementation of a range of control measures, Oerke (2006) estimated that an average of 35% of potential crop yields are lost to pre-harvest pests worldwide.

Therefore, home gardens represent a cherished ideal, contributing to a wide array of social and nutritional needs. Yet, the scope of research is narrow, tending to point towards statistical associations between home gardens and nutrition-related indicators, without considering the broader relationships between ES and EDS and relative to other livelihood activities. Agroecological literature operates on the presumption that home gardens produce beneficial outputs only and ignores unpleasant, unwanted or economically harmful effects which occur alongside the positive contributions. This chapter serves to counteract this imbalance. In the next section I provide empirical evidence on both ES and EDS in the same agricultural production system, recognising their role in the household by quantifying the economic contribution of ES and the potential economic losses by EDS.

## 3.2 Results

A wide variety of ES and EDS confer benefits and costs, respectively, to arable agriculture. These are supplied by various species and functional groups and occur over different scales. This section consists of two parts: the first describes the major ES generated by arable ecosystems in the form of food, and the second details EDS which reduce yields or increase production costs.

### 3.2.1 Ecosystem services

This sub-section details the contribution of small-scale agriculture, in small home gardens and in larger field plots, to livelihoods. It combines agronomic data about crop production with ethnographic data that links arable agriculture to the people growing the crops. Together this tells the story of crop production in each village.

#### 3.2.1.1 Home garden production

Home gardens in each village were located on residential lots, fenced off from the homestead structures and neighbouring plots, and ranged in size from 0.21±0.06 ha in Ludaka to 0.12±0.02 ha in Gogogo, and Njela (0.13±0.10 ha).  A few households had access to more than one garden, one in the residential plot and another outside it. Gardens outside the homestead were usually on sites where a friend or family member lived intermittently and had given permission for the use of the home garden site until they returned permanently.

##### 3.2.1.1.1 Cultivation, consumption and crop diversity

Across villages, 25 different crops were cultivated in home gardens during the 2016 cropping season. Maize (*Zea mays*) was the most widely cultivated crop in each village (Table 3.1), alongside other primary crops such as common beans (*Phaseolus vulgaris*), spinach (*Sinacea oleracea*), cabbage (*Brassica oleracea*), wild herbs (*imifino*) and pumpkin (*Cucurbita pepo*) (Table 3.1 and 3.2) which were staple ingredients for traditional dishes such as samp and beans

(*Umgqusho*) and the vegetable relishes which accompanied these dishes. The wide range of additional cultivated crops is highlighted in Table 3.2.

Table 3.1: Percentage (%) of all households (i.e. cultivators and non-cultivators) cultivating each dominant crop

| **Plant product** | **Njela** | **Gogogo** | **Ludaka** | **Mean±SD** |
|---|---|---|---|---|
| Maize | 74 | 75 | 88 | 79±8 |
| Wild herbs | 83 | 68 | 63 | 71±10 |
| Pumpkin | 60 | 75 | 28 | 54±24 |
| Spinach | 66 | 55 | 33 | 51±17 |
| Common beans | 51 | 65 | 28 | 48±19 |
| Cabbage | 43 | 43 | 43 | 43±0 |

Table 3.2: Ranked list of crop types in descending order according to frequency and quantity harvested in each village

| | **Njela** | | **Gogogo** | | **Ludaka** | |
|---|---|---|---|---|---|---|
| **Rank** | **Frequency of harvest** | **Amount used** | **Frequency of harvest** | **Amount used** | **Frequency of harvest** | **Amount used** |
| 1 | Maize | Maize | Cabbage | Spinach | Maize | Maize |
| 2 | Common beans | Common beans | Spinach | Cabbage | Common beans | Wild herbs |
| 3 | Cabbage | Cabbage | Maize | Wild herbs | Cabbage, spinach | Potato |
| 4 | Spinach | Spinach | Common beans, maize, wild herbs | Potato | Butternut | Spinach, carrot |
| 5 | Potato | Potato | Carrot | Carrot | Carrot | Guava, orange, peach and bananas |
| | Other crops: onion, tomato, beetroot, green pepper, pea, sweet potato, pumpkin, chilli, sugar cane, mango, lemon, paw paw | | | | | |

Amongst those involved in home garden production (97% Njela, 88% Gogogo and Ludaka), a diverse range of crops were cultivated. The majority of households practiced mixed cropping with a mean of 10.0±5.4 crops per home garden in Gogogo and 6.0±2.4 and 6.0±3.6, in Njela and Ludaka, respectively. Crops were planted at different stages to one another to enable year-round production which generated a fresh harvest over a longer period. Several crops were not reaped solely at the end of a defined growing period but were harvested throughout the growing season and consumed directly.

Common reasons from households not growing were: a) insufficient funds to purchase seedlings, b) no fencing around the home garden plot to prevent free-roaming livestock foraging on crops, which discouraged owners from cultivating a home garden, c) limited labour in the household to work the home garden, and d) members of the household had only been resident on the plot for less than one year and had plans to cultivate crops in the near future. Still, each of these households had been allocated a plot of land by the traditional leadership for cultivation as a home garden. This meant that should households navigate the constraints listed above, they have the option to engage in home garden production.

Gardeners in all three villages showed a preference for maize, allocating large portions of the home garden to maize cultivation and often intercropping with pumpkins and wild herbs. During the summer months in Ludaka, the entire home garden plot was used for maize cultivation and once harvested the land was cleared to cultivate other crops during the winter months. Maize was popular as a vegetable (green mielies) and a grain (processed into samp, flour, maize meal and poultry feed). A proportion of the dried maize was saved as seed to plant the following year's crop. Green mielies were harvested when needed throughout the growing period, while dry cobs were harvested together at the end of the defined growing period and either stored on or off the cob in 50 kg bags. During the timeline focus group discussions in each village, elderly members of the community highlighted that despite almost all households cultivating maize in home gardens, current maize yields were insufficient for a household's annual needs. This was in contrast to the past, when maize was cultivated in fields only and residents harvested enough to feed the household until the next harvest. As a result, all households in each village purchased some of their maize needs from those who cultivated surplus maize in their home gardens/field or local shops.

All types of fruit, except for bananas, were identified as seasonal and therefore not always available for household consumption or sale. For this reason, fruit was not ranked in the top positions. During the season however, villagers reported harvesting fruit in great quantities. For example, during guava season 53% of households in Gogogo harvested an average of 37 guavas, seven times a week.

The widespread harvest of wild herbs was not emphasised by home garden owners during focus group discussions and only acknowledged when prompted by the researcher. Household surveys however, reveal that 83% of households in Njela, 68% in Gogogo and 63% in Ludaka harvested an average of one 24 litre plastic bag of wild herbs from the home garden at least once a week. In Njela, more households harvested wild herbs than maize, making it the most harvested plant product. One species of wild herbs, *Laportea peduncularis*, was even transferred from local indigenous forests and propagated in home gardens. Common wild herbs in each village were *Galinsoga parviflora*, *Bidens pilosa*, *Sonchus oleorachus* and *Amaranthus hybridus*. Table 3.3 identifies a wider range of wild herbs in each village which were identified in home garden transect walks.

Table 3.3: Wild herbs harvested each village

| Xhosa Name | Latin Name | Njela | Gogogo | Ludaka |
|---|---|---|---|---|
| Iguzu/ Msobo/ Ibisenti | *Solanum nigrum* | ✓ | | ✓ |
| Imbhuya | *Amaranthus* | | ✓ | |
| Intshuku | *Zehneria sp.* | ✓ | | |
| Intshuku | *Kedrostis sp.* | | ✓ | |
| Irhwabe | *Sonchus oleorachus* | ✓ | ✓ | |
| Kakisa | *cf. Conyza sp.* | | | ✓ |
| Mbikicane | *Chenopodium album* | | | ✓ |
| Mbuledeni | *Convoluulus forinosus* | ✓ | | |
| Mfanothenqi | *Chenopodium murale* | ✓ | | |
| Nomdlomboyi | *Amaranthus hybridus* | ✓ | ✓ | ✓ |
| Tshomane | *Ipomoea sp.* | | | ✓ |
| Ububazi | *Laportea peduncularis* | | ✓ | ✓ |
| Umhlabangula | *Bidens pilosa* | ✓ | ✓ | ✓ |
| Utyuthu | *Avierenthus hybridus* | ✓ | | |
| Velamapondweni | *Galinsoga parviflora* | ✓ | ✓ | ✓ |

3.2.1.1.2 Monetary value of production outputs from home gardens

The average, annual, gross direct-use and traded value of crops, amongst households that cultivated home gardens, was highest in Gogogo at R 9 313±7 693, lowest in Ludaka R4 383±4 557 with Njela as an intermediate R7 964±6 366 (F=5.7; p=0.004) (Figure 3.1). The greatest significant difference occurred between Ludaka and Gogogo ($p<0.05$). High standard deviations reflect a great range in home garden values, which was greatly influenced by the number of crops, quantity harvested or size of garden. For example, some households with high values, specialised in the production of a specific crop or cultivated a diverse range of crops, while others, with low garden values, only cultivated wild herbs or harvested fruit during the season.

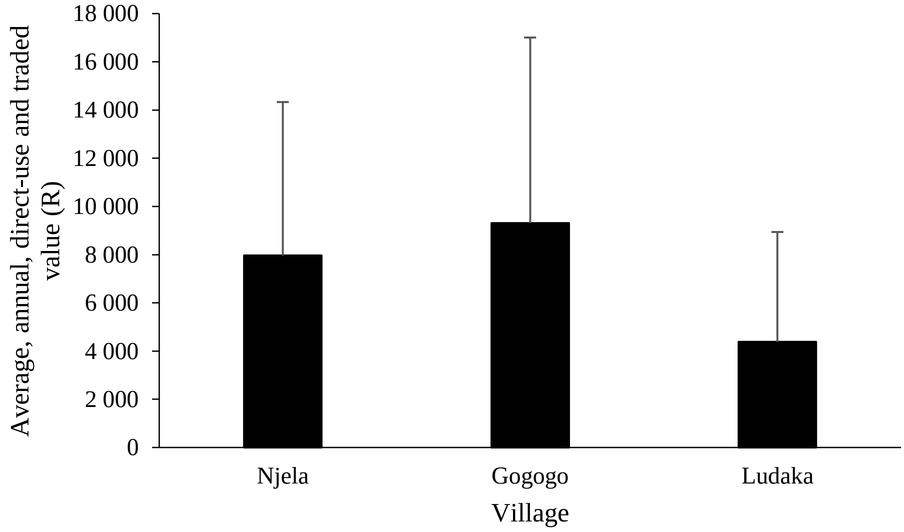



Figure 3.1: The average, annual, gross, direct-use and traded value (R) of home garden crops in each village

The highest recorded value of home garden produce of a single household was in Gogogo and totalled R34 168 per annum. This household cultivated 16 different products in two home gardens. Use of the first home garden was primarily for household consumption, while the second home garden was used to plant spinach, cabbage and sweet potato, for sale. The household consisted of 18 people, none of which had full-time employment, and the sale of crops represented the second-most important source of income to the household after the sale of livestock.

In Njela, the household with the highest annual direct-use value (R20 941), had a lower crop diversity but specialised in the production of beans. In this household 50 kg of beans was harvested five times a week for one month and represented more than 55% of the total value of the home garden. In this household of five people, the sale of crops was the only source of cash income. In most cases however, households with high crop diversity had a higher direct-use value of home garden (Njela: F=16.2, $R^2$=0.34; p<0.001; Gogogo: F=59.0, $R^2$=0.64; p<0.001; Ludaka: F=8.3, $R^2$=0.2; p<0.05) (Figure 3.2).

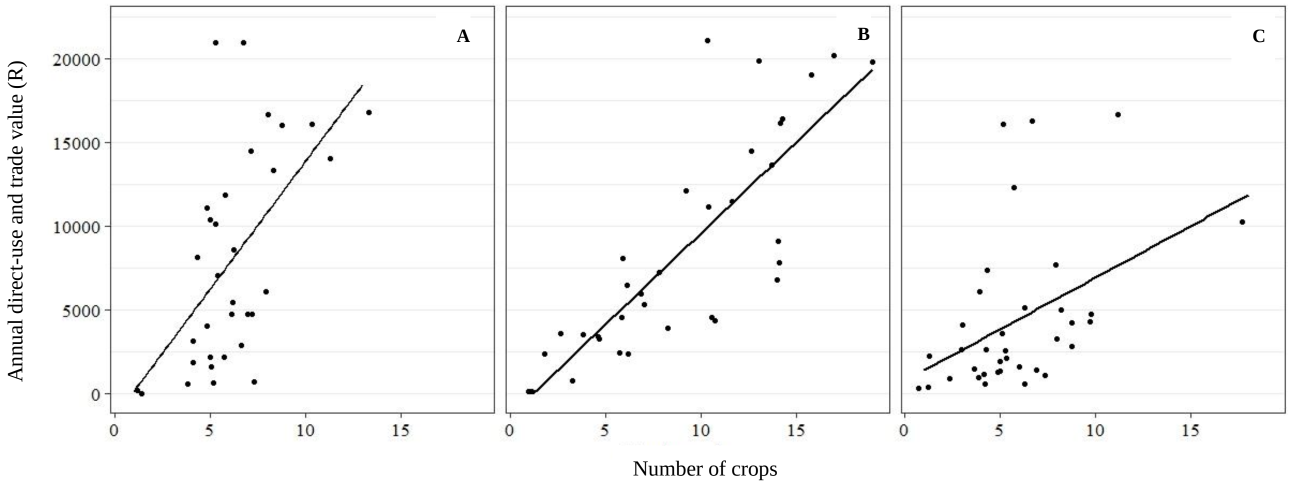



Figure 3.2: The number of crops and corresponding direct-use and trade value (Rand) per household per annum in Njela (A), Gogogo (B) and Ludaka (C) (an outlier of R34 168 was excluded from Gogogo)

Across all villages, Ludaka had the lowest greatest annual direct-use and traded value for a home garden (R16 669). This household cultivated 11 types of crops for both household consumption and sale. Consisting of 20 people (nine adults and 11 children), the sale of crops represented the second-most important source of cash income after one old age grant.

Overall, wild herbs and maize were responsible for the highest relative contribution to the mean gross value across all households (Table 3.4). The contribution of maize was highest in Ludaka at 31% in comparison to 11% in Njela and 12% in Gogogo, due to the allocation of large areas of land to maize. The value of specific crops were especially high in certain villages such as bananas and beans in Njela (12% and 16%, respectively), guavas in Gogogo (11%) and potatoes (7%) in Ludaka. Other widely grown crops such as cabbage, spinach and pumpkin were not amongst the highest relative contributing crops.

The focus of production activity was primarily for household consumption, but in some cases also for local trade with 46% of households in Njela, 28% in Gogogo and 38% in Ludaka involved in local trade to some extent in 2016. Of those selling crops, 20% of households in Njela, 10% in Gogogo and 8% in Ludaka rated income from crops within the top two most important income sources to their household. Traders highlighted that trade derived incomes were used by the household to buy food, clothing, pay school fees, etc. In some cases, traded fruit and vegetables were only sold if the household had surplus and in other cases, crops were grown specifically for sale. Sales were confined almost exclusively within the village. Some sales were made at the beginning of the month at the social grant distribution points while others were made straight from home garden plots throughout the course of the month. Some households also gave home garden produce to neighbours and relatives, which was seen as a way to strengthen relationships.

Household wellbeing, which was locally defined in each village through participatory processes, had a significant, albeit low, positive relationship to economic value of home gardens in Gogogo and Ludaka (Gogogo: $F=7.8$, $R^2=0.19$; $p<0.01$ and Ludaka: $F=17.6$, $R^2=0.34$; $p<0.001$). This highlights that wellbeing increases with the economic value of home gardens in each of these villages. No significant relationship was found between economic value of home garden and wellbeing in Njela ($F = 0.006$; $R^2=0.0001$; $p=0.94$).

Table 3.4: Average, annual, direct-use and traded values of crops in each village ([1]Lemon, Mango, Paw Paw)

| | Njela | | | Gogogo | | | Ludaka | | |
|---|---|---|---|---|---|---|---|---|---|
| **Crop** | **User HH** | **All HH** | **Relative av. contribution all HH(%)** | **User HH** | **All HH** | **Relative av. contribution all HH(%)** | **User HH** | **All HH** | **Relative av. contribution all HH(%)** |
| Avocado | 120(n=1) | 3±20 | 0±1 | 2234±2126 | 223±899 | 1±6 | NA | NA | 0±0 |
| Banana | 2641±3076 | 1057±2311 | 12±22 | 1619±1352 | 648±1161 | 6±11 | 671±922 | 67±327 | 1±3 |
| Beans | 3748±4346 | 1928±3613 | 16±26 | 1503±2264 | 939±1923 | 8±12 | 130±76 | 36±70 | 2±5 |
| Beetroot | 367±457 | 31±152 | 0±1 | 468±350 | 82±226 | 1±1 | 193±145 | 15±61 | 0±0 |
| Butternut | 20(n=1) | 1±3 | 0±0 | 598±479 | 135±333 | 1±3 | 1289±2388 | 322±1279 | 5±14 |
| Cabbage | 846±939 | 339±717 | 5±12 | 498±686 | 199±492 | 1±3 | 824±949 | 350±735 | 6±9 |
| Carrot | 303±208 | 52±141 | 1±3 | 944±860 | 260±610 | 2±5 | 320(n=1) | 8±51 | 0±0 |
| Chili | NA | NA | 0±0 | NA | NA | 0±0 | 588±526 | 29±155 | 1±4 |
| Green pepper | 203±140 | 41±101 | 1±3 | 413±396 | 124±285 | 1±2 | 109±117 | 19±62 | 1±2 |
| Guava | 1157±1197 | 397±880 | 5±10 | 1783±1825 | 891±1561 | 11±18 | 632±615 | 190±439 | 6±15 |
| L, M, P[1] | 469±656 | 18±143 | 0±2 | 316±287 | 32±130 | 1±2 | 144(n=1) | 1±13 | 0±0 |
| Maize (dry) | 1450±1959 | 1035±1775 | 11±15 | 1355±2388 | 1016±2143 | 12±19 | 1250±1791 | 1094±1724 | 31±26 |
| Onion | 913±2180 | 209±1063 | 2±7 | 141±176 | 42±114 | 0±1 | 538±433 | 40±174 | 1±3 |
| Orange | 726±743 | 124±398 | 3±13 | 646±414 | 162±346 | 6±17 | 1126±802 | 141±456 | 4±17 |
| Peach | 520±226 | 89±217 | 1±2 | 929±844 | 465±754 | 4±6 | 506±275 | 101±236 | 2±6 |
| Peas | NA | NA | 0±0 | 211±155 | 16±66 | 0±1 | 140±111 | 11±45 | 0±2 |
| Potato | 467±462 | 40±174 | 1±6 | 959±1154 | 168±584 | 1±3 | 1842±2584 | 645±1737 | 7±13 |
| Pumpkin | 1360±1571 | 350±972 | 4±7 | 799±799 | 559±761 | 8±12 | 267±272 | 160±247 | 6±10 |
| Sweet potato | 1575±1588 | 495±1137 | 5±13 | 1901±2136 | 665±1538 | 4±9 | 1294±1406 | 323±882 | 6±14 |
| Spinach | 566±614 | 356±557 | 7±13 | 894±672 | 470±661 | 5±8 | 934±895 | 234±594 | 4±13 |
| Sugar cane | NA | NA | 0±0 | 1065±885 | 373±725 | 3±7 | 95±123 | 10±45 | 0±1 |
| Tomato | 778±1143 | 89±422 | 2±10 | 794±1085 | 198±627 | 1±2 | 100(n=1) | 3±16 | 0±1 |
| Wild herbs | 1026±1993 | 821±1824 | 17±27 | 659±814 | 445±734 | 10±22 | 232±235 | 145±217 | 6±10 |
| **Av. gross value (R)** | **7964±6366** | **7509±6454** | | **9313±7693** | **8149±7831** | | **4383±4557** | **3945±4121** | |

#### 3.2.1.1.3 Production inputs

Labour was predominantly drawn from the household, including adults and school-going children, but in some cases was also supplemented with assistance from kin from other households. Home gardens were generally the responsibility of women who undertook weeding, planting and harvesting, while the construction of fencing and ploughing of home gardens was usually done by men. Focus group discussions with those involved in home garden production described the youth as disinterested in cultivation.

Seeds were bought in nearby towns or kept from previous seasons' harvests and fruit tree cuttings were most often obtained from neighbours. Land was prepared by hand (i.e. hoe), tractor, or cattle/donkey. Land preparation differed across villages with land prepared by hand dominating in Njela and Gogogo while it was most common for residents in Ludaka to hire a tractor at R500 a day. Soil fertility was promoted by manure collected from around the village or in the *kraal* (livestock enclosure), and in some households, 13% Njela, 18% Gogogo and 58% Ludaka, manure was supplemented by fertiliser purchased at least once a year. Residents often complained of the lack of farmer support services (e.g. technical advice through agricultural extension services) offered to home garden owners, which meant they relied on traditional knowledge passed over generations on how to ensure successful cultivation.

In some households, home gardens were surrounded by hedges (66% Njela, 44% Gogogo and 18% Ludaka), most of which were *Cestrum laevigatum* or *Lantana camara*, which are both declared invasive alien species. The most common reason for hedges in all villages was to protect the homestead against wind. Other common reasons for planting hedges included: a) to protect wire fencing from rusting in the sea air (Njela only), b) as a support for the metal fence, c) provide safe spaces for chicks to hide from birds of prey, d) provide shade for members of the homestead, e) a place to hang washing and f) to beautify the homestead.

#### 3.2.1.1 Field production

Unlike home garden production, only a few households cultivated fields (3% Njela, 5% Gogogo and 18% in Ludaka). This was related to an ubiquitous shift from extensive cultivation of maize in distant fields to intensive intercropping of maize and other food crops in home gardens. During one transect walk an elderly resident from Njela, who had lived in the village for over 70 years, noted that when he was growing up "each household cultivated both a small home garden for vegetables and a large maize field by the river. A household's status in the village was influenced by the size and productivity of their field. Now, in the absence of fields, home gardens are used to cultivate all crops and our fields have been covered in *Vachellia karroo*". The shift from fields to home gardens was also noted in trendline exercises (Table 3.5). Participants related the shift in cultivation practices to numerous drivers such as: a) the outbreak of tick-borne disease which reduced cattle numbers and therefore the ability to plough, b) the introduction of social grants which sparked a spirit of "laziness" amongst villagers, particularly the youth, and c) the lack of funds required to install fences to prevent livestock from foraging in fields. In the past, field integrity was secured by shepherds who prevented livestock from foraging on crops. Since democracy, education has been prioritised and school-going children no longer occupy the role of shepherd. As a result, livestock free range over fields and home gardens. This has necessitated the installation of fencing around fields, which not many can afford.

Residents currently involved in field cultivation consisted of individuals with access to non-farm capital required for arable inputs (e.g. tractor, fencing, seedlings, etc.). For example, in Gogogo an ex-school principal and the chief of Qandu cultivated fields, both of whom have access to non-farm capital. In Ludaka, however, field cultivation was associated with membership of a co-operative, which required an initial payment of R1 800 to cultivate your plot, and provided subsidised seed and fertiliser to members. Those that did not cultivate fields in Ludaka asserted that they did not have access to enough funds to be involved in this co-operative. Amongst cultivators, traditional methods of ox-drawn ploughing were still used, and those who did not own oxen would hire from other village residents or pay them to assist. Payment usually involved a slaughtered pig and traditional beer, and echoed smaller versions of traditional work parties.

Field cultivation patterns differed across villages. Njela and Gogogo have adopted intercropping methods, with crops primarily for sale to village residents, while in Ludaka crop cultivation echoes past cultivation, with households involved in monocropping maize, primarily for household consumption and any excess sold to villagers. The average annual economic contribution of crops from fields amounted to R23 296 (n=1) in Njela, R29 001±8 659 in Gogogo and R5 429±4 634 in Ludaka.

With only a small proportion of households cultivating fields in each village, a notable feature of fields in Njela and Gogogo was that the majority of fields lay fallow in any given year. Although still owned by residents, these allotments were overgrown by weeds and grass, were used for grazing cattle and have been rapidly invaded by *Vachellia karroo* and so have become sites for gathering fuelwood. This is different in Ludaka where fields that were not cultivated were left fallow with no visible invasion.

Table 3.5: Trendline depicting change in number of fields in each village over time

| Year | Village | No. of stones | Description |
|---|---|---|---|
| 1955 | N | 12 | Every household was dependent on fields to eat. Some families even cultivated three or four fields |
| | G | 8 | Households depended heavily on maize from the fields. Each household owned many cattle to plough fields. Some households had home gardens, but they were smaller than they are now. This small garden was called *icicungu*. Only sugar beans, potato and pumpkins were planted in this garden. Most time and energy was spent on the fields. Females were responsible for the home garden and males responsible for the field, but during harvest season females assisted the males |
| | L | 9 | Each household cultivated fields and was dependent on them for food |
| 1965 | N | 10 | Elderly people who cultivated the fields began to die and younger men found work in the mines |
| | G | 7 | Men began moving to the city to work in the mines, women got piece jobs. Children assisted the females with inputs in the home garden |
| | L | 9 | Households were reaping great maize harvests from their fields. They were not spending money to buy food but depending on the soil to feed the family |
| 1975 | N | 9 | Fields began to lose importance as people moved to the city. Households became interested in home gardens to diversify their crops as fields were only used to cultivate maize, beans and sweet potatoes |
| | G | 7 | Fields began to lose importance as more people moved to the city |
| | L | 9 | Same situation as above. Fields contained maize, beans and pumpkins. People started planting home gardens to increase diversity in crops |
| 1985 | N | 3 | Fields began to lose importance as people moved to the city. Branches which surrounded home gardens were replaced with fencing to prevent livestock from foraging on crops. This allowed more households to cultivate home gardens |
| | G | 6 | Fewer people cultivated fields due to rural urban migration. Children began to know their rights and were more interested in attending school than assisting in the cultivation of fields |
| | L | 4 | TRANCO arrived and took over fields. Payment was required to cultivate fields. Few people could afford to pay this and there was a drop in the number of people who cultivated fields. People relied more on home gardens. Fewer people cultivated fields |
| 1995 | N | 3 | Cattle began to die of tick-borne disease. Old fields became invaded by *Lantana camara* and *Vachellia karroo*. Home gardens began to rise in importance and the majority of households prioritised home gardens over fields |
| | G | 6 | Introduction of government grants provided an extra source of income which meant people were not as dependent on the land as before. Almost all fields stopped |
| | L | 3 | TRANCO left and few people planted fields. Home gardens increased in size and intensified cultivation in home gardens |
| 2005 | N | 2 | Only a few people cultivated fields, as most people in the village became too lazy to cultivate fields |
| | G | 4 | Households owned few cattle due to tick-borne disease. This meant they could no longer plough the fields. People began focusing on home gardens more. They used to share the manual labour between fields and home gardens, now all labour is concentrated into home gardens. They also pool labour, and neighbours help each other in the home garden |
| | L | 3 | Same situation as above. Tick-borne disease pervasive, fewer households own cattle needed for ploughing |
| 2015 | N | 1 | Cattle too weak to work the fields, there are no tractors or fencing. People rely mainly on social grants and home gardens |
| | G | 2 | Today livestock free roam in the old fields. There are no fences and no tractors so the majority do not cultivate their fields. There are a handful of people who cultivate their fields but they have access to external funds and can afford to hire a tractor and erect fencing. *Vachellia karroo* has taken over the old fields, which makes it difficult to cultivate them. Households prioritise home gardens which contribute food to the household |
| | L | 3 | Same situation as above. Tick-borne disease pervasive, fewer households own cattle needed for ploughing |

### 3.2.2 Ecosystem disservices

Agricultural systems were subject to an array of crop pests, considered to be organisms that consume crops during any stage of the agricultural cycle, from planting to harvest (Vang Rasmussen et al., 2017), impacting agricultural production by reducing yields and necessitating additional production inputs. Despite the active implementation of various crop protection strategies, ranging from traditional, built-in crop modification strategies to chemical control, crop losses were substantial. The following section outlines the range of crop pests in home gardens and fields, their change over time, estimates the economic value of crop losses and details various methods of pest control.

#### 3.2.2.1 Prevalence, severity and degree of crop damage

Ecosystem disservices identified during focus group discussions emanated from a broad spectrum of taxa including invertebrate pests (slugs, snails, arthropods, mites, nematodes), birds and small mammals (monkeys, moles). Weeds were also widely cited. Other constraining factors to arable agriculture, but which do not fall within the scope of an EDS, included: water scarcity, lack of equipment and labour. In this study, crop pests were identified by respondents to occur at various stages pre-harvest, and therefore the analysis is restricted to taxa that occur pre-harvest and no attention is devoted to pests that occur post-harvest or in storage. Between two and three agricultural pests were identified in households involved in smallholder production. Although similar pests were identified in all three villages (Table 3.6), the perceived degree of crop damage inflicted by the same pest differed both between neighbouring households in the same village and between villages (Table 3.7).

Table 3.6: Percentage (%) of home garden owners identifying specific type of crop pests affecting their garden

| Crop pest | Njela | Gogogo | Ludaka | Mean±SD |
|---|---|---|---|---|
| Birds | 0 | 53 | 69 | 41±36 |
| Bush pigs | 3 | 0 | 0 | 1±2 |
| Invertebrate pests | 77 | 100 | 94 | 90±12 |
| Monkeys | 87 | 0 | 0 | 29±50 |
| Weeds | 100 | 100 | 83 | 94±10 |

Table 3.7: Average percentage (%) of home garden yield destroyed by specific crop pests in each village

| Crop pest | Njela | Gogogo | Ludaka |
|---|---|---|---|
| Birds | 0 | 33±23 | 54±37 |
| Invertebrate Pests | 19±11 | 23±12 | 38±22 |
| Monkeys | 43±26 | 0 | 0 |

Invertebrate pests and weeds were considered the most common crop pests across all villages, emphasised in both ranking exercises and household surveys (Tables 3.6 and 3.8). On average, 90% of home garden owners identified some degree of damage by invertebrate pests in their home gardens, and 94% highlighted weeds as an issue (Table 3.6) but because households provided adequate weed control, weeds were not perceived to cause crop losses to the same degree as animal pests. Overall, invertebrate pests were considered easier to cope with than other crop pests and were associated with lower levels of crop damage. The average proportion of crop damage in home gardens linked to invertebrate pests were similar in Njela and Gogogo at 19±11% and 23±12%, respectively, and higher in Ludaka at 38±22% (Table 3.7). Of all invertebrate pests, ants were associated with the highest levels of damage, as they were responsible for damage during the seedling stage, surrounding the stem of the seedling and stunting its growth, and in some cases consuming the entire seedling (Table 3.8).

Although weeds were not associated with high levels of crop damage in each village, there were varied perceptions on the ability to manage them, with residents in Njela believing they were easier to cope with than residents in Gogogo and Ludaka (Table 3.8). Participants related this to the frequency with which control measures had to be carried out to ensure the successful growth of crops. Participants divided weeds into two categories: a) controllable weeds, usually wild herbs, which are easy to remove (Table 3.9) and b) uncontrollable weeds, usually alien invasive plants such as *Lantana camara*, *Plectranthus comosus*, and *Solanum chrysostichum*, which were perceived as harder to remove and to rapidly take over valuable space in the home garden.

Table 3.8: Ranked lists in descending order according to frequency, ability to cope, and severity of crop pests in each village

| Rank | Njela | Gogogo | Ludaka |
|---|---|---|---|
| **Frequency (most to least)** | | | |
| 1 | Weeds and cutworms | Ants | Cutworms and weeds |
| 2 | Snails | Weeds | Ants |
| 3 | Locusts | Moles | Moles |
| 4 | Monkeys | Cutworms | Millipedes |
| 5 | Moles | Snails and birds | Birds |
| **Severity (most to least)** | | | |
| 1 | Monkeys | Ants | Ants and birds |
| 2 | Moles | Moles | Moles |
| 3 | Weeds | Cutworms | Millipedes |
| 4 | Invert. pests[1] | Birds | Caterpillars |
| 5 | | Snails | Worm and weeds |
| 6 | | Locusts | |
| 7 | | Weeds | |
| **Ability to cope (hardest to easiest)** | | | |
| 1 | Monkeys | Weeds, ants and birds | Ants and weeds |
| 2 | Moles | Snails | Birds |
| 3 | Weeds | Worms | Millipedes |
| 4 | Invert. pests | Moles | Caterpillars |
| 5 | | Locusts | Earthworms |
| 6 | | | Butterflies |

*[1] Invertebrate pests

Table 3.9: Controllable weeds in each village

| Xhosa name | Scientific name | Njela | Gogogo | Ludaka |
|---|---|---|---|---|
| Idololenkonyane | *Persicaria sp.* | ✓ | | |
| Itshungu | *Xanthium spinosum* | | | ✓ |
| Ivivawe/Isinama | *Laportea peduncularis* | ✓ | | ✓ |
| Mpungempu | *Nicandra physalodes* | ✓ | | |
| Mpungempu | *Xanthium strumarium* | | | ✓ |
| Naki | *Chromolaena odarata* | | | ✓ |
| Ntsenguntsengu | *Tagetes minuta* | ✓ | | ✓ |
| Nwelezomntwene | *Conyza alluida* | ✓ | | |
| Siseyani | *Amaranthus sp.* | ✓ | | |
| Udwabane | *Commelina sp.* | | ✓ | |
| Uvivivane | *Sida rhombifolia* | | ✓ | |

Monkeys were only reported as an EDS in Njela, because the majority of home gardens bordered onto or were cleared out in indigenous coastal forest and provided easy access for monkeys to raid home gardens. Monkeys were less frequent than other crop pests but were considered difficult to manage and were associated with the highest levels of crop damage (Table 3.8). Eighty-seven percent of cultivators identified some degree of damage by monkeys in their home garden with the perceived proportion of crop damage ranging between 13% and 100% (i.e. the entire home garden) with a mean of 46% (Table 3.6 and 3.8). Participants noted that the frequency of crop damage was dependent on proximity of the homestead to the forest edge, i.e. homesteads closer to the forest experienced more frequent monkey visitation and higher levels of damage. One participant, whose garden boarded onto the forest, noted that "last season damage caused by monkeys was terrible. I usually harvest about 100 litres of maize but this season I only harvested 30 litres". Damage incurred by monkeys was also perceived to have increased over the last decade or two. During timeline focus groups, the elderly identified that in the past monkeys would raid home gardens and fields, but with an increasing trend towards field abandonment the number of monkey raids in home gardens has intensified.

Birds were considered problematic by 53% and 63% of home garden owners in Gogogo and Ludaka, respectively (Table 3.6). While birds were considered less frequent than other crop pests, when they occurred they were associated with severe damage in home gardens and were difficult to prevent (Table 3.8). Focus group participants identified different species of problematic birds such as the Cape Crow and various species of weavers. Household surveys indicate that the proportion of home garden produce damaged by birds ranged from 13% to 100% (i.e. the entire home garden) with an average of 33±23% and 54±37% of the home garden raided in Gogogo and Ludaka, respectively (Table 3.7). Residents in each village identified maize as the primary targeted crop which was damaged in two stages – seedling and mature cob bearing. Twenty-six percent of home garden owners in Ludaka reported replanting their entire maize crop more than once in a season due to crop loss by birds. One participant noted that his household "had to replant maize five times this season because the seedlings were eaten by birds each time". The number of birds, and associated damage to home gardens, was perceived to have increased over time (Table 3.10) and was locally explained as connected to fewer households involved in field cultivation and therefore an intensification of damage by birds in home gardens. This was further substantiated in focus groups with participants highlighting Ludaka as one of the few remaining villages in the area which continues to cultivate maize fields. This meant that the volume of birds is no longer divided between neighbouring villages and Ludaka, but instead is concentrated amongst the Ludaka home gardens and fields.

Table 3.10: Change in number of birds in Gogogo and Ludaka

| Year | Village | No. of stones | Description |
|---|---|---|---|
| 1965 | G | 4 | Birds were distributed between all fields |
| | L | 4 | The number of birds was low and fields were not destroyed. Veld fires were strictly managed and birds could eat in the long grasses |
| 1975 | G | 4 | Same as above |
| | L | 5 | Same as above |
| 1985 | G | 6 | The number of households cultivating fields decreased, and intensity of birds in home gardens increased |
| | L | 6 | The number of birds began to increase |
| 1995 | G | 6 | Same as above |
| | L | 7 | People in surrounding villages began to stop planting fields but Ludaka continued. Birds began to flock to Ludaka |
| 2005 | G | 10 | Same as above |
| | L | 10 | There were so many Cape Crows that they made shade on the ground when they flew together |
| 2015 | G | 10 | Same as above |
| | L | 8 | We developed tactics to chase birds away |

3.2.2.2 Seasonal changes

Most crop pests were seasonal, with periods of abundance (Table 3.11; indicated by thicker lines) and greater damage corresponding with the growing season (Tables 3.11a-c). Seasonal differences were primarily classified to fall within seasons such as summer, which was believed to occur between November and April, and winter, which fell between May and October in each village. Participants also related specific crop pests to particular crops. For example – although caterpillars were responsible for small-scale damage of most crops throughout the course of the year, the highest level of damage occurred to beans, seen in Ludaka to occur between September and December, the bean growing season (Table 3.11c). In all three villages, cutworms were most abundant during summer or periods of high rainfall as participants believed that cutworms thrive during wet periods (Tables 3.11a-c). Similar trends were seen with ants, which in Njela and Gogogo were believed to be most abundant during the wet season – November to February. Other invertebrate pests such as butterflies, millipedes and locusts were also most abundant during summer months in each village (Tables 3.11a-c). The incidence of weeds was perceived to be unaffected by the seasons. However, thicker lines in Gogogo and Ludaka, indicated the weeds were more abundant throughout the year in Gogogo and Ludaka than in Njela. Lower levels of damage by monkeys corresponded with periods of natural forage resources in the forest, while periods of extreme damage were seen to occur primarily within maize cultivation months.

Table 3.11a: Seasonal calendar of selected crop pests in Njela

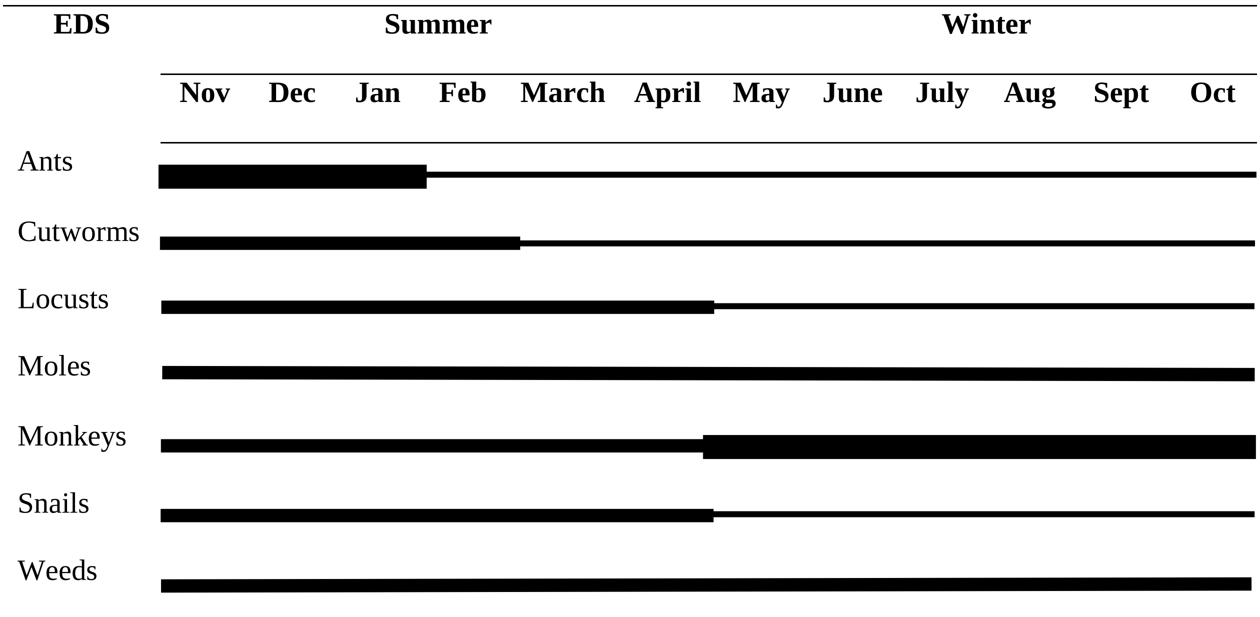


Table 3.11b: Seasonal calendar of selected crop pests in Gogogo

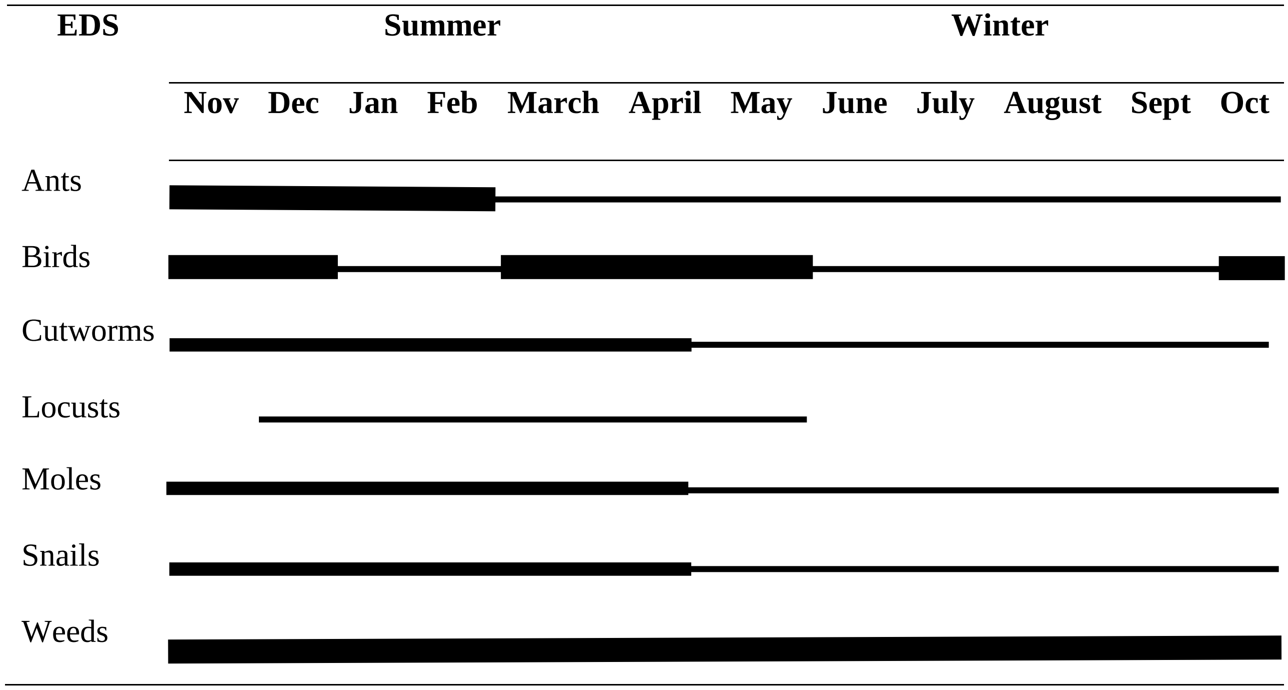
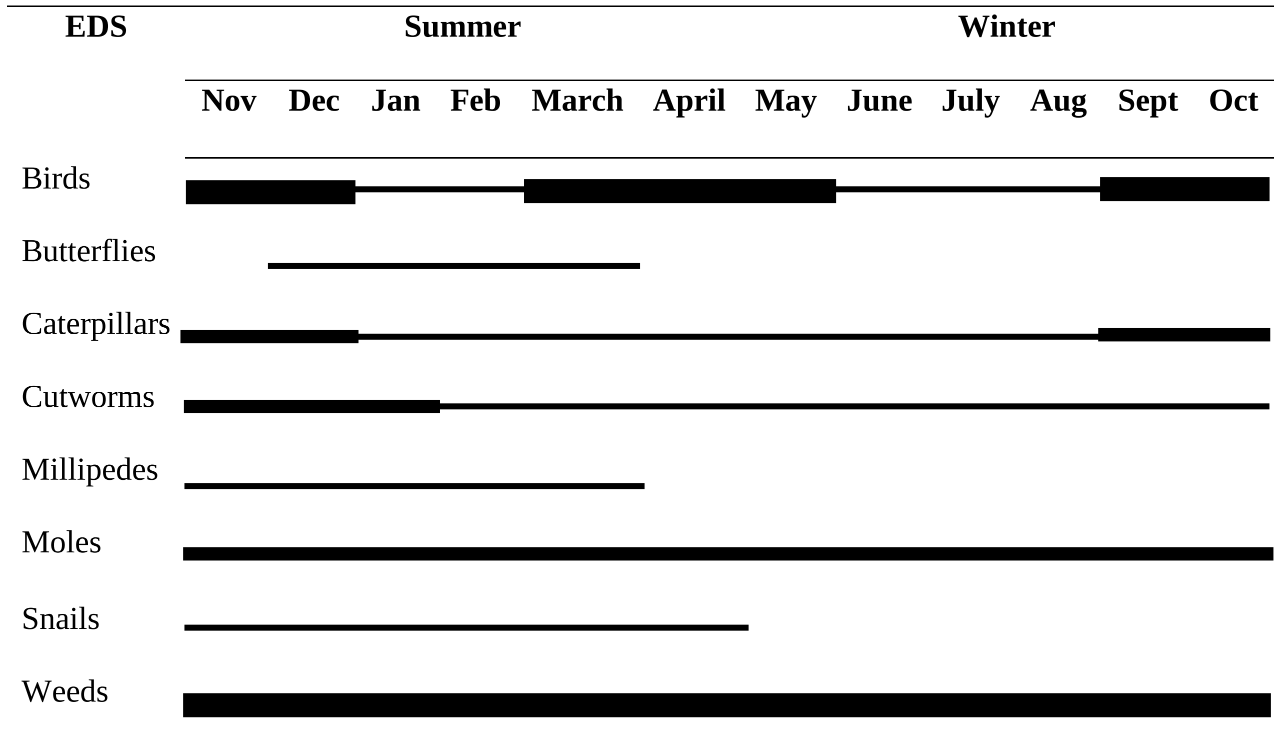



Table 3.11c: Seasonal calendar of selected crop pests in Ludaka



#### 3.2.2.3 Pre-emptive and reactive strategies

Households were pro-active in their approach to reduce loss or damage of crops in cultivated plots with overlapping methods of crop protection generally implemented by the female figure responsible for cultivation. The following section outlines the preventative or curative strategies according to type of crop pest, with little differentiation between villages as a result of similar management techniques.

- Invertebrate pests

Pre-emptive strategies to minimise loss by invertebrate pests included: a) planting more seedlings to ensure that the desired yield was harvested despite anticipated loss to invertebrate pests, b) adopting the opposite logic by reducing the number of planted seedlings to avoid wasting time and money on seedlings that participants anticipated would be damaged, c) no longer planting certain types of crops that were susceptible to particular invertebrate pests, such as cabbages which were frequently damaged by cutworms, d) crop-rotation, and e) surround the home garden with *Tulbaghia violacea* (locally known as long-leafed onion or Xhosa onion), the strong scent of which was perceived to act as a natural deterrent to invertebrate pests.

Common reactive strategies to invertebrate pests included: a) hand-picking of pests off individual crops, b) the application of insecticides such as 'DDT' or 'Blue Death', and c) in cases of lack of disposable income to purchase insecticide, the use of fire ash. More than half of the respondents in each village purchased pesticide at least once a year, with an average spending per annum of R110±102 in Njela and R202±427 and R221±298, in Gogogo and Ludaka, respectively. The greatest expenditure on chemical pest controls was R1 800 by a household in Gogogo who was involved in the cultivation of two home gardens, primarily for sale, and therefore went to great lengths to ensure minimal loss or damage. Households which did not purchase insecticide related it to insufficient funds.

- Birds

Pre-emptive strategies to reduce crop losses or damage by birds included: a) erecting scarecrows in the home gardens, b) attaching plastic bags on sticks which, in the wind, generated noise to deter birds, c) using sling shots and d) a member of the household present in the home gardens, particularly during seedling and mature stages of growth, to actively chase birds away. At least one of these strategies was adopted in home gardens where birds were present. Similar approaches were implemented by those who cultivated fields, especially during the mornings and evenings which were believed to be times when birds were most active. Cultivators, who anticipated loss or damage of maize to birds, engaged in additional pre-emptive strategies such as saving a proportion of seed from the previous season's harvest to plant after loss or damage by birds. Other long-term, pre-emptive strategies by field owners involved uniform timing of maize cultivation. Given that most damage by birds occurred during the seedling stage, field and home garden owners minimised losses by planting maize seedlings simultaneously. This meant that the total number of birds would be dispersed between all fields, rather than concentrated into individual fields during initial stages of growth. No coping mechanisms were identified for crop loss by birds.

- Monkeys

Monkeys were actively deterred by smallholder cultivators in Njela. Pre-emptive strategies included: a) a member of the household being visible in the homestead throughout the day to deter monkeys, b) tethering dogs to poles within the home garden, c) use of scarecrows and d) collection of ripe vegetables at once to prevent theft by monkeys. Other more inventive deterrents included a participant, from a household where crops were considered the primary source of income, who installed soccer goals for village children close to his home garden to provide a continuous presence which might deter monkeys. The severity of crop loss was illustrated by one participant involved in field production and noted "monkeys can destroy your fields so quickly that if there is ever a time when I can't be in the field, I pay someone R35 to keep watch". In the past, when maize production predominantly occurred in fields, small shade structures were constructed in the field where a child was stationed to actively chase away monkeys. Consequently, many children did not attend school during this time. Although the majority of residents were unable to rebound from monkey-related crop damage and often could not afford to replant crops and subsequently went without, a few turned to the sale of fuelwood as a means to repurchase seedlings. Despite the active implementation of strategies to reduce loss and damage by monkeys, households noted that their efforts were predominantly unsuccessful and harsher deterrence methods were limited by strict state laws which prohibited monkey hunting.

- Other small mammals

Only one household in Njela, which bordered directly onto coastal forest, identified bush pigs as a current issue. However, in the past when most households were involved in field cultivation, bush pigs were considered a significant crop pest. This was highlighted during the timeline focus group discussions and trendline exercises (Table 3.12). Pre-emptive mechanisms between 1965-1985 involved the use of traps and the construction of fires in the fields at night. Between 1985 and the present day, men hunted bush pigs which dramatically reduced bush pig numbers and as a result, they are no longer considered a problem.

Moles were identified as crop pests in all three villages with root vegetables, such as sweet potatoes, potatoes and carrots most at risk. Other than direct damage to the root, underground mole channels were prone to flooding during wet periods and promoted root vegetable rot. Common pre-emptive strategies were the distribution of red-bait shells in mole holes which generated a deterrent scent, and the use of empty two-litre plastic bottles, which, when cut in half and placed nozzle first in the mole hole, generated a deterrent whistle underground.

- Weeds

Every household identifying weeds as an issue in home garden production, was involved in some degree of weed control. Weeds were managed mechanically through hoeing or hand picking, then collected and dried on the side of the home garden. Participants described weed clearing to consist of an A,B,C system. The home garden was divided into three sections – A, B, C. Section A and B would be cleared, cultivated and maintained for a week, while wild herbs were harvested from section C. The following week section B and C would be maintained and wild herbs would be harvested from Section A. This strategy ensured that crops were not strangled by weeds but also allowed growth of wild herbs for harvest. A significant proportion of each day was spent weeding the home garden with household surveys highlighting that, on average, a household in Njela spent 2.7±1.5 hours a day removing weeds in the home garden. Similar time periods were spent removing weeds in Gogogo and Ludaka, 3.0±1.7 hours and 3.3±2.1 hours, respectively, and usually occurred during the early hours of the morning.

Table 3.12: Trendline indicating the change in number of bush pigs in Njela over time

| Year | No. of stones | Description |
|---|---|---|
| 1955 | 11 | Bush pigs were not hunted for the pot, so there were high numbers. People could not go into the forest alone. One participant noted how one person went into the forest alone and he never came back, they found only his head |
| 1965 | 6 | People began hunting bush pig with guns purely to reduce the level of damage in the home gardens |
| 1975 | 5 | Same situation |
| 1985 | 8 | New ways to hunt bush pigs developed as bush pig numbers increased. Field owners created traps through digging a hole in the ground, filling it with sweet beer and placing a temporary roof made of grass and sticks on top of the hole. Burning large fires in fields did not function well. During this period villagers learned from other villages that you could eat bush pig meat and people in Njela began hunting them for the pot |
| 1995 | 5 | The number started to decrease as people began hunting bush pig mainly for the pot |
| 2005 | 4 | Same as above |
| 2015 | 1 | Same as above |

### 3.2.3 Financial cost of home garden EDS to the household

To understand the magnitude of the effect home garden EDS have on the household, the average percentage loss by crop pests on home gardens was translated into monetary value. The total potential economic value, representing 100% of home garden value if not for EDS, was calculated as the sum of the direct use value of the home garden (yield in Rands) and the economic value of crop loss (calculated from the average percentage loss). For example, in Njela, a yield of R7 964 was reported, which represented the net yield after losses by EDS, accounting for 38% of the total potential yield (R20 958). Respectively, monkeys and invertebrate pests damaged 43% (R9 012) and 19% (R3 982) of the home garden (Figure 3.3).

In Gogogo, birds and invertebrate pests only were reported to cause loss or damage in the home garden and accounted for an average of 33% (R6 984) and 23% (R4 868) loss, respectively (Figure 3.3). The average yield of the home garden represented 44% (R9 313). This means that if no EDS had occurred the potential economic value of a home garden in Gogogo could be R21 165.

In Ludaka, the average percentage loss by EDS was 54% by birds and 38% by invertebrate pests. This represents R29 585 and R20 819, respectively (Figure 3.3). The average value of a home garden in Ludaka was R4 383, which represents the net yield after losses by EDS. This value only represents 8% of the garden, therefore when extrapolated, the potential economic value of a home garden is R54 787 if not for birds and invertebrate pests. Although this figure seems large, it is worth noting that the percentage crop loss by birds was greatly skewed by numerous residents who lost all maize seedlings to birds.

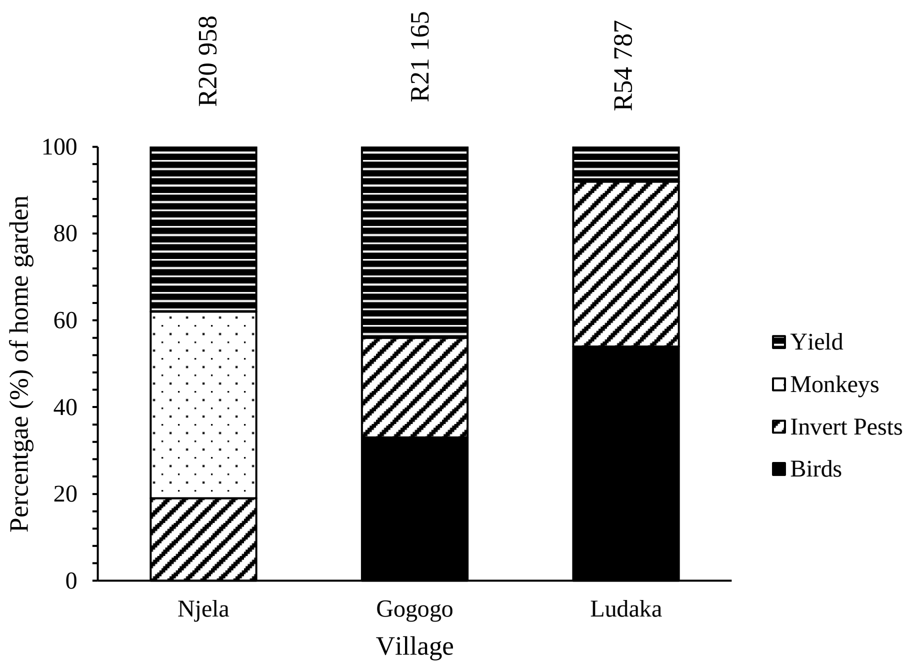



Figure 3.3: Percentage (%) allocation of home garden by crop pests in each village

3.2.4 The number of ES and EDS along a habitat biodiversity gradient

The number of ES far exceeded the number of home garden EDS in each village (Figure 3.4). This is not unusual as home gardens represent a highly managed ecosystem and therefore the number of ES would be less related to biological attributes such as soil fertility, and more related to the manifestation of culture or water availability, etc. There was a similar range of crops or ES in each village, with the number of EDS decreasing between Njela, the village with the greatest habitat biodiversity, and Gogogo and Ludaka, with less habitat biodiversity. This meant that the number of EDS per ES decreased from 0.2 EDS per ES in Njela to 0.1 in the last two villages, supporting Dunn (2010) who posited that the number of EDS may increase with the greater biodiversity.

Analysis of the economic value of ES and EDS in each village provide further insight into the magnitude of the effects home garden EDS have on crop production. For instance, despite there being the highest number of EDS in Njela, the effect of EDS in Ludaka was of a higher magnitude, resulting in greater economic losses. Figure 3.5 also highlights that despite there being fewer EDS than ES in each village, the impacts that EDS measured in Rand values were of a greater magnitude than the value of the ES.

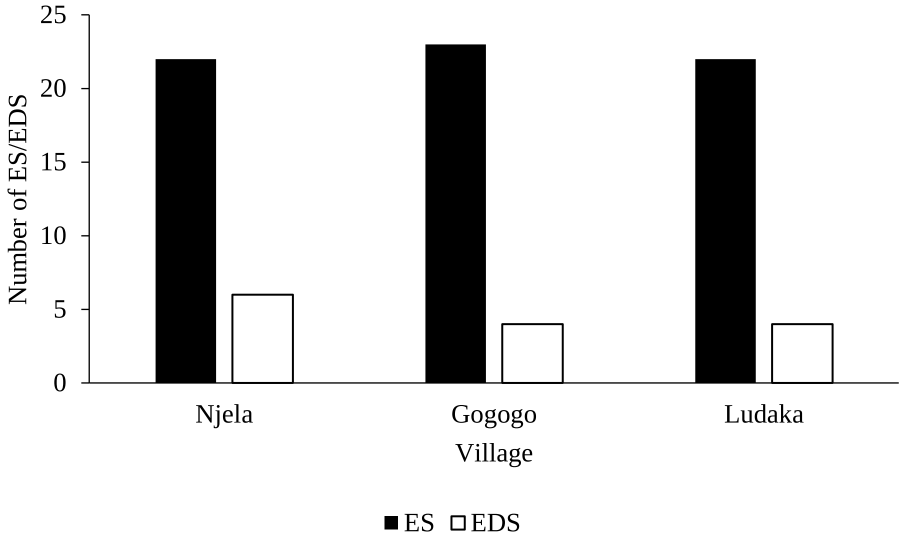



Figure 3.4: The total number of home garden-related ES and EDS

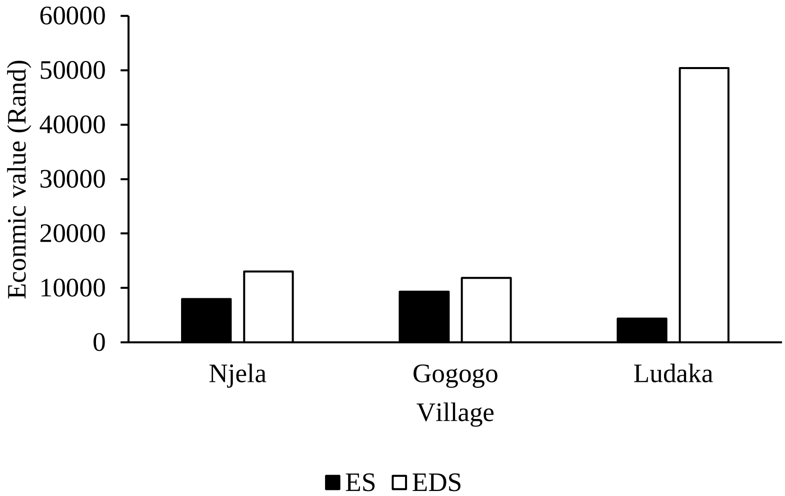



Figure 3.5: The economic value (Rand) of home garden-related ES and EDS amongst user households across villages

## 3.3 Discussion

A considerable array of crops were actively cultivated across the study sites, in home gardens and to a limited degree in fields, and represented an important source of food to the majority of households. Almost all sampled households were involved in the cultivation and harvest of at least one crop in home gardens during the 2016 season, with fewer involved in arable field cultivation (<10% of sampled households in Njela and Gogogo and <20% in Ludaka). Home gardens, were typically diverse in nature with maize, pumpkin, spinach, common beans and cabbage as the major crops. In addition, wild herbs, regarded as weedy species in the agricultural sense, formed a vital component of the local diet and were harvested in home gardens by more than two-thirds of households. The prevalence of wild herb harvest in rural livelihoods is widely noted (Cruz Garcia and Price, 2012, Dovie et al., 2007, High and Shackleton, 2000), with the pervasive use of a common genera of wild herbs, such as *Amaranthus, Bidens, Galinsoga* and *Sonchus*, reflected in other studies in communal areas across South Africa (Shackleton, 2003). The majority of these home garden crops were retained for household consumption, a phenomenon consistent with other studies (Baiphethi and Jacobs, 2009, Dovie et al., 2003, High and Shackleton, 2000). In contrast, the few households involved in field cultivation in Njela and Gogogo, cultivated fewer crop types, primarily for sale. A similar picture of crop cultivation has been mirrored in other parts of the Eastern Cape and South Africa, with analogous cultivation patterns (a move away from field cultivation toward home garden cultivation) and range of dominant crops (Adekunle, 2013, Andrew and Fox, 2004, Dovie et al., 2003, Dovie et al., 2005, Fay, 2013, Fay, 2015, Hebinck et al., 2018, Shackleton and Hebinck, 2018).

The trend of field abandonment in the former homelands and the process of livelihood and agrarian change, is widely recognised (Andrew and Fox, 2004, Connor and Mtwana, 2017, de la Hay and Beinart, 2017, Hebinck and Monde, 2007, Hebinck and van Averbeke, 2007, Shackleton et al., 2013, Shackleton and Luckert, 2015). These processes have been shaped by multiple interacting factors across different temporal and spatial scales, identified by villagers in this study as changing values, especially amongst the youth, practical issues such as loss of herding labour due to the growing importance of schooling, fewer cattle available for ploughing due to episodic disease outbreaks, and crop raiding. Similar driving factors have been echoed in other parts of the region (Andrew and Fox, 2004, de Klerk, 2007, D'Haese and Van Huylenbroeck, 2005, Fay, 2013, Hebinck and Monde, 2007, Hebinck and van Averbeke, 2007), alongside other notable factors not identified in this study, such as past colonial and apartheid settlement patterns, associated agricultural policies and changing migration patterns and influxes of people. Despite this, some cultivation remained central to the livelihoods and culture of village residents, albeit in a different form, which was also noted by Masterson (2016) in a different part of the Wild Coast. Andrew and Fox (2004) assert that cultivation has not been abandoned in the Transkei – but rather emphasise a shift in cultivation practices from fields to home gardens. Their study noted, through the analysis of aerial photographs and crop yields, the expansion in the number and size of home gardens. This is also supported by Fay (2015). In this way rural households were able to maintain or even improve their yields in home gardens (McMillan, 1989), which were found to be more productive, less risky and more viable given the current increasing risks and limited resources.

However, despite these trends, cultivation patterns differed in Ludaka, emulating those of the past with both the cultivation of diverse species in home gardens and monocropping of maize for household consumption in distant fields. This is supported by Shackleton and Hebinck (2018) who assert that the deagrarianisation literature tends to treat the process of field abandonment as a permanent shift away from field cultivation. However, after some years, as evident in Ludaka, some rural dwellers may attempt to re-activate and rejuvenate fields. For this reason, they assert a more nuanced approach to cropping activities in the Transkei, with the terms such as "de-activation/re-activation" to highlight the dynamic dimension to cultivation practices. It is worth noting however, that the re-activation of fields in Ludaka was supported through institutional structures, such as a co-operative. In this sense, not all households were equally positioned to participate in field cultivation, with households in Njela and Gogogo operating in resource and institution-poor environments, while those currently involved in field cultivation had access to the initial capital required for the purchase of inputs.

Crop cultivation, in home gardens and fields, formed a measurable component of rural food supply and was an important ingredient in securing the wellbeing of residents. This was emphasised in Gogogo and Ludaka by the significant correlation found between the economic value of the home garden, an indicator of the wide diversity or high volume of crops, and the local measures of human wellbeing. Rogan (2018), using the Statistics South Africa 2008/9 Living Conditions Survey and its annual General Household Surveys, showed that in the absence of wage income, hunger levels were lower amongst farming households.

The gross, direct-use and trade value of crops was highest in Gogogo (R9 313±7 693 per annum), owing to the greater mean diversity of crops per home garden at this site. This was illustrated by the regression analysis showing that a higher crop diversity had a greater direct-use and trade value of home gardens. Although intensive mixed cropping is a common feature in home gardens (Shackleton and Hebinck, 2018), other studies across South Africa have reported a much lower diversity of crops than the home gardens in this study. For example, Dovie et al. (2003) found the majority of households involved in the intercropping of two crops in the Bushbuckridge Lowveld, Limpopo, and the mean number of plants cultivated in Guquka and Koloni in the former Ciskei, Eastern Cape was four (Mtati, 2014). Although the economic value of home gardens in Njela and Ludaka was lower, they still represented considerable savings to the household on having to purchase commercial alternatives if home garden produce was not available. Maize and wild herbs were amongst those contributing the most to the value of crops across study sites, representing 28% in Njela, 22% in Gogogo and 37% in Ludaka of the gross home garden value. It is likely that had this study included the contribution of green maize harvested throughout the growing season, the value would be higher as found by Dovie (2001) in the Lowveld and Hebinck and Monde (2007) in the former Ciskei. The high contribution of wild herbs is not surprising, with their economic value widely acknowledged, such as by Shackleton (2003) who found their value to amount to R2 050 (inflation adjusted) in eight different sites across rural South Africa.

In general, the value of home gardens in this study was higher than home gardens in other parts of the country. For example, Mtati (2014) found a much lower net, direct-use and trade value at R729 and R650 (inflation adjusted) amongst cultivating households. In the Bushbuckridge region, High and Shackleton (2000) found that the direct-use and trade value of crops across all home gardens in the study was R4 387 (inflation adjusted). In the same Bushbuckridge region, Dovie et al. (2003) reported the annual, gross, direct-use and trade value per annum, across both home gardens and fields to be R12 947 (inflation adjusted) amongst growing households. These discrepancies in figures are probably related to the different criteria used by each study to calculate the total economic values.

The potential value of cultivation was undermined through a suit of EDS, widely reported across study sites. This has been echoed globally, primarily within human-wildlife conflict or integrated pest management literature, and been understood to threaten a household's food security (Barua et al., 2013).

Crop pests were ubiquitous, with between two or three pests per cultivated plot. The degree of crop loss was a function of the type and severity of the pest and the success of the implemented pest control. Further, in some cases the degree of crop loss was also dependent on the crop type, as some crops were favoured by more species over multiple stages of growth than others (Osborn and Hill, 2005). Although considered to occur less frequently than other EDS, birds and monkeys were perceived to pose the greatest threat to crops. Bird-related losses occurred in more than half of the home gardens in Gogogo and Ludaka, responsible for more than a third of home garden damage. The perceived degree of bird-inflicted crop losses, despite actual bird control, was slightly more than other studies such as de Mey et al. (2012) who calculated the econometric and farmer perceived bird-inflicted losses to range between 13-15% of production and by Sidibe et al. (2003), using a questionnaire survey, estimated the proportionate damage on rice crops in Mali at 22% of production. Vervet monkeys were notorious pests in Njela, considered to be very destructive, damaging just over a third of the produce of home gardens. Although primates as pests have been commonly reported, the percentage loss of the home garden in this study was higher than other reported figures such as raiding by tantalus monkeys in Gashaka, Nigeria (16% of the total area damaged) (Warren et al., 2007) and red-tailed monkeys around Kibale National Park, Uganda (15% of the total area damaged) (Naughton-Treves, 1997). Monkey-related crop damage within cultivated plots was not uniform, was affected by the proximity of the cultivated plot to the forest and the season, and was reflected in multiple studies which showed an increase in damage to home gardens closest to the forest boundary and during winter or periods of shortage of food within natural foraging spaces (Naughton-Treves, 1998, Saj et al., 2001, Warren et al., 2007).

At the other end of the spectrum, invertebrate pests were pervasive and noted by almost all cultivating households, but were associated with lower crop damage of approximately one-fifth of cultivated plots across all villages. Invertebrate pests were easier to mitigate, with pre-emptive mechanisms incorporated into cultivation practices. Although use of chemical control, through pesticide application, is expanding across study sites and indeed Southern Africa (de Bon et al., 2014), it was considered capital intensive, leading resource-poor cultivators to be more reliant on traditional pest-control methods.

Overall, a large variation between perceived percentage loss amongst larger crop pests and smaller crop pests existed in home gardens. Residents associated the severity of larger EDS in home gardens with increasing field abonnement, which saw the migration and intensification of larger crop pests from fields into home gardens. However, variation may reflect real differences between raiding species or could be due to variation in human perception. For example, larger animals and those responsible for more obvious damage tend to receive a larger emphasis in reports (Marchal and Hill, 2009, Naughton-Treves, 1998, Weladji and Tchamba, 2003). Still, when the overall percentage of home garden loss by all identified crop pests were compared to other studies, similarities existed. Grisley (1997) working in the Kenyan highlands estimated crop pest related losses in maize and beans to be at 57% and 42%, respectively, and

Warren et al. (2007) reported 42% loss of total expected yields in the dry season near Gashaka Gumti National Park, Nigeria.

Weeds, identified as plants not purposefully cultivated with anticipated negative effects on crop production, were considered as one of the primary constraints to cultivation in the region, yet a large proportion of these weeds were also harvested for food or medicinal purposes. This illustrates the potential dual character of the same ecosystem function suggested by Lele et al. (2013) and the possibility for it to be perceived as a ES or an EDS depending on the social-ecological context, or even perceived simultaneously as both by the same individual. Similar sentiments were echoed in Northern Laos by Vang Rasmussen et al. (2017) who identified various interconnected conversion factors where an ecosystem output can shift from an ES to an EDS and situations where both ES and EDS can co-exist.

Overall, traditional pest management was a finely tuned process, both biologically and socially, to counter the pressures of crop pests. It consisted of multiple control methods such as crop rotation, planting and harvesting timing, planting less vulnerable crops, and additional response actions to reduce pest attacks such as mechanical control, use of plants with repellent or insecticide properties, wood ash application, decoys (e.g. scarecrows or plastic bags) or scaring techniques. These methods have been widely noted within the literature (Abate et al., 2000, Mc Guinness and Taylor, 2014), and a combination of these techniques is often necessary to reduce the extent of crop damage (Warren et al., 2007). Although no single method guaranteed success, traditional methods are considered to be the most efficient pest controllers as highly technical and non-traditional methods are unlikely to be carried out or be affordable into the long-term.

In addition, these controls were associated with indirect costs (Ango et al., 2014). For many smallholder cultivators, the risk of losing much of their harvest to pests acted as a disincentive to plant extra crops, and in some cases reported to stop cultivating specific crops. In this sense, EDS has negatively impacted the diversity of production across sites and may impinge on the nutritional contribution of crops, the effects of which have already been noted among communities surrounding Queen Elizabeth Nation Park, Uganda (Akankwasah et al., 2010). In addition to crop or nutritional losses, mitigation strategies involved additional incidental costs to the household. For example, in the past, crop guarding by children meant foregoing school and currently results in the inability of members of the household to conduct necessary household chores as crop guarding is a time-consuming activity. Similar findings have been reported by Hill (2000), Mc Guinness and Taylor (2014) and Fuentes (2017) across different parts of the continent.

Financial losses incurred by crop pests were severe, with the actual yield representing between 8% and 44% of the potential economic value of the home garden. In Njela, crop raiding by monkeys totalled approximately R9 000 worth of damage, similar to figures found by Saj et al. (2001) who reported damage to range between R3 432 - R9 150 (inflation adjusted). Total estimates of losses, were similar in Njela and Gogogo at between R11 000 and R12 000, and much higher in Ludaka at R50 404 which was greatly influenced by the high costs involved in replanting an entire maize crop damaged or lost to birds in home gardens. Yet, economic figures of EDS in this study are a lot higher than estimates of annual monetary losses to crop raiding provided by locals surrounding a protected area in Rwanda, totalling between R587 and R1 164 per annum (inflation adjusted), possibly due to some deterrents which reduced losses (Mc Guinness and Taylor, 2014), as well as lower unit prices.

Although the value of home gardens and associated losses by crop pests has been widely noted, research is typically conducted in disciplinary silos, with limited empirical evidence available on ecosystems that possess or generate beneficial and harmful services to the same people, or that a potential switch between ES and EDS exists (Villa et al., 2014). As a result, a conceptual framework for understanding both ES and EDS remains elusive. This research has incorporated both to provide a full picture of how the same group of people benefit, or suffer costs, from nature, and acknowledges that some ES may be seen as EDS in particular contexts. Failure to recognise ES and EDS in the same framework has potentially important consequences, "as with many aspects of decision making there will be trade-offs, both positive and negative, that always need to be considered and balanced and this requires a full account of ES and EDS" (Sandbrook and Burgess, 2015: 2).

## 3.4 Conclusion

The majority of households were involved in some form of cultivation, predominantly in home gardens, generating produce for household consumption, and to a limited degree, sale, representing significant savings to the household. Households involved in crop production with higher values were also found to derive higher wellbeing scores. Yet, pervasive EDS reduced crop yields across all sites, in some cases destroying 92% of the potential production value of home gardens. The degree of crop losses varied between households within a village and between villages, with crop losses dependent on the type and severity of the EDS, the interaction between crop pests which worked together to cause substantial crop losses, and the success of the implemented control measures. Crop losses represented multiple direct costs, such as a household forced to purchase alternative food, and indirect costs, such as evidence that crop raiding had caused households to stop growing certain crops or disincentivised people from investing time and money into larger cultivation initiatives.  This chapter also recognised dual character of ES/EDS with some weeds considered both ES, for household consumption, and EDS, constraining the growth of crops. Yet, a framework that considers the role and value of both ES and EDS, and potential shifting between ES and EDS, is notably absent in the literature. Therefore, to enhance understanding of the linkages between ecosystems and wellbeing and the management options required to control EDS, it is essential to acknowledge the role of EDS in agricultural ecosystems. This will support management plans to create a way for overall net benefit to occur.

# CHAPTER FOUR: LIVESTOCK HUSBANDRY

## 4.1 Introduction

Livestock are a common component of rural livelihoods across the globe, providing multiple goods and services (Dovie et al., 2006, Shackleton et al., 2005, Shackleton et al., 2000), which aid livelihood diversification and hence, resilience (Vetter, 2013). However, smallholder livestock owners often face multiple production constraints, some originating from local ecosystems and therefore EDS, which reduce the potential yield of consumptive livestock outputs, undermine herd growth and diminish the value of livestock for trade. Yet, within a livelihoods framing a full catalogue of livestock-related EDS and estimates of resulting economic losses, alongside the value of their service, has not been reported. This may lead to an inadequate understanding of the net value of goods and services provided by livestock in communal areas. Therefore, this study aims to counter this imbalance, presenting a composite picture of the role and value of livestock in rural livelihoods, using an ES framing, which include accounting for EDS.

Cattle and small stock provide diverse cash and non-cash benefits to rural dwellers (and some urban ones too), such as a protein-rich food (such as meat, milk, blood) and other consumptive outputs including, hides, manure, and draught power which enable crop production and income generation, and serve as a buffer during income fluctuations as well as other cultural and social functions. Several studies provide further insight into these functions such as Randela (2003), who quantified the economic value of cattle outputs in several areas across the former Venda homeland, and found that cattle-owning households harness outputs amounting to R2 718 (inflation adjusted) per annum. Milk was the highest contributor (46%), followed by sales (31%), draught (23%) and manure (1%). Further, Mburu et al. (2012), working in rural communities in West Africa, illustrated the role of livestock in increasing agricultural productivity, as households who possessed livestock were able to cultivate larger areas more efficiently, which gave rise to a higher crop value than households who did not own working livestock. In addition, livestock constitute crucial assets for safeguarding livelihoods during periods of food insecurity or unforeseen shocks. Livestock are purchased during higher income years, as a means to store capital, and in lower income years, or periods of misfortune, are sold to satisfy consumption requirements. Hanke and Barkmann (2017) detail the insurance function of livestock during periods of arable crop failure in rural livelihoods in Madagascar. During these periods, income generated through the sale of livestock accounted for more than 56% of the average cash food expenditures. Amongst asset-poor households, small stock and chickens were more important in cash generation than cattle. Similar sentiments are shared by Ncube et al. (2018), as a way of coping with food stress during drought in the Zvishavane district, Zimbabwe.

Although the range of goods and services generated by livestock are similar in communal areas throughout Southern Africa, the degree of importance and relative contribution of individual outputs may differ from place to place and across economic groups. This is related to various factors such as the agroecological condition, access to alternative sources of income or a combination of these (Campbell et al., 2002). For example, in semi-arid and arid areas, off-take for sales is often more important than goods for consumption, such as manure and draught, as agriculture is less viable (Ainslie et al., 2002). Furthermore, households which participate in non-farm employment are more likely to increase agricultural spending on crop and livestock inputs, which was illustrated by Dedehouanou et al. (2018) in rural Niger. However, as contexts or owner's priorities change, so might the ranking or degree of use of various livestock outputs.

In South Africa, smallholder livestock free-range on communal rangelands. In most cases, households are completely dependent on natural pasture to feed their livestock throughout the year. Yet, this is often considered a major constraint to livestock production as many rangelands are perceived to be in poor condition and often with low nutritional value (Beyene et al., 2014, Nqeno et al., 2011). Other commonly identified EDS include diseases, the most serious of which are spread by ticks and other ectoparasites (Brown et al., 2013). As the most widely reported livestock-related EDS, ticks are responsible for significant economic losses. For example, Adehan et al. (2018) reported a 20% reduction in meat production, 16% reduction in milk production, an 11% increase in mortality rate, and a 5% depreciation of skin value due to ticks. Loss of livestock to predators are also a widely reported EDS across the globe, particularly in the human-wildlife conflict literature, and largely reported in communal areas bordering wildlife reserves. For example, Butler (2001) reported that 241 livestock, representing 5% of the total livestock holding, were killed by wild carnivores in the Gokwe communal area bordering the Sengwa Wildlife Research Area. Baboons, lions and leopards were the most serious predators, contributing 52%, 34% and 12% of the kills, respectively. Therefore, EDS increase livestock mortalities or undermine livestock health, an essential pre-requisite for small-scale farmers to succeed (Adesehinwa et al., 2004), as well as raising the cost of production through necessitating the implementation of prevention measures.

A cohesive picture of livestock production in communal areas of the Eastern Cape cannot be established without recognition of the losses associated with livestock-related EDS. Therefore, this study aimed to empirically identify the role and value of livestock alongside losses induced by livestock-related EDS and identify increased production costs through the implementation of potential prevention or coping mechanisms.

## 4.2 Results

This section reports on the role and economic value of livestock goods and services across the three study sites. It also seeks to understand the factors that undermine herd and flock growth and the yield of associated goods and services. The term 'livestock' encompasses four-legged animals (cattle, goats, sheep, pigs) while 'poultry' refers to chickens. Although a few households in each village also owned donkeys, horses, geese and ducks, there were too few to include.

### 4.2.1 Ecosystem services

#### 4.2.1.1 Livestock and poultry ownership, numbers and importance

Common livestock kept in each village were cattle and goats, while pigs and sheep were only present in Gogogo and Ludaka. Residents in Njela related the absence of sheep to the unsuitable rangeland around the village and the few pigs to the outbreak of swine flu in 2012 which catalysed their widespread removal by the state. Although state removal of pigs was also mentioned in other villages, a small proportion of households had rebuilt their numbers (Table 4.1).

Approximately half of all households in each village owned at least one type of livestock, with a greater proportion of households in Ludaka (70%) in comparison to Gogogo (53%) and Njela (29%). A similar proportion of households in each village owned poultry (74-80%) (Table 4.1). Overall, the combined number of all livestock per household was relatively high. The mean number of animals per stock-owning household was similar in Gogogo (15±22) and Ludaka (19±15) but lower in Njela (6±6). A few owners with large numbers resulted in large standard deviations. The average number of chickens amongst poultry owning households was similar across villages (7±6 - 9±8). A higher proportion of households in Gogogo and Ludaka owned both livestock and poultry, while in Njela most households owned poultry only (Table 4.2).

Amongst stock-owning households in each village, small stock dominated. This was evident in household surveys and ranking exercises. In Njela and Gogogo, goats were the most common livestock owned by 90% and 62% of livestock owning households, respectively (Tables 4.1 and 3). In Ludaka sheep were kept by 79% of stock-owning households (Tables 4.1 and 4.3). Ranking exercises highlighted that goats and sheep were kept for similar purposes, i.e. their role in ritual slaughter and for income. In each village, cattle were the second most commonly owned livestock type (Tables 4.1 and 4.3). The proportion of stock-owning households with cattle varied between villages, being highest in Gogogo and Ludaka (52% and 68%, respectively) and lowest in Njela (14%) (Table 4.1). However, when considered amongst all households in each village, cattle ownership was more diluted ranging from 11% in Njela to 48% in Ludaka (Table 4.1). Despite higher proportions of stock-owning households possessing small stock, cattle ownership was preferred because of the greater diversity of goods and services obtainable from cattle such as trade, bride-wealth payment, draught power, transport, milk, manure and ritual slaughter.

Although household surveys illustrated the ubiquity of chicken ownership across villages (Table 4.1), ranking exercises in Gogogo and Ludaka highlighted that the number of chickens per household was low due to the high frequency of disease (Table 4.3). This forced homesteads to regularly rebuild stocks. Despite this, chickens were the most frequently used animals in most villages as they were easy to slaughter when guests visited or for household consumption with little financial loss to the household (Table 4.3). Overall, cattle, sheep, goats, and chickens occupied various combinations of the top three positions of the most frequently owned and used livestock and poultry in each village for reasons in line with those previously mentioned.

Table 4.1: Characteristics of livestock and poultry ownership in each village

| Category | Cattle | Poultry | Goats | Pigs | Sheep |
|---|---|---|---|---|---|
| **Njela** | | | | | |
| All HH (%) | 11 | 80 | 26 | - | - |
| LS owning HH (%)[1] | 40 | NA[2] | 90 | - | - |
| Mean no. per owning HH | 4±2 | 7±6 | 5±3 | - | - |
| Range | 2-7 | 2-30 | 2-12 | - | - |
| **Gogogo** | | | | | |
| All HH (%) | 28 | 74 | 33 | 10 | 8 |
| LS owning HH (%) | 52 | NA[2] | 62 | 19 | 14 |
| Mean no. per owning HH | 6±6 | 9±7 | 15±20 | 1±0 | 12±12 |
| Range | 2-12 | 1-30 | 1-70 | 1-1 | 5-26 |
| **Ludaka** | | | | | |
| All HH (%) | 48 | 75 | 8 | 25 | 55 |
| LS owning HH (%) | 68 | NA[2] | 11 | 36 | 79 |
| Mean no. per owning HH | 6±5 | 9±8 | 7±2 | 4±3 | 16±12 |
| Range | 1-15 | 1-30 | 5-8 | 1-8 | 5-58 |

[1] LS- livestock owning

[2] Poultry and livestock are considered in different categories and therefore do not fall within "livestock owning households"

Table 4.2: Percentage (%) of households within each livestock or poultry category

| Category | Njela | Gogogo | Ludaka | Mean±SD |
|---|---|---|---|---|
| Chickens only | 58 | 25 | 17 | 33±22 |
| Livestock only | 5 | 13 | 13 | 10±5 |
| Livestock and chickens | 23 | 40 | 57 | 40±17 |
| None | 14 | 22 | 13 | 16±5 |

Table 4.3: Livestock and poultry ranked in descending order in terms of frequency of use and amount owned

| Rank | Own the most of | | | Frequency of use | | |
|---|---|---|---|---|---|---|
| | **Njela** | **Gogogo** | **Ludaka** | **Njela** | **Gogogo** | **Ludaka** |
| 1 | Chickens | Goats | Sheep | Chickens | Goats | Chickens |
| 2 | Goats | Cattle | Cattle | Goats | Cattle | Cattle<br>Goats<br>Sheep |
| 3 | Cattle | Pigs | Chickens | Cattle | Sheep | Pigs |
| 4 | | Chickens | Goats | | Chickens | |
| 5 | | Sheep | Pigs | | Pigs | |

The herd size of livestock and poultry fluctuated from year to year, as indicated by the decrease in almost all livestock types and poultry between 2015 and 2016 (Table 4.4). Overall, the greatest decline in herd/flock numbers was amongst poultry (-48±66), further illustrating the effects of pervasive poultry diseases, and the greatest herd growth occurred amongst pigs, probably due to the slow re-introduction of pigs after state removal in 2012. Livestock and poultry herd/flock sizes are not static and fluctuate over time and it is important to appreciate that the average herd size figures reflected below present a snapshot of trends over a one-year period. Trendline exercises in Njela and Gogogo also depicted a general decline in livestock and poultry numbers over time (Table 4.5). This was attributed to a combination of factors such as the absence of shepherds, the outbreak of disease and non-functional dipping facilities (Table 4.5).

Table 4.4: Change in the average number of animals per household between 2015 and 2016[1]

| | **Cattle** | **Poultry** | **Goats** | **Pigs** | **Sheep** |
|---|---|---|---|---|---|
| **Njela** | | | | | |
| Av. no. 2015 | 6±1 | 16±11 | 7±7 | - | - |
| Av. no. 2016 | 4±2 | 7±6 | 6±3 | - | - |
| Av. change | -2±4 | -6±11 | -3±4 | - | - |
| % change[2] | -35±25 | -39±59 | -31±32[3] | - | - |
| **Gogogo** | | | | | |
| Av. no. 2015 | 6±6 | 8±6 | 20±23 | 0±0 | 20±21 |
| Av. no. 2016 | 6±6 | 6±6 | 15±20 | 1±0 | 12±12 |
| Av. change | 0.2±3 | -0.5±4 | -4±6 | 1±0 | -8±10 |
| % change[2] | +3±34 | -72±24 | -13±46 | +100±0 | -35±9 |
| **Ludaka** | | | | | |
| Av. no. 2015 | 8±5 | 20±11 | 11±1 | 3±4 | 23±20 |
| Av. no. 2016 | 6±4 | 9±8 | 7±2 | 4±3 | 16±12 |
| Av. change | -2±4 | -10±13 | -4±1 | 1±3 | -6±13 |
| % change[2] | -21±46 | -33±92 | -38±11 | 73±129 | -13±50 |
| **Av.% change** | **-16±42** | **-48±66** | **-12±60** | **+81±10** | **-16±47** |

[1] These calculations of averages only include households that had holdings in both 2016 and the previous year

[2] The average percentage change reflected in the table will not equate to additions of average number of livestock in each year because it is derived from the empirical data per household

[3] An outlier of 200% herd growth in a goat owning household in Njela was excluded from this figure

Table 4.5: Trendline of the change in number of livestock in Njela and Gogogo

| Year | Village | No. stones | Description |
|---|---|---|---|
| 1955 | N | 10 | Each homestead owned many cattle as they relied on cattle for many functions such as fresh meat, milk, ploughing, transport and sale. The climate conditions supported large herds of livestock - there was enough rain for livestock to drink and good quality grass for livestock to eat. Ticks were uncommon. There was no western medicine, disease was treated only with medicinal plants |
| | G | 15 | Large livestock herd sizes because people highly dependent on livestock for survival. Money sent home by men working in the mines used to buy livestock |
| 1965 | N | 10 | Similar situation |
| | G | 10 | Fewer people going to the mines and fewer people able to buy as many livestock |
| 1975 | N | 6 | Disease began to affect livestock numbers. *Umbendene* was prominent |
| | G | 7 | Children in homelands compelled by law to attend school. Homesteads forced to sell livestock to purchase school uniforms |
| 1985 | N | 6 | Similar situation |
| | G | 5 | An absence of shepherds because children were at school. Adult livestock owners forced to look after their own livestock. Outbreak of *Manzabomvu* |
| 1995 | N | 3 | Livestock disease became common. Ticks began to spread rapidly. The dip was weaker than before and people relied heavily on natural medication |
| | G | 1 | Absence of shepherds resulted in pervasive livestock neglect. As a result, households lost many livestock in the veld. There was an increase in tick-borne disease due to lack of dipping, and an increase in theft |
| 2005 | N | 3 | The youth become less interested in taking their fathers' livestock to the dip. Cattle became ill more frequently |
| | G | 1 | Similar situation |
| 2015 | N | 2 | The state dipping system no longer functioned and livestock disease was a prominent issue |
| | G | 1 | Similar situation |

4.2.1.2 Economic value of livestock goods and services

This section details the economic values associated with livestock and poultry goods and services. This is complex because there are multiple types of products across different livestock and multiple ways of reporting. Therefore, it commences with discussions around the frequency of use of livestock and poultry goods and services, then considers the economic value of livestock and poultry goods and services per village and concludes by highlighting the differences and similarities between villages.

#### 4.2.1.2.1 Proportion of households receiving consumptive benefits

The goods and services rendered by livestock and poultry were widely used. In general, livestock and poultry owning households frequently made use of at least one output in the preceding 12 months. The most widely used goods and services amongst owning households were cattle manure, as floor sealant and manure, and chicken eggs (Tables 4.6a-c). Cattle manure was also used in large quantities by more than two-thirds of non-livestock owning homesteads in each village. Although cattle and poultry occupied the top few positions in ranking exercises, the role of chickens in egg production and cattle in manure production was not pronounced as a significant reason for ownership.

The primary reasons for livestock ownership identified in ranking exercises was for their role in slaughter and income. Yet, other than the high proportion of sheep slaughter (100%) by owner households in Gogogo, less than half of stock-owning households in each village had engaged in cash sale or slaughter of other livestock in the previous 12 months. This may be because owners valued the potential for sales or slaughter in the face of shock or to satisfy an immediate household need and it was this option value that was important, rather than the actual number of sales or slaughtering events. This logic was supported by households involved in livestock slaughter or sale who emphasised that each activity was carried out to meet a specific need. For example, in Ludaka one homestead sold 41 sheep to pay for a child's university fees, while in Gogogo a household slaughtered five cattle to contribute to the funeral costs of a family member. Conversely, the majority of households owning poultry, slaughtered an average of between 6±3 – 10±6 chickens per annum across villages. Reasons for this were emphasised in section 4.1.1.

Other livestock outputs, such as milk and ploughing, were harnessed by only a few households in Gogogo and Ludaka, with a greater proportion of households ploughing in Ludaka. This is probably related to the higher proportion of households engaged in field cultivation there. Pig owning households in Gogogo had not slaughtered any in the previous 12 months. This may be to ensure an increase in herd size.

Table 4.6a: Gross direct-use and traded values of livestock and poultry benefits to households in Njela

| | Benefit status | Goods and services | Proportion (%) of | | Average value (R/yr) per | |
|---|---|---|---|---|---|---|
| | | | all HH | owner HH | owner user HH | owner HH |
| Cattle | Direct-use value | Milk | 0 | 0 | 0 | 0 |
| | | Manure (fertiliser+sealant) | 71 | 75 | 324±213 | 244±238 |
| | | Plough | 0 | 0 | 0 | 0 |
| | Trade value | Cash sales | 0 | 0 | 0 | 0 |
| | Other | Slaughter (ritual+consumption) | 0 | 0 | 0 | 0 |
| | **Total (R/yr)** | **a) owner user HH: 324±213; b) owner HH: 244±238; c) all HH: 28±106** | | | | |
| Chickens | Direct-use value | Eggs | 74 | 93 | 1 362±1 564 | 1 073±1 494 |
| | Trade value | Cash sales | 3 | 4 | 413 (n=1) | 15±78 |
| | Other | Slaughter (ritual and HH consumption) | 51 | 64 | 884±797 | 568±766 |
| | **Total (R/yr)** | **a) owner user HH: 1 990±1 886; b) owner HH: 1 848±1 888; c) all HH: 1 478±1 842** | | | | |
| Goats | Trade value | Cash sales | 3 | 11 | 9 000 (n=1) | 1 000±3 000 |
| | Other | Slaughter (ritual and HH consumption) | 9 | 33 | 2 000±866 | 667±1 090 |
| | **Total (R/yr)** | **a) owner user HH: 5 000±4 822; b) owner HH: 1 666±3 473; c) all HH: 429±1 840** | | | | |
| Pigs | Trade value | Cash sales | 0 | 0 | 0 | 0 |
| | Other | Slaughter (ritual and HH consumption) | 0 | 0 | 0 | 0 |
| | **Total (R/yr)** | **a) owner user HH: 0; b) owner HH: 0; c) all HH: 0** | | | | |
| Sheep | Trade value | Cash sales | 0 | 0 | 0 | 0 |
| | Other | Slaughter (ritual and HH consumption) | 0 | 0 | 0 | 0 |
| | **Total (R/yr)** | **a) owner user HH: 0; b) owner HH: 0; c) all HH: 0** | | | | |
| | **Av. Gross Total (R/yr): a) owner user HH: 2 605±3 311; b) owner HH: 2 257±3 203; c) all HH: 1 935±3 065** | | | | | |

*Tables 4.6a-c reflect trade and consumptive values only. Herd growth was not included
*The final averages will not equate to being added up on the table because they are derived from the empirical data per household across livestock types

Table 4.6b: Gross direct-use and traded values of livestock and poultry benefits to households in Gogogo

| | Benefit status | Goods and services | Proportion (%) of | | Average value (R/yr) per | |
|---|---|---|---|---|---|---|
| | | | all HH | owner HH | owner user HH | owner HH |
| Cattle | Direct-use value | Milk | 3 | 9 | 1 792 (n=1) | 162±540 |
| | | Manure (fertiliser+sealant) | 78 | 82 | 462±229 | 378±261 |
| | | Plough | 13 | 45 | 440±313 | 275±303 |
| | Trade value | Cash sales | 0 | 0 | 0 | 0 |
| | Other | Slaughter (ritual+consumption) | 5 | 18 | 20 000±14 142 | 3 636±9 244 |
| | **Total (R/yr)** | **a) owner user HH: 5 352±10 797; b) owner HH: 4 379±9 897; c) all HH: 1 204±5389** | | | | |
| Chickens | Direct-use value | Eggs | 60 | 92 | 1 497±1 568 | 1 239±1 534 |
| | Trade value | Cash sales | 3 | 4 | 640 (n=1) | 25±126 |
| | Other | Slaughter (ritual and HH consumption) | 48 | 73 | 1 044±676 | 709±743 |
| | **Total (R/yr)** | **a) owner user HH: 2 169±1 750; b) owner HH: 2 016±1 777; c) all HH: 1 410±1 750** | | | | |
| Goats | Trade value | Cash sales | 8 | 21 | 9 333±6 110 | 2 000±4 641 |
| | Other | Slaughter (ritual and HH consumption) | 10 | 29 | 3 500±3 000 | 1 000±2 184 |
| | **Total (R/yr)** | **a) owner user HH: 6 000±5 164; b) owner HH: 3 000±4 690; c) all HH: 1 050±3 071** | | | | |
| Pigs | Trade value | Cash sales | 0 | 0 | 0 | 0 |
| | Other | Slaughter (ritual and HH consumption) | 0 | 0 | 0 | 0 |
| | **Total (R/yr)** | **a) owner user HH: 0; b) owner HH: 0; c) all HH: 0** | | | | |
| Sheep | Trade value | Cash sales | 3 | 33 | 12 000 (n=1) | 4 000±6 928 |
| | Other | Slaughter (ritual and HH consumption) | 8 | 100 | 4 667±4 618 | 4 667±4 618 |
| | **Total (R/yr)** | **a) owner user HH: 4 667±4 616; b) owner HH: 4 667±4 616; c) all HH: 350±1 626** | | | | |
| | **Av. Gross Total (R/yr): a) owner user HH: 5 353±8 228; b) owner HH: 4 866±7 987; c) all HH: 4 014±7 473** | | | | | |

Table 4.6c: Gross direct-use and traded values of livestock and poultry benefits to households in Ludaka

| | Benefit status | Goods and services | Proportion (%) of | | Average value (R/yr) per | |
|---|---|---|---|---|---|---|
| | | | all HH | owner HH | owner user HH | owner HH |
| Cattle | Direct-use value | Milk | 3 | 5 | 1 792 (n=1) | 94±411 |
| | | Manure (fertiliser+sealant) | 93 | 100 | 472±291 | 447±303 |
| | | Plough | 15 | 32 | 600±310 | 200±336 |
| | Trade value | Cash sales | 8 | 16 | 20 000±6 928 | 3 158±7 841 |
| | Other | Slaughter (ritual+consumption) | 10 | 21 | 15 000±6 000 | 3 333±6 894 |
| | **Total (R/yr)** | **a) owner user HH: 7 438±12 168; b) owner HH: 7 046±11 959; c) all HH: 3 347±8 962** | | | | |
| Chickens | Direct-use value | Eggs | 43 | 57 | 1 184±574 | 606±701 |
| | Trade value | Cash sales | 13 | 17 | 976±891 | 232±571 |
| | Other | Slaughter (ritual and HH consumption) | 60 | 80 | 508±271 | 407±318 |
| | **Total (R/yr)** | **a) owner user HH: 1 328±958; b) owner HH: 1 240±984; c) all HH: 954±1 009** | | | | |
| Goats | Trade value | Cash sales | 0 | 0 | 0 | 0 |
| | Other | Slaughter (ritual and HH consumption) | 3 | 33 | 8 000 (n=1) | 2 667±4 619 |
| | **Total (R/yr)** | **a) owner user HH: 8 000 (n=1); b) owner HH: 2 667±4 619; c) all HH: 200±1 265** | | | | |
| Pigs | Trade value | Cash sales | 8 | 30 | 3 333±1 155 | 1 000±1 155 |
| | Other | Slaughter (ritual and HH consumption) | 13 | 50 | 1 800±1 304 | 900±1 287 |
| | **Total (R/yr)** | **a) owner user HH: 3 800±2 950; b) owner HH: 1 900±2 807; c) all HH: 475±1 585** | | | | |
| Sheep | Trade value | Cash sales | 13 | 23 | 15 900±25 601 | 3 614±13 090 |
| | Other | Slaughter (ritual and HH consumption) | 28 | 50 | 3 136±1 951 | 1 568±2 095 |
| | **Total (R/yr)** | **a) owner user HH: 8 142±15 991; b) owner HH: 5 182±13 205; c) all HH: 2 850±10 035** | | | | |
| | **Av. Gross Total (R/yr): a) owner user HH: 9 753±20 177; b) owner HH: 9 457±19 931; c) all HH: 8 002±18 614** | | | | | |

4.2.1.2.2 Annual, gross direct-use and traded values of livestock and poultry outputs

Njela

In terms of consumptive and trade value, goats were the most significant in Njela. This was mainly attributed to slaughter as only one household sold goats. However, the high income derived from goat sales by that single household highlights the ability to make a meaningful cash income.  Next were chickens, which were mainly represented by the production of eggs and some slaughter. The consumptive value derived from cattle was very low, mostly from manure. The value of stock and poultry, to those who owned and used outputs was estimated at R2 605±3 311 per annum and when averaged across all households, including those who do not own livestock, was R 1 935±3 065 per household per annum (Table 4.6a). Therefore, the estimated total value of livestock and poultry products for the entire village, consisting of 85 households (Stats SA, 2011), was approximately R164 475 per annum.

Gogogo

Of the direct-use and trade values in Gogogo, goats contributed the highest value annually (Table 4.6b). Goat owning households that participated in trade contributed the most to this value at R9 333±6 110 per annum. Cattle and then sheep were next, which were both mainly represented by slaughter. The total, average, value of livestock and poultry goods and services was R5 353±8 228 per annum amongst those who owned livestock and poultry and used outputs, and R4 014±7 473 averaged amongst all households in the village. Therefore, the estimated total value of goods and services for the village as a whole, consisting of 206 households (Stats SA, 2011), was approximately R826 884 per annum.

Ludaka

In Ludaka, sheep contributed the highest direct-use and trade value which is probably related to the high frequency of ownership. Sheep trade contributed five times the amount resulting from slaughter (4.6c). The sale of wool was mentioned by some households but not recorded. Although the total consumptive and trade value of goats was high, this was derived from one household slaughtering four goats at R2 000 per unit. Next was cattle, with both trade and slaughter as significant values. However, these averages were dominated by a few households with large slaughter and trade numbers. This explains why the total direct-use and trade value for those that own cattle and use outputs was lower than expected. Therefore, the total monetary value derived from all livestock and poultry outputs was highest in Ludaka at R9 753±20 177 per household per year that owned and made use of livestock outputs, and when averaged across the whole village was R8 002±18 614 per household per year. The estimated total of livestock and poultry goods and services for the village, consisting of 144 households (Stats SA), was approximately R1 152 288 per annum.

4.2.1.2.2 Comparison between output values in each village

The use of goods and services from livestock and poultry in each village offer a considerable direct-use value to owners. The overall direct-use and trade value amongst households that owned and used outputs was highest in Ludaka at R9 753±20 177 per annum and lowest in Njela (R2 605±3 311) with Gogogo intermediate (R5 353±8 228), however, no statistical significance was found (F=2.3; p=0.1). The higher economic value in Ludaka was probably due to a combination of factors such as a) a higher proportion of livestock owners (Table 4.1), b) a higher proportion of livestock owning households harnessing livestock outputs (Table 4.6a) and c) a greater capital value of cattle (Table 4.7).

It was difficult to generalise about the type of livestock or poultry that generated the highest direct-use and trade value as they differed between villages. In Njela, chickens were the most significant with an average total of R1 990±1 886 per annum, while in Gogogo, amongst those households that own and use livestock outputs, goats dominated, generating an average of R6 000±5 164 per annum. In Ludaka, sheep contributed the highest value amongst owner user households at R8 142±15 991 per annum. The consumptive outputs rendered by cattle were low in each village despite offering a greater diversity of goods and services.

An important finding was the difference in consumptive and trade values between owner user households and owner households in all villages, i.e. some households owned livestock and poultry but did not use livestock outputs in 2016. This supports the idea that for many households the value of livestock or poultry for these goods and services, was a potential or an insurance, rather than an actual value, but this potential could be harnessed at any point. This was illustrated by an elderly man in Ludaka who emphasised the importance of older men owning livestock to ensure that their wives had access to some form of cash income after their husbands' death.

Despite less than half of stock-owning households participating in trade, in general this activity made the highest contribution to total average value of goods and services in each livestock category. Amongst poultry owning households the average direct-use value of chicken eggs was the most significant, as chickens produced an average of 17-26 eggs per week in each village at between R1.10-1.50 per egg. Manure, as a frequently used function of cattle by owning and non-owning homesteads, had relatively little overall monetary value.

Table 4.7: Price (R) per unit of livestock in each village in 2016

| Livestock | Njela | Gogogo | Ludaka | Mean±SD |
|---|---|---|---|---|
| Chickens | 103 | 107 | 84 | 98±12 |
| Cattle | 9 000 | 10 000 | 12 000 | 10 333±1 528 |
| Goats | 1 500 | 2 000 | 2 000 | 1 833±289 |
| Sheep | - | 2 000 | 1 500 | 1 750±354 |
| Pigs | - | 2 000 | 1 000 | 1 500±707 |

Household wellbeing, which was locally defined in each village through participatory processes, had a significant positive relationship to the consumptive economic value of livestock in each village (Njela: $F=4.2$, $p<0.05$; Gogogo: $F=10.4$, $p<0.001$; Ludaka: $F=8.0$, $p<0.001$). This indicates that wellbeing increases with livestock output value. However, in each village less than one fifth of the variance of the response was represented by the predictor (Njela $R^2=0.11$; Gogogo $R^2=0.21$; Ludaka $R^2=0.20$).

### 4.2.2 Ecosystem disservices

While livestock and poultry provide multiple benefits to their owners, and even some non-owners (e.g. manure), and represent significant economic savings, livestock and poultry health was compromised, and herd/flock growth undermined by various EDS across villages. In many instances, the loss of livestock and poultry, as a result of EDS, had significant effects on the household as they were no longer able to harness the goods and services that livestock offer and were more vulnerable due to loss of significant assets used to cope in the event of a shock or stress. For example, in some households children were no longer able to attend school because the sale of goats, which once facilitated the purchase of school uniforms, could no longer occur, and disposable income had to be re-directed to purchase goods and services that were once provided by their own stock. This section explores a range of EDS affecting livestock and poultry and details local ideas about control and prophylaxis.

#### 4.2.2.1 Frequency, ability to cope and associated economic impact

Livestock and poultry-related EDS were similar in each village. Those affecting livestock included unpalatable rangelands for livestock to graze, ticks and tick-borne diseases, and the rapid spread of invasive woody species such as *Lantana camara*. Common factors which affected poultry production included chicken diseases and various predators preying on mature birds and chicks. What follows is an outline of each of these EDS across villages.

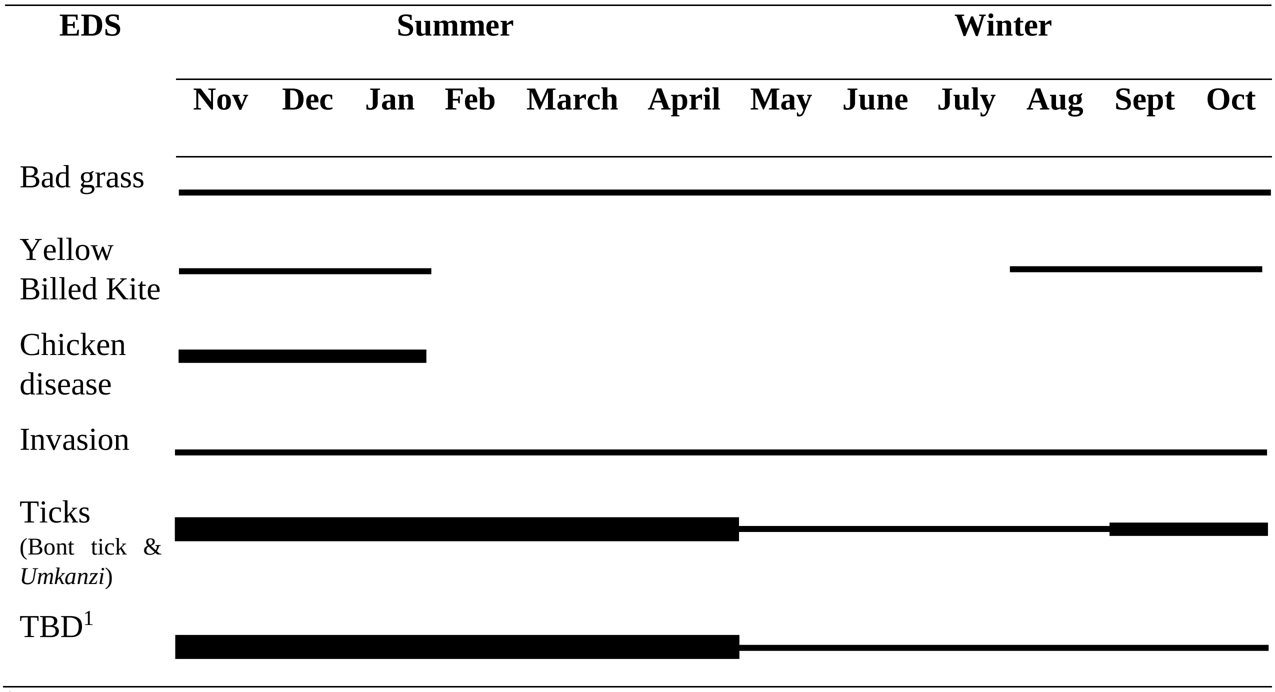
- Poultry-related EDS

Overall, birds of prey were ranked as the most frequently occurring EDS in each village but were considered the easiest to prevent and cope with financially (Table 4.8). Three species of birds of prey were mentioned in each village, each being responsible for similar levels of damage. These were locally referred to as: a) *Untloyiye*, and b) *Umkhuzi* (Yellow Billed Kite) (*Milvus aegyptius*) both of which caught thermals and lived in forests, and c) *Nongena* which "walk on the ground and prey on the chicks from there". Yellow Billed Kites were seasonal, catching chicks between August and January (Table 4.9). More than two-thirds of chicken owning households in each village identified birds of prey as an issue in their household (Table 4.10). Predation was most acute in Njela where chicken owning households lost an average of 163±202 chicks annually which amounted to approximately R5 727±7 093 per annum (Table 4.10). This was supported by a young female who noted "last month I had 60 chicks, but this month I have 7. This is big problem as I was going to eat or sell these chicks when they became chickens. Now I am wasting my maize fattening these chicks for birds of prey". Greater damage by birds of prey in Njela may be the result of greater habitat suitability as the village borders both dense indigenous forests and coastal cliffs.

Table 4.8: Ranked lists in descending order according to frequency, ability to cope, and severity of EDS affecting livestock and poultry in each village

| Rank | Njela | Gogogo | Ludaka |
|---|---|---|---|
| **Frequency (most to least)** | | | |
| 1 | Chicken disease and birds of prey | Chicken disease and birds of prey | Bad grass |
| 2 | Ticks and tick-borne diseases | Ticks and tick-borne diseases | Birds of prey |
| 3 | Invasion | Invasion | Ticks, tick-borne diseases and chicken disease |
| 4 | Bad grass | | |
| **Severity (most to least)** | | | |
| 1 | Ticks and tick-borne diseases | Ticks and tick-borne diseases | Ticks and tick-borne diseases |
| 2 | Birds of prey and chicken disease | Birds of prey | Birds of prey and chicken disease |
| 3 | Bad grass | Chicken diseases and birds of prey | Bad grass |
| 4 | Invasion | Invasion | |
| **Ability to cope (hardest to easiest)** | | | |
| 1 | Invasion | Invasion | Ticks and tick-borne diseases |
| 2 | Ticks and tick-borne diseases and chicken disease | Ticks and tick-borne diseases | Bad grass |
| 3 | Bad grass | Chicken disease | Birds of prey and chicken disease |
| 4 | Birds of prey | Birds of prey | |

Table 4.9: Seasonal calendar of EDS in all villages




[1] Tick-borne disease

In most cases, birds of prey were equally ranked or closely followed by chicken disease. It was cited as a dominant cause of premature death amongst adult birds and in turn reduced the number and the productivity of birds. More than half of chicken owning households in each village reported having experienced diseased birds in the previous 12 months (Table 4.11). The close proximity of homesteads within the villages facilitated easy interaction and rapid spread of disease. Signs of the disease, as perceived by the community in all three villages, were swollen eyes, cough, and watery white and yellow droppings. It was also described as an acute condition, lasting 3-5 days, frequently killing a household's entire flock. Loss to disease represented a significant economic loss (R1 115-R1 500 per annum) and forced households to purchase poultry-related goods and services at local shops. The general feeling amongst poultry owners was the spread of disease was getting worse and some households had even given up rearing poultry as a result of the perceived increase in outbreaks of disease. At the onset of disease, mature birds were slaughtered and frozen to prevent anticipated financial loss as, after death by disease, chickens were not even considered suitable for consumption by dogs.

Table 4.10: Scope of the average economic loss per annum amongst owner households as a result of EDS

| | EDS | Njela % owner HH | Njela Av. unit lost p.a | Njela Av. econ. loss per HH (R/yr) | Gogogo % owner HH | Gogogo Av. unit lost p.a | Gogogo Av. econ. loss per HH (R/yr) | Ludaka % owner HH | Ludaka Av. unit lost p.a | Ludaka Av. econ. loss per HH (R/yr) |
|---|---|---|---|---|---|---|---|---|---|---|
| Cattle | Tick-borne disease | 50 | 3±1 | 27 000±12 728 | 18 | 5±4 | 50 000±42 426 | 53 | 4±4 | 50 400±47 598 |
| Chickens / Chicks | Birds of prey | 68 | 163±202 | 5 727±7 093 | 100 | 86±63 | 3 014 ±2 203 | 77 | 9±6 | 329±236 |
| | Forest cats | 18 | 11±16 | 1 136±1 725 | 23 | 4±2 | 409±196 | 3 | 1 (n=1) | 84 (n=1) |
| | Monkeys | 14 | 36±24 | 1 242±852 | - | - | - | - | - | - |
| | Chicken disease | 50 | 14±15 | 1 439±1 615 | 96 | 11±8 | 1 115±824 | 63 | 18±23 | 1 500±1 930 |
| Goats | Disease | 44 | 4±4 | 6 000±6 363 | 50 | 4±4 | 8 286±7 251 | 33 | 3 (n=1) | 6 000 (n=1) |
| Pigs | Disease | - | - | - | - | - | - | 20 | 2±0 | 4 000±0 |
| Sheep | Disease | - | - | - | 100 | 2±2 | 4 667±3 055 | 68 | 7±7 | 11 000±11 405 |

**Average economic loss amongst owner HHs (R/yr):**
**Njela: 8 326±9 657; b) Gogogo: 8 289±15 073; c) Ludaka: 22 426±38 208**

*The final averages will not equate to being added up on the table because they are derived from the empirical data per household across livestock types

- Livestock-related EDS

Ticks and associated tick-borne diseases were always the first livestock-related EDS mentioned in focus group discussions, and were ranked by livestock owners to have the most severe effect on the households (Table 4.8). Three local names were used in each village to describe dominant ticks: *Umkhanzi* for pepper tick (*Rhipicephalus* sp.), *Qhizani* for engorged pepper tick, and *Qwelagibe* for multi-coloured, striped tick with hard outer casing (*Amblyomma hebraeum*) (South African Bont tick). Ticks were seasonal, causing the most damage in summer, especially in February and March when they reproduced, and were less active in winter (Table 4.9). Despite overall consensus that ticks were less active in winter, residents in each village highlighted that ticks were becoming more prevalent in winter as a result of the changing climate. Bont ticks caused the most anxiety and heavy infestations were responsible for damaged hides, ears, tails, genitals and mammary glands which often stopped producing milk and consequently affected the health and mortality rates of calves. Residents distinguished the impact of the bont tick on livestock from other ticks, as they had large mouth-parts which were able to bite deeper and as a result were harder to remove. Clustering often resulted in open wound sores which would not heal and in which flies laid their eggs. When lodged in livestock ears, they were believed to invade the brain and generate unusual behaviour. Bont ticks were also regarded as vectors of disease which were perceived as a major limiting factor for building up herds and responsible for widespread death amongst livestock. Dominant tick-borne diseases such as gallsickness (anaplasmosis) (*inyongo*), redwater (babesiosis) (*manzabomvu*), as well as heartwater (ehrliosis) were identified, and affected all ruminants. Other livestock diseases which were not perceived to be related to ticks were also mentioned, such as *nomkhonwana* and *umbendene.* The headman of Ludaka described how in the 1970s, when *umbendene* was prominent, he lost 35 cattle and was forced to leave the village and work in the mines in Gauteng in order to build his herd again.

The greatest financial losses, as a result of tick-borne diseases, were amongst cattle. This is probably related to the high price of a single animal. Overall, more than half of cattle owning households in Njela and Ludaka experienced the effects of tick-borne disease. As a result, loss of cattle to tick-borne disease averaged R27 000±12 728 and R50 400±47 598 per household per annum, in Njela and Ludaka, respectively (Table 4.10).

In each village, residents perceived there to be an increase in livestock deaths. This was associated with multiple factors such as: recent introductions of bont ticks into each village

(Table 4.11), pervasive neglect of livestock and dysfunctional state dipping systems (Tables 4.11 and 4.12). Various explanations were given for the recent prevalence of the bont tick. In timeline exercises, elderly residents in each village related the rise of the bont tick to the provision of weaker dip and later the disappearance of compulsory and frequent state-enforced dipping. These were common beliefs and were reflected in the trendline exercises of each village (Tables 4.11 and 4.12). Residents in Gogogo offered a second explanation, that bont ticks were harboured by monitor lizards in the forests and when slaughtered by hunters for food moved from the forests into the village settlements. Ludaka residents echoed similar views, claiming that in the past bont ticks were not present in their village, but the trade of livestock with villages near forests led to the introduction of the bont tick into Ludaka.

In Njela the state dipping system was no longer operational, while in Gogogo and Ludaka dipping systems were operated by what were regarded as inefficient dipping committees and were largely dysfunctional with several months lapsing between dip treatments. Focus group discussions with the youth in Ludaka highlighted the need for more consistent dipping systems that operated weekly and were run by state officials who would ensure consistent operation. Elderly residents in timeline exercises in Ludaka added that the dipping system would only be truly effective if the strength of the dip increased to what it used to be during the apartheid era.

Table 4.11: Trendline of change in number of ticks across villages

| Year | No. of stones | Description |
|---|---|---|
| **Njela** | | |
| 1965 | 5 | Livestock taken to state dip every week |
| 1975 | 6 | Same |
| 1985 | 6 | Same |
| 1995 | 7 | Dip became weaker with introduction of new democratic government. Winter began getting warmer, and ticks did not all die in winter |
| 2005 | 7 | The youth, who were traditionally responsible for livestock, became careless and failed to collect livestock every day. They did not take them to government dips as they were not punished for disobeying their parents requests. The effects of the bont tick began to increase and many people lost their livestock to tick-borne disease |
| 2015 | 9 | Situation described above intensified |
| **Gogogo** | | |
| 1965 | 2 | Ticks were infrequently noticed by residents. Only small red ticks were present at this time. There were no state dips during this period |
| 1975 | 5 | People noticed a new tick, the bont tick and it began to spread |
| 1985 | 5 | Regular dipping was enforced. State-appointed officials taught residents about types of ticks |
| 1995 | 7 | Bont ticks began to kill more animals. Dips still operated but bont ticks began to resist the dip |
| 2005 | 8 | Bont ticks resistant to dip. Children became lazy and failed to take livestock to the dip regularly. Dipping officials were corrupt and did not open dipping systems as they were paid to do |
| 2015 | 13 | Ticks are at an all-time high. The dipping system functions sporadically. Dip is provided by the government but local people are required to apply the dip themselves |
| **Ludaka** | | |
| 1965 | 2 | The dip was strong and very few ticks. Only *Umkhanzi* was prevalent |
| 1975 | 3 | Same as above |
| 1985 | 3 | Same as above |
| 1995 | 6 | The type of dip changed. It smelled different, and was weaker. Residents began buying cows from other villages which introduced bont ticks into Ludaka |
| 2005 | 10 | Change of dip led to an increase in ticks |
| 2015 | 16 | Although there are more bont ticks than in the past, *Umkanzi* still predominates. The current dip is weaker than the one supplied in the past, which means that the day after you have dipped your livestock they need to be dipped again. This is in contrast to the past, when the dip was effective and would resist ticks for an entire month |

Table 4.12: Trendline of change of prevalence of livestock disease in each village

| Year | No. of stones | Description |
|---|---|---|
| **Njela** | | |
| 1965 | 4 | Disease was uncommon |
| 1975 | 6 | Gallbladder disease dominated |
| 1985 | 5 | Disease was uncommon |
| 1995 | 8 | Ticks became a bigger issue in their lives. Weaker dips and increase in neglect of livestock led to rise in tick-borne disease |
| 2005 | 8 | Lack of dips and shepherds meant that disease spread rapidly. Only option to cure livestock was expensive Western medication |
| 2015 | 9 | Same as above |
| **Gogogo** | | |
| 1965 | 1 | Disease was uncommon |
| 1975 | 1 | Disease was uncommon |
| 1985 | 6 | White people began to vaccinate their livestock. This may have given rise to spread of disease |
| 1995 | 7 | Lack of shepherds, weaker dip and pervasive neglect led to increase in tick-borne disease |
| 2005 | 10 | Increase in neglect amongst livestock owners. People were no longer interested in taking them to the vet to get an injection. Children no longer came home from school to look after livestock, they now play soccer with their friends or go to town. There was also a high rate of theft during this period. There are no shepherds taking livestock to the *kraal* in the evenings, so criminals use that opportunity to take livestock, not farm them but rather to sell and slaughter |
| 2015 | 15 | Not all livestock are taken back to the *kraal* at night. As a result, they eat dewy grass in the morning which they believe may cause diseases. The best time of day for cattle to eat is about 10am when the grass is dry. Ticks also dominate and cause disease |
| **Ludaka** | | |
| 1965 | 2 | Not much disease |
| 1975 | 2 | Same as above |
| 1985 | 3 | Same as above |
| 1995 | 5 | Livestock disease became more common with the increase in the bont tick |
| 2005 | 8 | Same as above |
| 2015 | 20 | The effect of disease has affected all livestock owners. It was not common for livestock to die of disease in the past. If livestock got sick they could cure them, but now it is difficult to cure them |

Hardy, thick tufted, sourveld dominated communal rangelands in each village and represented the primary source of forage for livestock. During focus group discussions in Njela and Ludaka, residents highlighted that sourveld rangelands possessed little nutrient value and palatability, particularly during the dry season, which directly affected the health of their livestock. In Gogogo poor quality rangeland was not considered an EDS, probably due to access to the large size of rangelands in the village. A key sourveld species mentioned in each village was *Aristida junciformis*, locally referred to as *isilevu* in Gogogo and Ludaka and *iqunde* in Njela. During a transect walk in Ludaka, an elderly man who owned many cattle and had spent his entire life in the village, described how when *Aristida junciformis* is old and dry it "kills the teeth of livestock", i.e. it was especially tough and caused livestock teeth to become loose and fall out. Residents highlighted that *Aristida junciformis* has continued to spread over time and related this to annual burning of the veld in the past. Annual burning of the veld by livestock owners no longer occurs on a routine basis, but may occur through error such as a lit cigarette dropped in the veld, etc. The spread of *Aristida juncifomis* was also perceived to replace thatch grass species such as *Cymbopogan plurinodis* (*Umqungu*) and *Miscanthus capensis* (*Umtala*). Although *Themeda triandra* (rooigras) occurred in small patches and was perceived to be a more palatable species, it could not sustain continuous grazing. The youth in Ludaka believe that the dominance of *Aristida junciformis* will affect the future of livestock ownership in the village as only those who can afford to purchase lucerne will own healthy livestock. No economic figures were ascribed to the effect of unpalatable grassland.

Various invasive alien species were identified as an EDS in Njela and Gogogo. Problematic alien plants included *Lantana camara* (*Ubuqholo*) in both villages and *Solanum chrysostichum* (*Umtuma*), and *Plectranthus comosus* (*Uqombo*) in Gogogo only. In Ludaka, alien species were scant and not considered an EDS. Overarching concerns raised about all alien species were the extensive invasion of rangelands which reduced available grazing land, invasion of old fields which reduced yields and limited the potential to cultivate fields in the future, invasion within the village settlement which closed footpaths and hindered the movement of people, thorns, and harbouring of snakes and criminals. The density of alien species along fuelwood collection routes also meant that women were hesitant to collect fuelwood unaccompanied for fear of criminals hiding within dense alien bushes.

Specific concerns raised by residents about *L. camara* included the dehydration of the soil (which was of particular concern when found within the boundaries of a home garden) and dense thickets which ensnared wandering livestock. Trendline exercises highlight that it had been in their area for more than 30 years (Table 4.13). Most respondents (97% in Njela and 70% Gogogo) were of the opinion that *L. camara* was increasing in density and extent. One resident in Njela claimed "soon the entire village will be taken over by lantana, it will even climb into our houses". Direct observation by the researcher noted there was a greater spread and density of *Lantana camara* in Njela. Despite negative views associated with *L. camara*, household surveys highlighted that it was the dominant hedge species in both villages. Negative perceptions were also challenged by the youth, who valued lantana for its aesthetic contribution to the village and fruit production.

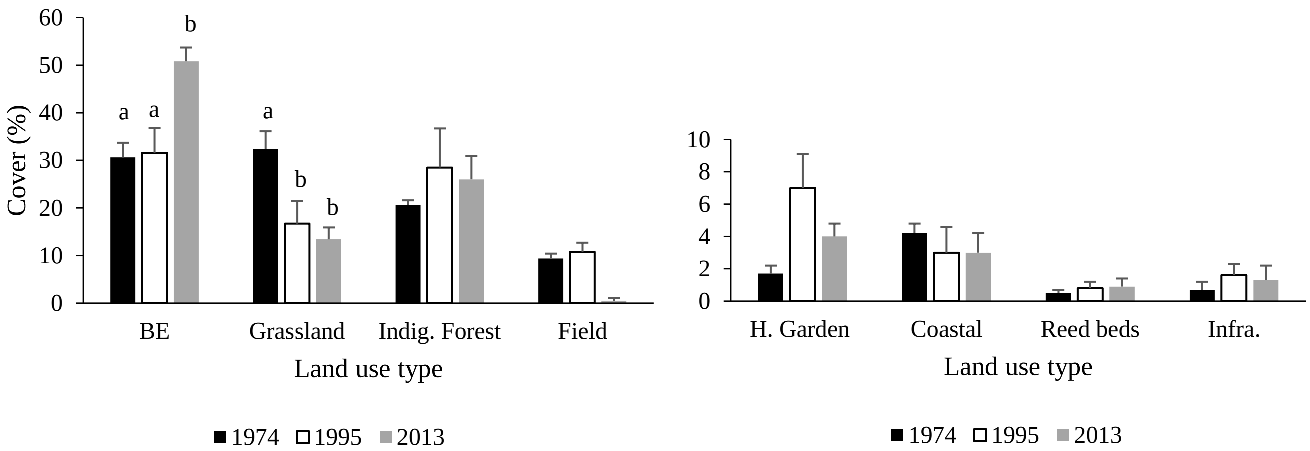
Table 4.13: Change in spread of *L. camara*

| Year | Village | No. of stones | Description |
|---|---|---|---|
| 1965 | N | 0 | |
| | G | 0 | |
| 1975 | N | 0 | |
| | G | 0 | |
| 1985 | N | 2 | It was believed to have been spread by birds |
| | G | 5 | Began noticing *Lantana camara* |
| 1995 | N | 9 | Fruit produced by the plant was eaten by birds and dispersed throughout a greater extent in the village |
| | G | 8 | Only noticed in the fields |
| 2005 | N | 10 | After veld fires the wind dispersed the seeds further. It no longer only grew in old fields but in vacant land in the village |
| | G | 11 | Moved from fields to vacant land within the village settlement and encroached on home gardens |
| 2015 | N | 19 | Livestock forced to graze closer to the village due to invasion of rangeland |
| | G | 16 | There is so much of it that it is even replacing the grass |

The rapid establishment in disturbed sites or old arable fields by an expansive pioneer species, *Vachellia karroo* (*Umga*), was recognised as an EDS in Njela and Gogogo but not ranked. Although it was the most desired fuelwood species in each village, there was ubiquitous concern over its increasing invasion, consequently reducing grazing potential for livestock and limiting future ability to cultivate fields. One man in Gogogo, who cultivated fields in the village for cash income and was the current leader of the Port St Johns Farmers' Association, believed that it could take up to two years to manually clear one hectare of land invaded by *V. karroo.* Invasion was also perceived to replace growth of thatch grass in each village. During a transect walk in Njela, one woman, who collected thatch as a primary income source, described how the spread of *V. karroo* and subsequent reduction of thatch has forced thatch collectors to walk long distances to neighbouring villages to collect thatch at an additional fee. This meant that thatch collection took double the length of time and reduced available time for household activities.

The perceived increase in invasion of *V. karroo* over time by residents in Njela and Gogogo was corroborated by GIS analysis. Bush encroachment in Njela expanded 160%, from 146±24 ha in 1974 to 234±14 ha in 2013 (Figure 4.1a). Significant change occurred during the 1974-2013 ($p<0.05$) and 1995-2013 ($p<0.05$) time steps. In Gogogo bush encroachment increased 500%, from 43±4 ha in 1974 to 215±8 ha in 2015 (Figure 4.1b). Significant change occurred during the 1974-2013 ($p<0.001$) and 1995-2013 ($p<0.001$) time steps. Figure 4.1c shows a decrease in grassland and corresponding increase fields between the 1995-2013 time steps in Ludaka.

In Njela, an average of 87 hectares of grassland was lost between 1974 and 2013 representing more than what remained in 2013 at 62±11 ha. This represents a significant loss of 41% grassland ($F=22.12$, $p=0.001$). In Gogogo, an average of 158 hectares of grassland was lost which represented a significant loss of 66% ($F=80.25$; $p<0.001$).




*BE-Bush encroachment, Indig. Forest-Indigenous Forest, H.Garden-Home gardens, Infra-infrastructure, Burnt land.-burnt landscape, IV-Invasion in village settlement

Figure 4.1a: Comparison of average land use change over time in Njela (n=2 304)

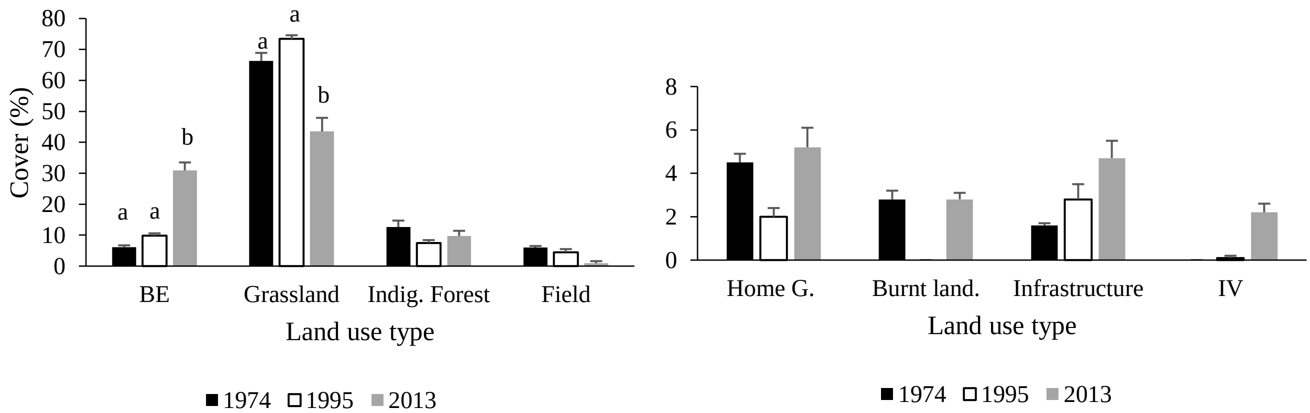



Figure 4.1b: Comparison of land cover change over time in Gogogo (n=3 474)

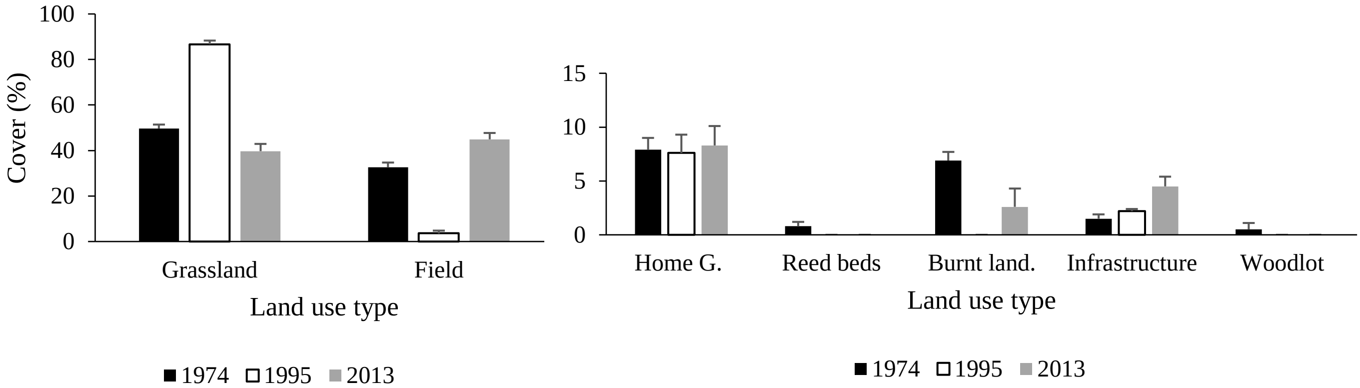



Figure 4.1c: Comparison of land cover change over time in Ludaka (n=2 340)

4.2.2.2 Pre-emptive and coping strategies

Despite the prevalence of livestock and poultry-related EDS and their significant effects on the household, residents actively engaged in multiple pre-emptive or reactive strategies to minimise loss by particular EDS such as birds of prey, chicken disease, ticks and tick-borne disease. Similar strategies were employed in each village and are discussed below. The management of invasive plants and unpalatable rangeland was not identified in any village.

- Birds of prey

Various preventative measures were established to reduce the number of chicks snatched by birds of prey. In Gogogo and Ludaka women described how, in the past, papers or plastic bottles were attached to wires and hung between buildings in the homestead. It was hoped that the movement of these objects would mimic movement of humans and deter birds of prey. Dispelled as ineffective, this method has been replaced by the establishment of big-leafed plants along homestead boundaries which provide a safe space for the chicks to forage out of view of birds of prey, or the construction of small structures for chicks to hide in. In most cases, households mentioned shouting and waving arms in the direction of the bird to be most effective.

- Chicken disease

Respondents recognised that there was little a household could do once an outbreak of chicken disease had occurred, but acknowledged the importance of engaging in preventative measures. Those who could afford to, spent more than R100 per annum on biomedical products which were added to water troughs (Table 4.14). Those who lacked financial resources added A*loe sp.* leaves to water troughs to create a weak infusion.

- Ticks and tick-borne disease

Due to the inconsistency of the state dipping system, stock owners were forced to manage ticks and tick-borne disease independently. More than half of stock-owning households of each livestock type purchased some form of biomedical product (Table 4.14). These households spent an average of R1 000 per annum per type of livestock for both treatment and prevention. Direct observation highlighted that wealthier households systematically administered preventative biomedical products, such as injections and dipping, while poorer households only took action when ticks began to accumulate or once an animal was already sick. This was related to a lack of disposable income and an inability to ensure frequent and regular dosing. These owners also purchased decanted bottles of dip from more affluent members of the community. In both cases, owners relied on literate members of the community to read instructions and explain how to use biomedical products.

Effective tick prevention was only associated with biomedical products, and respondents were unaware of other ways to control tick infestations. However, stock owners, especially those that lacked financial resources, took advantage of locally available plants to make their own acaricidal preparations to treat both tick-borne disease and other unrelated diseases or wounds.

Cash-strapped residents relied on a local institution, locally known as *Inqoma*, to replace stock lost to disease. This involved borrowing a breeding pair of animals from members of the community, and once the pair had reproduced, returning the breeding pair to the original owners and keeping the young. This practice did not only occur amongst households who lost animals to disease but also amongst financially constrained households as a means to build wealth.

Table 4.14: Price (R/yr) of the biomedical treatment or prevention for livestock and poultry-related EDS

| | Njela | | | Gogogo | | | Ludaka | | |
|---|---|---|---|---|---|---|---|---|---|
| | % of owners | Av. Cost (R/yr) | Range (R/yr) | % of owners | Av. Price (R/yr) | Range (R/yr) | % of owners | Av. Price (R/yr) | Range (R/yr) |
| Cattle | 50 | 550±212 | 400-700 | 73 | 1 075±685 | 250-2 000 | 84 | 913±818 | 250-3 000 |
| Chickens | 18 | 149±127 | 13-350 | 46 | 112±141 | 7-500 | 51 | 167±158 | 30-500 |
| Goats | 89 | 350±303 | 52-1 000 | 86 | 986±1 662 | 12-1 000 | 100 | 900±557 | 300-1 400 |
| Pigs | - | - | - | 0 | 0 | 0 | 0 | 0 | 0 |
| Sheep | - | - | - | 66 | 1 105±1 265 | 200-2 000 | 91 | 958±690 | 100-3 000 |

4.2.2.3 Financial cost of selected EDS to households

The potential consumptive services, i.e. the average economic value of services that would have accrued per household if not for disservices such as tick-related deaths, was calculated as the sum of the direct-use and traded value per household and the potential consumptive services lost as a result of disservices. Figure 4.2 reflects ES and EDS as an average percentage of the potential economic value of consumptive services per livestock type and poultry in each village. The low average proportion of EDS across villages can be attributed to a high variation in EDS-related losses across owner households. For example, EDS-related losses range from no losses in some households to 96% in others.

The greatest proportional loss was amongst poultry which ranged from 19±16% in Ludaka to 40±32% in Gogogo. This was related to the regular death of large number of chickens caused by chicken disease and meant that households were no longer able to trade or slaughter chickens and collect eggs.  It represented the loss of consumptive outputs equating to R2 013±4 207 in Njela, R2 324±2 863 in Gogogo and R346±454 in Ludaka. No other consistent trend was noted across villages, however significant economic losses occurred in goats in Gogogo R1 140±1 838 (20±24%) and sheep in Ludaka R1 413±2 350 (21±25%).

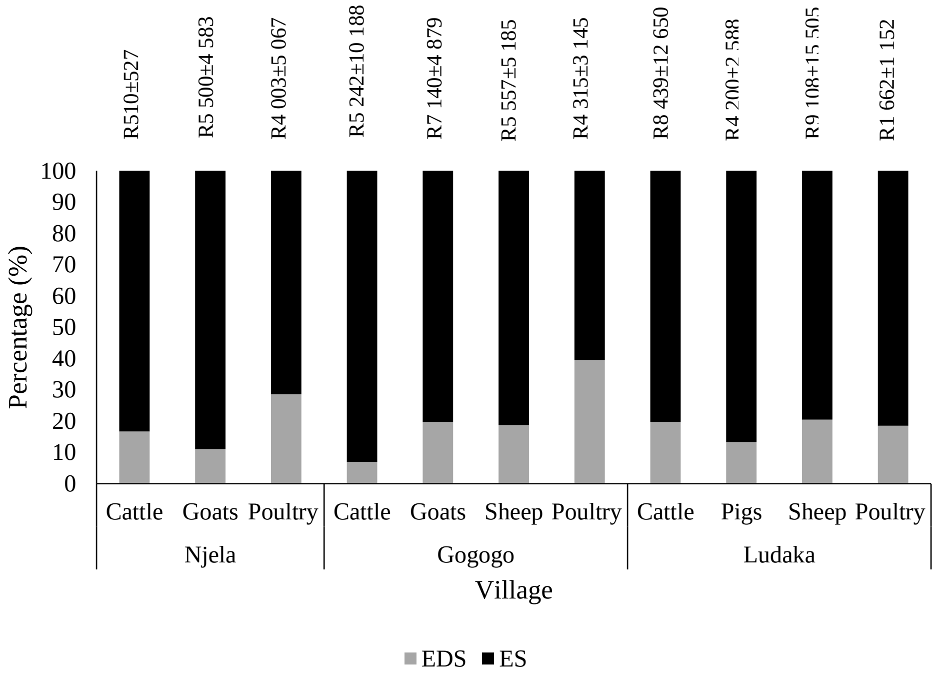



Figure 4.2: ES and EDS reflected as a percentage of the average potential household value of livestock consumptive outputs amongst owner households, economic values at the top of graph represent total potential values if not for disservices

### 4.2.3 Number of ES and EDS along a habitat biodiversity gradient

Despite differing habitat diversity across study sites, the number and type of livestock and poultry-related EDS remained broadly the same in each village. No new EDS were found in Ludaka, the village with the greatest number of households involved in livestock husbandry, or Njela, the village with the greatest habitat diversity. This is unlike EDS in other land-based livelihood types, where the number of EDS is greatest in the village with the greatest habitat diversity, Njela.

However, the number of ES increased along the gradient of habitat diversity. More specifically, the number of ES were highest in Ludaka, the village with the lowest habitat biodiversity, but the greatest number of households involved in livestock husbandry, harnessing numerous livestock and poultry outputs (Figure 4.3). However, the ratio between ES and EDS is in accordance with Dunn (2010), as in Njela for every one ES there was one EDS, in comparison to Gogogo (0.3) and Ludaka (0.2). Figure 4.4, mirrors the trend illustrated in Figure 4.3, with a greater economic value derived from ES than losses incurred by EDS.

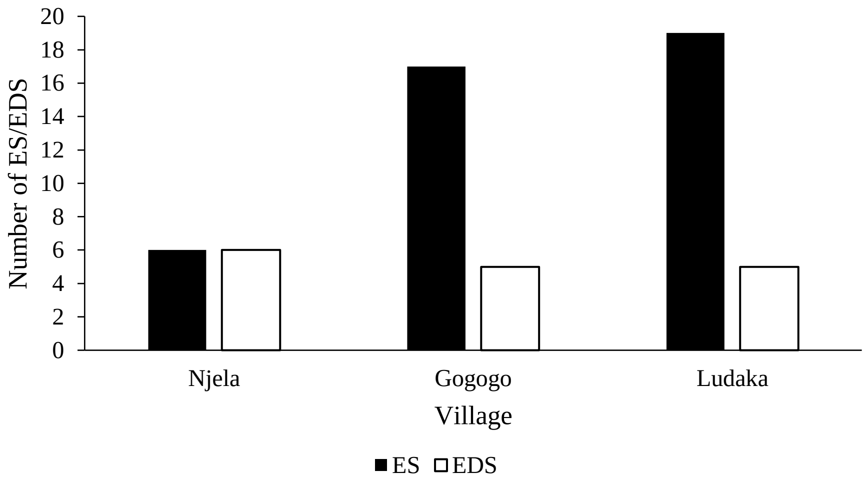



Figure 4.3: The total number of livestock related-ES and EDS

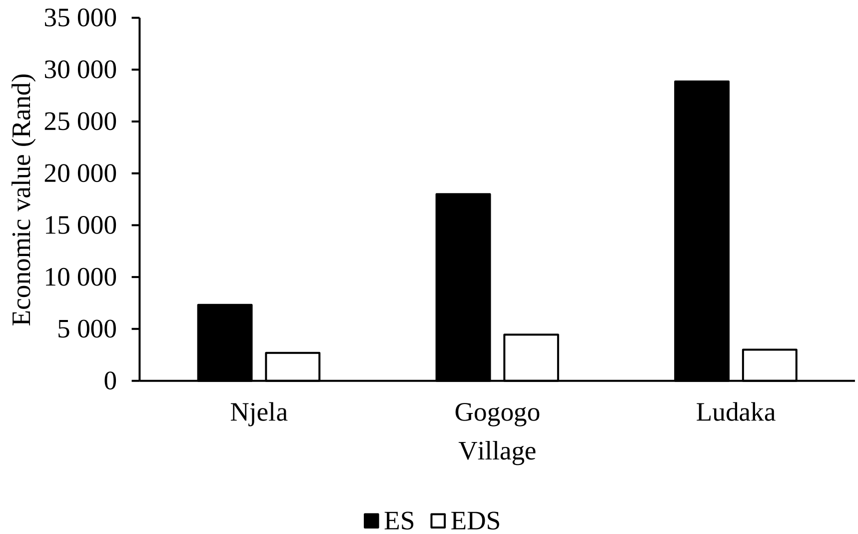



Figure 4.4: The economic value (Rand) of livestock-related ES and EDS amongst user households across villages

## 4.3 Discussion

Low-input, small-scale livestock husbandry and poultry ownership was a common activity across the study sites and was actively pursued by more than half of the households in each village as a means of subsistence or of financial buffering during unfavourable times. The majority of respondents kept a mixture of livestock species, a common feature in many communal production systems in southern Africa (Beyene et al., 2014, Gwelo, 2012, Nqeno et al., 2011, Tavirimirwa et al., 2013). Herd diversity has been identified as a way in which to maximise consumable products and services as well as to increase income, savings and security and to spread risk (Dovie et al., 2006), as households that hold a diversity of livestock and poultry may have a stronger economy and ability to respond to risks than those who only possess only single livestock types. Small stock (sheep and goats) dominated both in terms of the proportion of households involved in ownership and in terms of herd size, followed by cattle. This is a common pattern reflected elsewhere, for example Mapiliyao et al. (2012), working in two villages near Alice in the Eastern Cape, found the mean herd size of sheep to be more than nine times that of cattle, and Shackleton et al. (2005) found the proportion of goat owners in the Bushbuckridge region in Limpopo to be three times that of cattle owners. The dominance of small stock is commonly associated with the lack of purchasing power to own larger stock such as cattle. Further, goats which are easily liquidated during times of economic upheaval, or to raise funds for housing projects, are considered cheaper to raise by resource-limited people, and provide a higher rate of return compared to cattle (Dovie et al., 2006).

Despite the prevalence in small stock, ownership of cattle was preferred. Similar sentiments have been reflected in other studies such as Beyene et al. (2014) who, in a rural settlement in the Eastern Cape, found cattle as the highest ranked livestock, primarily for their cash generation potential to finance household requirements but also generation of other contributions such as milk, meat, ploughing and ritual slaughter. Similar sentiments were shared by Ncube *et al.* (2018) in their study in the Zvishavane district, Zimbabwe, because of the role they play in the agricultural, cultural and social sphere. In this sense, while small stock are kept for their short-term monetary returns, cattle serve as long-term investments or savings which can substantially supplement cash earnings (Dovie et al., 2006). Ainslie (2013) offered additional insight into cattle ownership, which is seen to form part of a cultural tradition that connects residents to their ancestors and symbolises a ‘proper’ African homestead.

The average herd size across all livestock types differed between study sites. The mean number of animals was a lot greater in Gogogo and Ludaka, in comparison to Njela which was almost three times less than its counterparts, the majority of whom owned poultry only. The few livestock-owning households in Njela, with markedly smaller herd sizes, may be a result of less rangeland available for grazing, a symptom of its location, among coastal indigenous forest, and the rapid encroachment of *Vachellia karroo*, which plays a typical pioneer species role, establishing in disturbed sites (e.g. old fields). On top of reducing forage potential, *L.*

*camara* also encroached into old fields and rangeland producing dense thickets which ensnared livestock. These negative impacts of this species have been noted elsewhere such as by Shackleton et al. (2017) who in their study in eastern Africa, found that residents perceived the invasive species to reduce the livestock carrying capacity by invading 50-70% of rangeland, and Jevon and Shackleton (2015) who documented that dense thickets of *L. camara* hinder the movement of people and livestock. In this study, bush encroachment increased 160% and 500% over a 39-year period in Njela and Gogogo, respectively. Increasing encroachment of woody plants into grasslands has been observed throughout South Africa, showing a 20% increase in the extent of woodland over a 23 year period (Skowno et al., 2017). In another communal area in the Eastern Cape, Chalmers and Fabricius (2007) reported a 49% increase over a 27-year period and Wigley et al. (2009) found a decrease in grass (21%) and tree (5%) cover and an increase in shrub cover (13%) over a 67-year period in a communal area within the Hlabisa district of KwaZulu-Natal. Drivers for bush encroachment have typically been linked to interactions between broader social, economic and historical factors – such as change in fire regimes, climate and, amongst other factors, changing cultivation patterns from fields to home gardens as a result of the unavailability of child labour to deter livestock from entering unfenced fields (Chalmers and Fabricius, 2007, O'Connor et al., 2014). These invasions also have economic impacts, both due to the loss of certain ecosystem goods and services as well as the cost of control. For example, Mugasi et al. (2000) estimated that returns per cow on bush encroached land were reduced 53% due to low body condition, and reduced growth, calving rates and milk yields in encroached areas of Uganda.

In contrast, a far larger proportion of households owned livestock in Ludaka, maintaining relatively large herds. This may be connected to larger rangelands with no visible bush encroachment and a pervasive livestock-culture, seemingly even amongst the youth. The livestock sharing institution, *Inqoma*, also provides evidence of the prioritisation of livestock with the intention to maintain or even grow livestock numbers in the village. Consequently, the average, annual, gross direct-use and trade value of livestock amongst owner households was more than three times greater in Ludaka (R9 457) than in Njela (R2 257).

Previous studies have not reported the composite consumptive and trade value across all livestock types in a household. However, a few provide figures for specific livestock types, providing comparable literature. Consumptive and trade values of cattle in communal areas are widely reported, in line with those generated for Gogogo (R4 379) and Ludaka (R7 046). For example, Shackleton et al. (2005) report the annual, gross value of cattle outputs amongst cattle owning households to be R6 807 (inflation adjusted) in the Bushbuckridge region of Limpopo, and Chaminuka et al. (2014), in another region of Limpopo, report R6 648 (inflation adjusted). The value of small stock outputs was generally greater than that of cattle which is in contrast to other studies, such the same study by Shackleton et al. (2005) cited above where the value of goats was R623 (inflation adjusted), representing more than ten times less than the value of cattle. A higher small stock value in this study may be related to a larger proportion of households involved in small stock ownership, and more frequent use of outputs such as sale or slaughter as they were more easily replaced than cattle.

Perceptions regarding the most important reasons for keeping livestock and poultry and the associated frequency of use and value of these outputs did not necessarily correspond. For instance, in Njela, the only benefit harnessed from cattle during the previous 12 months was manure, as a fertiliser and a floor sealant. This was the most widely used cattle output across sites, with almost all owner households and two-thirds of non-owner households benefiting from it, yet it represented a low economic value ranging from R244 in Njela to R447 in Ludaka. At the same time, sale and slaughter, which were considered the primary reasons for ownership and represented a high economic value, were functions used by only a few households. Similar findings occurred amongst small stock owners, who reported similar reasons for ownership, yet were scarcely involved in harnessing these outputs, which supports the frequently observed notion that although many households did not use several of the benefit streams that livestock offered, they valued the potential to do so (Dovie et al., 2006, Masika and Mafu, 2004, Shackleton et al., 2005). A noteworthy exception to the general findings across other studies was the low importance and value derived from draught power and milk. For example, Dovie et al. (2006) report the value of milk to contribute to 60% of the total direct-use value amongst cattle owning households, and draught power 14%, only slightly less than the contribution of meat. In this study however, these outputs represented a low economic value and were not amongst the primary motivations for ownership – probably the result of various changes in rural livelihoods such as the shift in cultivation from fields to home gardens, the increased availability and affordability of mechanised ploughing noted by Rasch et al. (2016), and an increase in reliance on stores for commercial alternatives suggested by D'Haese and Van Huylenbroeck (2005).

With almost all households owning chickens and ranked within the top few positions of frequency of output use, poultry occupied a unique position as they were not labour intensive, and as suggested by Mwale and Masika (2009) could be kept as a side line enterprise and required fewer land resources. Although the value of poultry outputs was less than other livestock types across sites, egg collection and slaughter for meat generation were consistently used by more than two-thirds of poultry owning households, a much greater percentage than any other livestock output. The role of these outputs amongst rural inhabitants has frequently been observed, such as in the central highlands of Ethiopia (Dessie and Ogle, 2001) and the Zhombe communal area of Zimbabwe (Mlambo et al., 2011). Further, poultry often plays a significant role amongst females in households, who were seen as responsible for their care and survival, and therefore provides direct access to cash amongst women in cash-strapped periods,  a function reported by Mwale and Masika (2009) in Centane District of the Eastern Cape province.

The average flock size was less than those observed in other communal areas in South Africa such as 22 in Limpopo and 28 per household in KwaZulu-Natal (Malatji et al., 2016). This could be linked to poultry-related EDS, such as chicken disease and large birds of prey snatching chicks, which were identified as the most frequently occurring EDS and affected the flocks of the greatest proportion of village residents. Both poultry-related EDS are ubiquitous and have been reported across the Eastern Cape and in other regions of the globe. For example, Mwale and Masika (2009) in the Cantane District of the Eastern Cape, report that 23% of households regard predation by hawks and eagles to be more of a problem than parasites/disease. The degree of loss to birds of prey is highlighted elsewhere, for example Zuluaga and Echeverry-Galvis (2016) report that 57% of households claimed to suffer losing 1.3 chickens per annum to a large bird of prey in the eastern Andes of Columbia, and Biswas et al. (2008) reported losses of 211 chicks to eagles across 600 smallholder households in Bangladesh. The degree of loss in this study is particularly severe with approximately 163 chicks lost per owner household per annum, representing economic losses of R5 727, almost three times the value of the consumptive outputs harnessed by chick owning households, or up to 30% of the potential economic value of poultry.

Although livestock and poultry numbers fluctuate at both a household and village level, respondents stated that over the last few decades the herd and flock sizes of livestock and poultry in each study site have declined. Decreasing livestock numbers have been noted elsewhere in the country such as by Bennett and Lent (2007) and Hebinck et al. (2018), who relate the decline in herd size between 1938 and 2010 in Guquka and Koloni in the central Eastern Cape, to a mix of factors such as implementation of state imposed regulations of livestock herd sizes such as Betterment Planning, theft, disease, drought, economic hardships and wool marketing problems. In this study, the decline in herd/flock numbers ranged from -12% in goats to -48% amongst poultry in a single year, a direct result of the interplay of a mix of social, economic and environmental factors. These include the absence of shepherds which allows for ruminants to wander into neighbouring villages or become ill without the owner treating the issue during the initial stages, the recent introduction of the bont tick coupled with the deterioration of the state dipping facilities which has seen the rise of tick-borne disease, changes in frequency of rangeland burning which was perceived to affect the quality of pasture and the rapid spread of chicken disease between households - possibly the result of homestead proximity.

As a result, the maximum potential value in terms of goods and service generation and wealth creation from livestock and poultry was not realised, as production and herd/flock growth were constrained by multiple EDS. Moreover, in some cases, livelihood vulnerability was further exacerbated in an attempt to prevent losses, as households were forced to direct cash resources from household expenditure towards preventative treatments or post-hoc management of damage.

Livestock-related EDS were not unique and have been highlighted in varying severities in multiple studies across South Africa. A particular challenge to the success of animal husbandry in this study were ticks, primarily the South African Bont tick, which has been well-documented as one of the major constraints to smallholder livestock production in communal areas across southern Africa (Sungirai et al., 2016, Wesonga et al., 2010) and South Africa (Getchell et al., 2002, Hesterberg et al., 2007, Mapiliyao et al., 2012, Mapiye et al., 2009, Masika et al., 1997, Moyo and Masika, 2009, Nqeno et al., 2011). Although present in all ruminants, ticks were considered to be a major problem in cattle, and less so in goats and sheep, not only because they transmitted debilitating diseases, such as gallsickness, heartwater and redwater, but also because heavy tick-loads damaged the reproductive capacity of cows by damaging their urinary tracts, udders and teats. Teat damage results in cows failing to produce milk and as a result calves do not get the colostrum necessary for immunity (Moyo and Masika, 2009). Other than increasing mortality rates, animals infected by diseases, whether overtly or sub-clinically, exhibit greater morbidity, are listless and therefore both less productive and less fertile (Minjauw and McLeod, 2003). The Eastern Cape in particular is acknowledged to suffer virulent tick-borne diseases, with Masika et al. (1997) reporting tick-borne disease as the most common cause of death in livestock in the region after malnutrition. The high temperature and humidity prevalent in the Eastern Cape are favourable for the growth of tick species especially during the wet season (Marufu et al., 2010, Muchenje et al., 2008).

Tick-borne diseases were of economic significance, responsible for devastating levels of loss. The greatest financial loss by tick-related deaths occurred in Gogogo and Ludaka, amongst cattle owning households, who lost five and four cattle in their herd, respectively, between 2015 and 2016. Although the economic value of losses was not particularly high, representing losses of between 7% in Gogogo and 20% in Ludaka of the potential value of goods and services, the death of beasts totalled approximately R50 000, the value of approximately half of the current cattle herd size. This undermines the savings function that cattle provide.

Livestock owners were alert to the quality of pastures and the nutritional value to livestock. Much of the rangeland was dominated by *A. junciformis*, an unpalatable species frequently highlighted by villagers to provide few nutrients to livestock and to cause teeth damage. The poor nutrition also decreased overall animal health making them more prone to other EDS (e.g. ticks). Poor quality rangelands is a common challenge in the communal areas of South Africa (Mngomezulu, 2010, Raats, 1999), reported by Sigwela et al. (2017) where residents, in a communal area in a different region of the Transkei, identified grassland in poor condition as an EDS, as it was dry and unproductive and did not provide food for livestock. Further change in grass species composition, invasion of rangeland and poor quality of forage were all identified as indicators of rangeland degradation, identified as a primary constraint to livestock production in Tsengiwe village, a rural settlement in the Eastern Cape province (Beyene et al., 2014). The perceived increase in unpalatable grasslands was associated with pervasive burning of grasslands by livestock owners in the past, which no longer occurs, to maintain young, palatable swards and to remove ticks which bred in the old grass. This is supported by Kepe (2005) not far from this study. In this sense burning acted as a management tool for ticks and to promote younger grass shoots, but was also perceived to promote the spread of an unwanted grassland species, which according to the youth in Ludaka, will be a primary reason for lack of cattle ownership in the future.

The implementation of mechanisms to prevent livestock and poultry-related EDS are noted elsewhere and include the treatment of chicken disease through ethno-veterinary controls such as *Aloe sp.* (Mwale and Masika, 2009) and use of traditional plants or biomedical products for tick control (Brown et al., 2013, Hesterberg et al., 2007, Hlatshwayo and Mbati, 2005, Moyo and Masika, 2009). Yet, in this study livestock and poultry-related EDS persisted. This was also often at substantial cost to the household. For example, prevention or treatment of tick-borne disease amongst cattle ranged from R550 per household in Njlea to R1 075 per household per annum in Gogogo. Further, this study highlighted that the effects of livestock-related EDS were linked to or exacerbated by the breakdown or change in institutional arrangements at varying scales – for example the disintegration of the state dipping system which was initiated in the early 20th century after the spread of East Coast fever and saw the construction of many dip tanks and the implementation of a large-scale compulsory dipping system. However, since the change in government in 1994, provincial governments have been responsible for overseeing veterinary services, who, faced with budgetary constraints, deprioritised tick control and devolved the husbandry of livestock and disease management to owners (Brown et al., 2013, Hesterberg et al., 2007, Hlatshwayo and Mbati, 2005). Other institutional changes include the breakdown of cattle committees responsible for burning the grass to control ticks, and households no longer retrieving livestock at night, which makes it difficult for smallholder livestock owners to appraise their cattle more frequently. Further, a change in cultivation patterns and increase in field abandonment has given rise to the rapid spread of woody plant species, limiting the areas that livestock are able to graze.

## 4.4 Conclusion

Low-input, small-scale livestock husbandry and poultry ownership was a common feature across the study sites, actively pursued by more than half of the households in each village as a means of subsistence or financial buffering during unfavourable times. The annual value of livestock and poultry goods and services per owner household was substantial, at approximately R2 257 in Njela, R4 866 in Gogogo, and R9 457 in Ludaka. Although the role and value of livestock in rural livelihoods has been widely cited, there is notably little recognition and valuation of livestock-related EDS in parallel to their value. The presented results highlight that each livestock type was affected by at least one EDS, undermining herd growth and limiting production of goods and services. These EDS represent losses of between 7% and 40% of the potential economic value of consumptive outputs of livestock. In many instances, the effect of EDS on ES was aided through the collapse of various institutional arrangements. Therefore, this study provides a more balanced appraisal as it details the factors which limit livestock production, and the economic value of the resulting incurred losses, alongside estimations of the goods and services livestock generate.

# CHAPTER FIVE: NON-TIMBER FOREST PRODUCTS COLLECTION

## 5.1 Introduction

A range of biological products, harvested directly from the wild, are widely used amongst the rural communities of southern Africa (Campbell et al., 1997, Mutenje et al., 2010, Shackleton et al., 2007a). This is mirrored globally, with an estimated 350 million people, largely in developing countries, dependent on these resources to fulfil several livelihood requirements which contribute to livelihood security and welfare (FAO., 2005, UNDP., 2004). These products are referred to as NTFPs and include all biological products, except for commercial timber, that are extracted from all natural terrestrial or marine habitats or modified systems, for local consumptive and non-consumptive uses (Shackleton, 2015, Shackleton et al., 2011a). This study recognises marine resources as NTFPS, like other studies such as Gosling et al. (2017) who include aquatic resources from wetlands and streams as NTFPs in their study in the Bigodi Wetland Sanctuary in Uganda and Shackleton et al. (2007b) who recognise marine resources as NTFPs in a study conducted in a different part of the Transkei.

Since the potential role and value of NTFPs was first revealed in the 1980s (Peters et al., 1989), NTFPs have garnered considerable attention in research, practice and policy across multiple disciplines such as conservation, economics, forestry, anthropology, and livelihood studies (Arnold and Ruiz Perez, 2001, Cocks and Wiersum, 2003, Kaimowitz, 2003, Shackleton and Shackleton, 2004, Sunderlin et al., 2005, Ticktin, 2004, World Bank, 2002). Work within the latter has been particularly important in understanding the socio-ecological dynamics of the lives of rural dwellers and has revealed multiple ways in which NTFPs benefit livelihoods (Dovie et al., 2005, Shackleton et al., 2007a, Vedeld et al., 2004). This includes recognition that the sustainable use of NTFPs offers significant returns (e.g. direct-use, indirect-use, cash income, safety net) and hence a dual contribution to livelihoods and conservation goals.

One of these returns includes the ordinary daily use of NTFPs to support current consumption or to meet a household’s subsistence needs. This may take the form of seasonal gap-filling or regular direct subsistence use, each of which assist households, particularly the poorest, from falling deeper into poverty (Rueff et al., 2009, Shackleton et al., 2008). Regular subsistence use extends further than the mere consumptive value as free access to NTFPs provides a cost saving function to the household and allows cash to be redirected to goods and services that require capital, such as school fees or purchasing agricultural inputs (Shackleton and Shackleton, 2004).

Although the bulk of NTFPs collected by households tend to be for direct consumption, the sale of NTFPs also provides an important means for some rural individuals and households to generate cash income (Shackleton et al., 2007c). A diverse range of NTFPs are sold, in raw form or after some value-added process, and are marketed primarily in local or regional markets (Scherr et al., 2004). The trade of NTFPs is growing with more people taking advantage of the low entry barriers and the opportunity to generate cash incomes, particularly during periods of income shortage (Shackleton and Shackleton, 2004). For example, the sale of marula beer in Limpopo, South Africa, generated a modest income but came at an important time of year where there was high demand for cash for school fees, books and uniforms (Shackleton and Shackleton, 2004). Similarly, Mjoli and Shackleton (2015), investigating the trade of palm frond hand brushes on the Wild Coast, South Africa, found that although income from trade was modest, it was still rated highly by traders for which it represented the second-most important source of cash income.

Another function of NTFPs is as a safety net or a form of self-insurance as NTFPs may act as a coping mechanism to mitigate unexpected shocks such as drought, income shortfalls or death of a family member (McSweeny, 2005, Mugido and Shackleton, 2017, Paumgarten, 2005). In these cases, NTFPs may be used until the shock has passed or the household has modified their livelihoods to adapt to it (Wunder et al., 2014). The value of NTFPs as safety nets was illustrated by Hunter et al. (2011) who, in examining household strategies following recent adult mortality, found higher dependence on natural resources such as fuelwood and water. Not only are the tangible benefits to rural communities important, but so too are in the indirect benefits (such as cultural sites and species and aesthetic benefits) (Cocks and Wiersum, 2003). While recognising the range of NTFP functions and their invaluable contributions to livelihoods, this chapter focuses solely on the first two returns in its investigation of the subsistence use and trade of NTFPs in rural livelihoods in the Transkei.

Over the last decade or so there has been considerable research effort to quantify the role of NTFPs in livelihoods as a means of measuring the contribution of NTFPs in rural livelihoods and the extent of the dependency of rural people on these resources. Moreover, quantification sheds light on the severity of potential loss should local ecosystems become degraded through overexploitation or transformation. Several potential measures that demonstrate the value of NTFPs in household provisioning have been developed. These range from the number of calories or nutrients provided, the number of days of ill health avoided by the use of medicinal plants, the rate of extraction of specific species, to replacement values if the equivalent goods had to be purchased elsewhere (Shackleton, 2015). More recently, econometric figures have held sway (Angelsen et al., 2014). These determine the monetary value of resources used over a defined time period and are expressed in absolute terms as well as a percentage of all income streams in the household. However, the nature and the magnitude of the contribution varies spatially and temporally (Angelsen et al., 2014, Shackleton and Shackleton, 2006). For instance, in northwest South Africa, Thondhlana et al. (2012) report the contribution of NTFPs to rural household income to be less than 10% while in other areas of the continent Mutumba (2013), reports >45% contribution. This may be related to a range of contextual factors such as proximity to markets, diversity of resources available, viability of alternative livelihood (such as livestock husbandry or farming), biodiversity of the region or abundance of key resources, etc.  Individual NTFP values at the household level can be aggregated across villages or regions. For example, Schaafsma et al. (2014) reported that the annual total value of four NTFPs (fuelwood, charcoal, poles and thatch) amounted to US$ 42 million in the Eastern Arc Mountains region in Tanzania. These aggregate numbers are useful in communicating the value associated with the direct-use value of NTFPs to policy makers and planners.

Despite the role and value of NTFPs in rural households increasingly being acknowledged, few have considered the threats or EDS which effect the yield or harvest of NTFPs, the loss of which may require significant changes to livelihoods to cope and adapt (Ninan and Inoue, 2013, Ninan and Kontoleon, 2016). Amongst the available literature, EDS which originate from forests and affect other livelihood options dominate, such as Bandara and Tisdell (2002) who explore levels of crop depredation by elephants in rural Sri Lanka, while no literature considers a wider range of EDS which directly affect access to particular NTFPs. Therefore, this chapter seeks to identify the full range of NTFP-related EDS as well as position them alongside the contributions of NTFPs. This will generate a more balanced picture of both NTFP-related ES and EDS in rural livelihoods.

## 5.2 Results

This section consists of two parts: the first details the range of NTFPs (terrestrial and marine), the extent of their use, and their mean, annual, direct-use and trade contributions to household income. In these sections, resources directly collected by members of the household between 2015 and 2016 were considered, and those purchased or gifted from other households were not included in calculations. Apart from grass brushes, the value of the raw material rather than the processed product was noted. The second section details EDS which affect NTFPs supply or value.

5.2.1 Range and extent of use of NTFPs from local environments

Across the sample, NTFP use was a common activity with all households in Njela, 95% of households in Gogogo and 63% of households in Ludaka, harvesting at least one NTFP product per annum. Although use of NTFPs was widespread, the number of NTFPs procured per household varied between villages. This was largely associated with location and proximity of the village to NTFP-rich habitats. For example, in Njela, which was closer to coastal, woodland and grassland habitats, an average of 9±4 NTFPs were harvested per household (this includes coastal NTFPs). In contrast, Gogogo and Ludaka, which had immediate access to fewer habitat types, collected 5±3 and 0.9±0.8 NTFPs per household, respectively.

Patterns of resource use were similar in Njela and Gogogo. The most widely used terrestrial NTFPs, fuelwood, indigenous poles, thatch grass and wild fruits, were collected by more than half of respondents in these sites (Table 5.1). Ranking exercises in these villages also emphasised the frequent collection of other products such as medicinal plants and wild herbs. The least collected resources were bushmeat, palm fronds, wooden utensils and wild honey. In Ludaka, only two NTFPs, namely grass hand-brushes and thatch grass were collected by <50% of households and therefore the following sections report on NTFPs in Njela and Gogogo only.

Fuelwood dominated in terms of frequency of collection and amount harvested. On average, two head-loads of fuelwood were collected twice a week by 97% of households in Njela and 83% in Gogogo. Residents believed that the availability of fuelwood in each village had not changed over the last 50 years and related this to the rapid re-establishment of *V. karroo* (*Umga*) in old field sites. This meant that women did not have to walk far to collect fuelwood. *V. karroo* was unanimously identified as the preferred fuelwood species because “it is strong, burns for a long time and is easy to access”. Despite the continuous use and availability of fuelwood, there was a perceived decline in reliance on fuelwood since the 1950s. This was explained in focus group discussions as a consequence of the introduction of paraffin into the area in the 1970s, gas in the 1980s, electricity in the 1990s and inter-generational changes such as young girls currently being unwilling to collect fuelwood and live an “out-dated” way of life. This was despite the association of fuelwood collection as a qualifying factor of a traditional isiXhosa female. Nevertheless, fuelwood was identified as the main source of energy for heating and cooking heavy meals such as pap and samp and for use in traditional ceremonies. The sale of fuelwood also represented an important source of income to some households, particularly in Gogogo, which was conveniently placed along the main road to villages without local fuelwood sources, such as Ludaka.

Although ranking exercises highlighted that thatch grass and indigenous poles were collected less frequently than other NTFPs, each was collected in large quantities in Njela and Gogogo i.e. >200 bundles of thatch grass as roofing material and >35 indigenous poles per household per annum (Table 5.2). Indigenous poles collected from local communal forests were primarily used for fencing and *kraals*, while poles for the construction of permanent structures in the homestead were purchased from government plantations. Although the collection of these resources was largely to meet direct household needs, some households also reported collecting excess for local trade. For a few households, trade was relatively undeveloped, and occurred on an *ad hoc* basis or on demand from a specific customer to supplement disposable income during times of need. However, in other cases trade was well developed in that a large proportion of households were selling, or a specific household regularly sold a specific resource. In these cases, trade often represented the primary cash generating livelihood activity.

The collection of medicinal plants was observed but not quantified. Focus group participants explained that small quantities of medicinal plants were collected when needed. Although wild fruit was reported to be collected opportunistically by women undertaking household chores, such as collecting fuelwood, household survey questions surrounding the quantification of wild fruits were always re-directed by the head of the household to children as they were considered the primary consumers. A few handfuls of various wild fruit, including *intongwane*, *ingwenya* (*Harpephyllum caffrum*), *mbombo* (*Caesalpinia decapetala*) and *amaqanube* were collected in season en route to school. However, thin lines in the seasonal calendar (Table 5.3) indicate that they were collected in small quantities in comparison to other NTFPs such as fuelwood and poles. Trendline and timeline exercises indicated that there was little change in use or harvest of NTFPs over time.

All indigenous forests and communal lands were under customary tenure. This allowed residents to freely collect natural resources within the confines of their village, but the collection of resources in spaces outside of their village required a small fee payable to the traditional leadership of the area. Traditional leadership were identified in focus group discussions as responsible for the management of natural resources. Yet, other than the management of the period over which thatch grass could be collected, it was evident that it lacked relevant expertise or financial resources for natural resource management activities.

Table 5.1: Prevalence of use (% of households) and average annual contribution of NTFPs to rural households (self-collected use)

| Resources | | Njela | | Gogogo | | Ludaka | | Av. annual direct-use and traded value per user HH across villages (R/yr) | Av. annual direct-use and traded value in all HH across villages (R/yr) |
|---|---|---|---|---|---|---|---|---|---|
| | | % of HH | Av. annual direct-use and traded value per user HH (R/yr) | % of HH | Av. annual direct-use and traded value per user HH (R/yr) | % of HH | Av. annual direct-use and traded value per user HH (R/yr) | | |
| Bushmeat | | 11 | 3 052±3 496 | 8 | 5 933±3 754 | 0 | - | 4 287±3 630 | 216±1 240 |
| Fuelwood | | 97 | 3 744±3 404 | 83 | 8 807±8 296 | 0 | - | 6 238±6 759 | 3 635±5 999 |
| Grass hand-brushes | | 51 | 53±77 | 45 | 53±77 | 48 | 356±599 | 158±380 | 76±273 |
| Marine resources[2] | | 83 | 37 407±33 559 | 0 | - | 0 | - | - | - |
| Mushrooms | | 34 | 50±166 | 63 | 52±58 | 0 | - | 51±79 | 16±50 |
| Palm fronds | | 14 | 1 534±2 146 | 5 | 1 030±1 371 | 0 | - | 1 390±1 856 | 84±541 |
| Poles (fence) | | 66 | 2 532±7 837 | 60 | 566±581 | 0 | - | 1 573±5 645 | 588±3 511 |
| Wooden utensils | Fighting[1] | 0 | - | 18 | 1 376±3 029 | 0 | - | 1 376±3 029 | 84±770 |
| | Stirring[1] | 0 | - | 8 | 5 016±8 646 | 0 | - | 5 016±8 646 | 131±1 399 |
| | Tool handles | 0 | - | 35 | 895±3 024 | 0 | - | 895±3 024 | 109±1 063 |
| | Walking[1] | 13 | 290±529 | 8 | 5 591±6 760 | 0 | - | 2 058±4 316 | 161±1 270 |
| Thatch grass | | 69 | 2 749±5 128 | 40 | 13 044±17 847 | 38 | 1 017±1 506 | 5 510±11 536 | 2 779±8 614 |
| Weaving reeds | | 34 | 862±1 107 | 40 | 991±1 388 | 0 | - | 926±1 237 | 258±768 |
| Wild fruits | | 77 | 374±437 | 68 | 130±154 | 0 | - | 252±347 | 118±268 |
| Wild honey | | 8 | 850±1 227 | 10 | 812±1 130 | 0 | - | 829±1 068 | 50±316 |
| Wild herbs | | 40 | 240±130 | 25 | 209±128 | 0 | - | 228±128 | 47±109 |

1. **Av. direct-use value per user HH (R/yr): a) Njela: 39 843±38 802; b) Gogogo: 16 796±19 702; c) Ludaka: 1 573±2 894**
2. **Av. direct-use value across all HH (R/yr): a) Njela: 39 843±38 802; b) Gogogo: 15 956±19 545; c) Ludaka: 983±2 398**

[1] High trade by a few individuals [2] Details of marine resources in Table 5.5

Table 5.2: Focus group ranking (in descending order) to frequency and amount of NTFPs collected in Njela and Gogogo

| Rank | Njela | Gogogo |
|---|---|---|
| **Frequency of collection (most to least)** | | |
| 1 | Fuelwood | Fuelwood |
| 2 | Medicinal plants | Medicinal plants |
| 3 | Wild fruit and wild herbs | Wild herbs |
| 4 | Walking/fighting/stirring sticks | Bushmeat |
| 5 | Thatch | Wild fruit |
| 6 | Poles (fencing) | Thatch |
| 7 | Bushmeat | Walking/fighting/stirring sticks |
| 8 | Wild honey | Palm fronds |
| 9 | | Wild honey |
| 10 | | Poles (fencing) |
| **Amount collected (biggest to smallest)** | | |
| 1 | Fuelwood | Fuelwood |
| 2 | Poles (fencing) | Poles (fencing, *kraal*) |
| 3 | Thatch | Thatch |
| 4 | Wild herbs | Medicinal plants |
| 5 | Walking/fighting /stirring sticks | Walking/fighting /stirring sticks |
| 6 | Medicinal plants | Wild fruit |
| 7 | Wild honey | Wild honey |
| 8 | Bushmeat | Wild herbs |
| 9 | | Medicinal plants |
| 10 | | Palm fronds |

Table 5.3: Seasonal calendar of selected NTFPs in Njela and Gogogo

| **NTFP** | **Summer** | | | | | | **Winter** | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Nov** | **Dec** | **Jan** | **Feb** | **March** | **April** | **May** | **June** | **July** | **Aug** | **Sept** | **Oct** |
| Bushmeat | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Fuelwood | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Med Plants | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Poles | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |
| Wild fruit: *Amaqunube* | | ■ | ■ | ■ | ■ | ■ | | | | | | |
| *Mbombo* | | | | | | | | ■ | ■ | | | |
| *Intongwane* and *Ingwenya* | | | | | ■ | | | | | | | |
| Wild honey | | | | | | | ■ | ■ | ■ | ■ | ■ | ■ |
| Wild herbs (from forest) | ■ | ■ | ■ | ■ | ■ | ■ | | | | | | |

5.2.2 Proportion of households in Njela using a range of marine NTFPs

The collection of marine provisioning services in Njela was pervasive, with 83% of respondents harvesting at least one marine resource in the last year. Fishing and related activities were a small-scale, artisanal operation for substance use or local-level trade. Fishing and harvesting activities took place within a 1.4 km radius from the village, in most cases using simple, traditional fishing gear. Some residents had access to professional crayfishing gear which was provided by a local business who later purchased the catch for sale in the nearby town. Fishers did not have access to any vessel and were limited to fishing along the shore. Artisanal fishing was dominated by men, while women gleaned the intertidal zone for edible shellfish and other marine products. According to villagers, marine systems were an open access regime with no effective controls, and outside of specific crayfish regulations (season, size and quantity of crayfish per day) which were infrequently monitored, anyone who wanted to harvest marine resources could do so wherever and whenever they wanted.

Crayfish, mussels and fish were ranked as the most frequently collected marine products as well as being collected in the largest quantities (Table 5.4). This accorded with household surveys which highlighted that 71% of households harvested an average of six crayfish three times a week and 12 litres of mussels twice a week. Forty-five percent of households caught an average of three fish, twice a week. Other marine resources such as red bait, limpets and octopus were collected by >50% of respondents as bait for fishing and crayfish activities, while oysters were collected by 20% of households primarily for sale at privately owned cottages nearby.

Table 5.4: Focus group ranking (in descending order) of frequency of collection and amount of marine provisioning services in Njela

| Rank | Frequency of collection | Amount collected |
|---|---|---|
| 1 | Crayfish | Mussels |
| 2 | Mussels | Crayfish |
| 3 | Fish | Fish |
| 4 | Red bait | Oysters |
| 5 | Limpets | Red bait |
| 6 | Oysters | Limpets |
| 7 | Octopus | Octopus |

5.2.3 Gross direct-use and traded values of NTFPs to households

In this study, direct-use and trade values are reflected as a combined figure. There was a significant difference in the yearly NTFP values amongst user households between villages ($H=62.8$, $p<0.001$), with the highest value in Njela (R39 843±38 802) and less than half the value in Gogogo (R16 796±19 702). The greatest significant difference was found between Njela and Ludaka, which had a direct-use value of R1 573±2 894 per annum. This was a reflection of the contribution of marine resources, which yielded a mean annual value of R30 994±33 646 in each Njela household (Table 5.5), representing 60±33% of the total average, annual value of all NTFPs in Njela. When extrapolated across the whole village, consisting of 85 households (Stats SA, 2011), the estimated total value of marine resources for the entire village was R3 179 595 per year.

Mussels and fish were the highest contributors to the total value of marine products in Njela (mean R14 669±20 485 and R14 185±13 462 per user household, respectively). These were primarily for domestic consumption within the household, while crayfish, which contributed an average of R13 351±13 077 per year in user households (Table 5.5), were a highly traded marine resource.

Table 5.5: The prevalence of use (% of households) and the average annual value (R) of marine provisioning services to rural households (self-collected use only) in Njela

| Resource | Proportion (%) of HH | Av. annual direct-use and traded value per user HH (R/yr) | Av. annual direct-use and traded value across all HH (R/yr) |
|---|---|---|---|
| Crayfish | 71 | 13 351±13 077 | 9 536±12 654 |
| Fish | 45 | 14 185±13 462 | 6 485±11 695 |
| Limpets | 54 | 1 005±1 190 | 443±965 |
| Mussels | 71 | 14 669±20 485 | 11 113±18 854 |
| Red bait | 51 | 3 261±3 781 | 1 677±3 212 |
| Octopus | 57 | 1 347±1 526 | 884±1 415 |
| Oysters | 20 | 7 834±10 223 | 1 662±6 030 |
| **Av. direct-use value per: a) user HH (R/yr) 37 407±33 559; b) all HH (R/yr): 30 994±33 646** | | | |

A few terrestrial NTFP products also contributed disproportionally to the total NTFP value per household. For example, fuelwood, thatch grass and indigenous poles, represented 78% of the total terrestrial NTFP value amongst all households (user and non-users) in Njela (Table 5.6). Corresponding cumulative figures contributed 82% in Gogogo. Although widely used in each village, the remaining NTFPs represented very low income contributions to the household. This may be due to infrequency of collection, and/or low local prices.

The mean direct-use value of the three highest contributing terrestrial NTFPs, fuelwood, thatch grass and bushmeat, were more than double the value in Gogogo than in Njela (Table 5.1). This was likely a reflection of both unit price and quantity consumed, as for some NTFPs the range in prices between villages was larger than the quantities consumed and vice versa. For example, the average price of a fuelwood load in Njela was R27 in comparison to R50 a load in Gogogo. In contrast, thatch bundle prices were similar but the average number of bundles collected differed at 101 and 387 bundles per household per annum in Njela and Gogogo, respectively. The majority of other NTFPs provided similar yearly income to households in Njela and Gogogo.

Table 5.6: Average proportional contribution of NTFPs to overall terrestrial NTFP value amongst all households (i.e. users and non-users) in Njela and Gogogo

| **NTFPs** | **Average % value** | | |
|---|---|---|---|
| | **Njela** | **Gogogo** | **Combined** |
| Fuelwood | 49±28 | 56±38 | 52±33 |
| Thatch grass | 18±20 | 22±34 | 20±28 |
| Poles (fence) | 11±20 | 4±6 | 7±15 |
| Weaving reeds | 5±8 | 5±17 | 5±13 |
| Wild fruit | 6±12 | 2±3 | 4±9 |
| Walking stick | 1±6 | 3±9 | 2±8 |
| Bushmeat | 2±9 | 1±4 | 1±7 |
| Fighting stick | 0±0 | 2±10 | 1±7 |
| Palm fronds | 2±9 | 0±1 | 1±6 |
| Wild herbs | 1±3 | 1±1 | 1±2 |
| Grass hand-brushes | 1±1 | 1±3 | 1±2 |
| Stirring stick | 0±0 | 1±6 | 1±5 |
| Wild honey | 1±5 | 0±1 | 1±4 |
| Tool handles | 0±0 | 1±4 | 1±9 |
| Mushrooms | 0±1 | 1±3 | 1±2 |

The range in gross, annual, direct-use values between user households within the sampled communities was large, from less than R60 per household per annum to almost R143 000. Households that harvested a wide number of NTFPs, for household consumption and/or trade, were among those with the largest average annual economic values (Njela: $R^2$=0.41, F=23.3, p<0.001; Gogogo: $R^2$=0.43, F=29.1, p<0.001) (Figure 5.1). For example, one household in Njela harvested 15 NTFPs (terrestrial and marine) with an approximate annual value of R142 922. Over 60% of this value was represented by marine NTFPs such as crayfish (which alone was valued at R48 372 per annum), fish and mussels. Amongst terrestrial NTFPs, poles dominated and contributed a cash equivalent of R37 056 through the collection of 1 500 poles per year valued at R25 each. In this household of eight persons the trade of crayfish and poles, represented the most important source of household income. Another household in Gogogo frequently harvested 14 types of NTFPs. In this household, collection of wood for walking, stirring and fighting sticks contributed R28 885 alone, followed by the harvest of wood for tool handles at R11 400 and thatch grass at R16 388 per annum. In this household, trade of various

NTFPs was identified as the primary source of income. The head of the household was responsible for the harvest, craft and sale of the various sticks, while his wife was responsible for thatch grass collection. Thatch grass was stored in a separate structure in the homestead, protected against the elements, and sold throughout the course of the year.

Conversely, households that receive little economic value from NTFPs collected few NTFP products infrequently. For example, one household in Gogogo, with a NTFP value of R60 per annum, collected a few handfuls of wild fruit, or made a stirring stick and two grass brushes per annum. This household was heavily dependent on social grants as ill health constrained the ability to collect NTFPs.

No significant relationship between wellbeing and total NTFP economic value ($R^2$=0.003; F=0.25; p=0.6) or the number of NTFPs per household was found in the two villages ($R^2$=0.001; F=0.14; p=0.7).

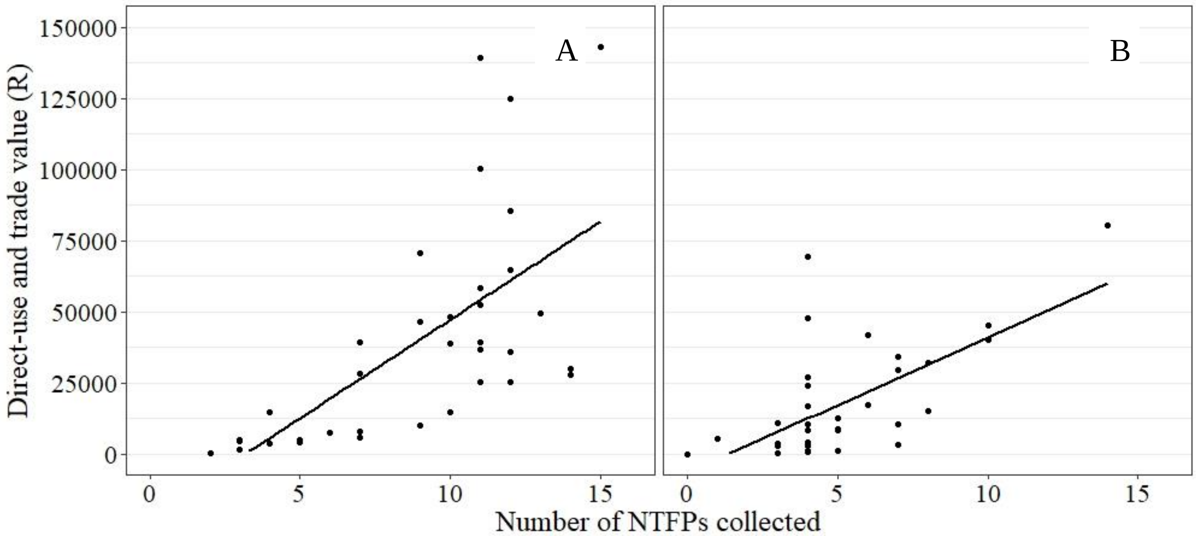



Figure 5.1: Regression indicating the number of NTFPs collected and corresponding direct-use and trade value (Rand) per household per annum in Njela (A), Gogogo (B)

### 5.2.4 Forest and marine related EDS

Ecosystem disservices which effected all NTFPs were considered mostly of a nuisance value and did not deter villagers from harvesting NTFPs. In most cases EDS had a minimal or insignificant effect on the household and consequently residents scarcely implemented management strategies to reduce the incidence or effect of EDS. Similar forest-related EDS were identified in each village and ranged from insects and thorny or stinging plants to larger mammals. This section presents EDS and associated management strategies in unison.

Interactions with insects, such as ants and caterpillars, thorny plants (*Caesalpinia decapetala* (*ubobo*)) and/or stinging plants (*Urtica dioica* (*umbabazane*)), occurred regularly but were associated with low levels of 'damage' such as skin irritation (Table 5.7). As a result, when collecting resources within forested areas, villagers wore long-sleeved clothing to prevent irritation. Snakes, spiders and bush pigs occurred less frequently but were associated with higher levels of risk and were perceived as harder to cope with (Table 5.7). In Gogogo, one elderly man described how, during his youth, he was bitten by a snake whilst on a hunting trip and consequently spent a month in hospital. Locals asserted the importance of bathing in diluted disinfectant, locally known as '*madubula*', which had a strong scent and was believed to repel snakes when in the forest. Others highlighted the importance of the *Ugwidi* bird, which announced the presence of a snake to villagers. Spider bite injuries were also common, especially amongst fuelwood collectors. One young lady in Njela recalled spending many hours in a clinic queue following a spider-bite injury. Recovery time was approximately two weeks during which she was unable to attend school or assist in household chores. However, focus group participants emphasised that these stories were uncommon and most participants had lived their entire lives without ill effects from snakes and spiders.

Of marine-related EDS, eels and sharks were associated with the most fear and severity (Table 5.8), particularly amongst crayfish divers. Although residents could not recall a shark attack, the frequent presence of sharks deterred crayfish divers from entering the water. This reduced the number of crayfish caught and subsequently cash income. The effect of eels on crayfish divers was widely known and residents recalled many occasions when crayfish divers returned to the village with the residue of eel poison in their hand which left them unable to dive for more than one month.

Due to the infrequent and often minimal effect of EDS on NTFPs and the fact these EDS effect the human rather than the ES, an economic figure representing the loss experienced by each household has not been calculated.

Table 5.7: Focus group ranking (in descending order) of forest-related EDS in Njela and Gogogo

| Rank | Njela | Gogogo |
|---|---|---|
| **Frequency of occurrence (highest to lowest)** | | |
| 1 | Mosquitos | Caterpillars |
| 2 | *Urtica dioica* and scorpions | Red ants |
| 3 | Wasps and caterpillars | *Umbabazane* |
| 4 | Snakes | Spiders |
| 5 | *Caesalpinia decapetala* | Mosquitos |
| 6 | Spiders and ants | Scorpions |
| 7 | Bees | Wasps |
| 8 | Bush pigs | *Utongothi* (*Maytenus sp*.) |
| 9 | | Bees |
| 10 | | Snakes |
| 11 | | *Gcamche* |
| 12 | | Bush pigs |
| **Severity (high to low)** | | |
| 1 | Snake, bush pigs, and spiders | Snake and bush pigs |
| 2 | Wasps, scorpions, caterpillars | Wasps, bees, spiders, scorpions |
| 3 | Mosquitos, ants, *Urtica dioica*, *Caesalpinia decapetala* and bees | Caterpillars, *Urtica dioica* and *gcamche* |
| 4 | | *Utongothi* |
| 5 | | Mosquitos and red ants |
| **Ability to cope (hardest to easiest)** | | |
| 1 | Bush pigs and snakes | Snakes and bush pigs |
| 2 | Wasps and bees | *Utongothi* and spiders |
| 3 | Spiders | Caterpillars, wasps, mosquitos, red ants, *Urtica dioica*, *gcamche*, bees, scorpions |
| 4 | Mosquitos | |
| 5 | Scorpions | |
| 6 | Caterpillars | |
| 7 | *Caesalpinia decapetala* and *Urtica dioica* | |

Table 5.8: Focus group ranking (in descending order) of marine-related EDS in Njela

| Rank | Frequency (most to least) | Severity (high to low) | Ability to cope (hardest to easiest) |
|---|---|---|---|
| 1 | Eels | Sharks | Sharks |
| 2 | Sea urchins | Eels | Eels |
| 3 | Sharks | Jellyfish | Jellyfish |
| 4 | Blue bottles | Sea urchins | Sea urchins |
| 5 | Jellyfish | Blue bottles | Blue bottles |

5.2.5 The number of ES and EDS along a biodiversity gradient

The number of NTFPs decreased along the biodiversity gradient, with Njela harvesting the greatest number of NTFPs and Ludaka harvesting the fewest (Figure 5.2). Similarly, the number of EDS decreased along the biodiversity gradient, with the greatest number of EDS in Njela, and none identified in Ludaka. The number of EDS per ES, was greatest in Njela (0.4), intermediate at Gogogo (0.3) and lowest in Ludaka (0). This fits Dunn's (2010) hypothesis that the number of EDS increases with the number of ES.

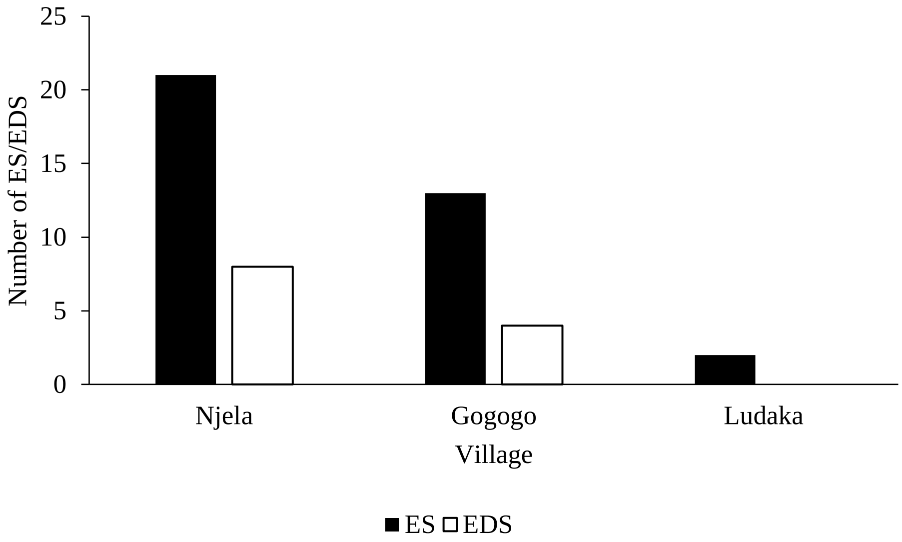



Figure 5.2: The total number of NTFP-related ES and EDS

## 5.3 Discussion

Non-timber forest products played a significant role in rural households in Njela and Gogogo, but to a limited extent in Ludaka. This was illustrated by the pervasive use of a wide range of NTFPs from communal indigenous forests and other natural, non-cultivated environments to fulfil several livelihood requirements, particularly direct household consumption and trade for the generation of cash income. The use and high value of NTFPs is a common feature amongst rural households and is highlighted by numerous other studies in the Eastern Cape (Shackleton et al., 2002a, Shackleton et al., 2007b), South Africa (Cocks and Wiersum, 2003, Dovie et al., 2002, Dovie et al., 2005, Mugido and Shackleton, 2017, Shackleton and Shackleton, 2004, Shackleton et al., 2002a, Shackleton et al., 2002b, Thondhlana et al., 2012, Twine et al., 2003) and further abroad (Fu et al., 2009, Kar and Jacobson, 2012, Schaafsma et al., 2014, Tesfaye et al., 2011). Most households in each village harvested at least one NTFP, but there was variation in the average number of resources harvested per household in each village. A greater number of NTFPs were harvested by residents in Njela, who had immediate access to a wider range of habitats, including key habitats such as marine ecosystems, than residents in the inland villages.

Most households (83%) in Njela were reliant on marine NTFPs in one way or another, with crayfish and mussels as the most widely harvested resources. This is comparable to Shackleton et al. (2007b) who reported widespread harvest (>85% of households) of marine resources, primarily mussels and fish, in Ntubeni, a coastal village approximately 85 km south of Njela. Apart from marine resources only immediately available to residents in Njela, patterns of resource use were similar in Njela and Gogogo. While in Ludaka, use of NTFPs was scant owing its location and the distance from woody areas and marine habitats. In Njela and Gogogo, fuelwood and wild fruits were among the most widely harvested resources. Widespread use of these resources is echoed in other studies in South Africa, for example: Twine et al. (2003) reported pervasive use of fuelwood and wild fruit by a mean of 97% and 95% of households, respectively, across three villages in Limpopo and Shackleton et al. (2002a) found a mean of 99% and 92% of households using fuelwood and wild fruit, respectively, in three villages in the Kat River, Eastern Cape. Similar proportions of fuelwood users were mirrored elsewhere in Africa, with 89% of rural households in villages in eastern Ethiopia (Asfaw et al., 2013). However, across these studies and elsewhere (e.g. Paumgarten and Shackleton, 2009, Shackleton and Shackleton, 2006, Shackleton et al., 2002b), a higher proportion of households (> 90%) harvested an abundance of other key resources such as wild herbs, wooden utensils, and grass hand brushes. In comparison, less than half of the households in this study harvested these resources. Differences in grass hand brush collection may be related to easily accessible local trade of grass hand brushes by individuals in each community and therefore few households were involved in the self-collection of materials to make grass brushes. This is supported by Shackleton and Campbell (2007) who note that grass hand brushes are amongst the most extensively traded natural product in South Africa. The increase in local markets and access to some household items that they would have formally made for themselves is explained by Shackleton et al. (2007c) who relate it to globalisation and modernisation, which has resulted in an increasing need for cash. Alternatively, fewer households involved in the harvest or construction of grass hand brushes or wooden utensils may be an indication of product specialisation, as households who indicated use or collection of these products usually collected the raw materials for these products in large quantities. This is corroborated by Wollenberg and Nawir (2005: 319) who, in investigating resin production in agroforests in Pesisir Sumatra, found that certain people developed their entire livelihood around this selected product. This was despite the value of the product appearing low, as households compensate for low unit value by increasing the quantity sold and benefitting from economies of scale.

Although many previous studies have shown the pervasive use of wild herbs in South Africa and neighbouring countries (e.g. Maroyi, 2011, Shackleton, 2003), it is likely that in this study, wild herbs were more readily and/or frequently harvested from home gardens than from nearby natural habitats. It is also likely that the use of some products, like wooden utensils, that have traditionally played a key role in livelihoods are diminishing and are being replaced by synthetic modern goods (plastic household utensils, furniture, etc.) (Shackleton et al., 2011b) and that the interest, knowledge and time required to make them is diminishing (de Vletter, 2001, Mutua et al., 2004). Conversely, despite broader shifts towards electricity-based energy and alternative construction materials, other NTFPs such as fuelwood and construction materials (indigenous poles and thatch), remained central to the livelihoods of the respondents in this study, with approximately two-thirds of households in Njela and Gogogo harvesting these resources.

The results indicate that the gross annual value of NTFPs consumed and traded by households varied with changing proximity to habitats. Similarly, households harvesting a greater number of NTFPs generally benefited from a greater direct-use and trade value. On average, NTFPs provided a gross, annual direct-use and trade income of R39 843±38 808 to all households (user and non-user) in Njela, and lower amounts in Gogogo (R15 956±19 545) and Ludaka (R983±2 398). Values in Njela and Gogogo were considerably higher than other areas in the Eastern Cape province with access to similar NTFPs as reported by Shackleton et al. (2007b) amounting to R24 066 and R9 181 in two coastal villages in the Transkei or savanna biomes reported by Shackleton et al. (2002a) in three villages in the Kat River which amounted to R5 987, R3 899, and R3 809. Similarly, these values exceed global averages of environmental income (natural forest and non-forest environmental) at R8 733 or the African average at R5 229 per annum (Angelsen et al., 2014). Values in Njela were 78% higher than global figures (because all these studies occurred over different time periods, values have been adjusted to a common year price).

A few possible explanations for higher values in this study exist. First, most studies that report on the value of natural resources consider the direct-use values as a single figure, whereas this study reports a cumulative figure of both direct-use and trade value. Naturally, this figure would be higher but in most cases NTFPs were consumed directly and only a few households were involved in trade which usually occurred on an *ad hoc* basis. Secondly, the high values in Njela are related to the high contribution (60% of total NTFP value) of marine products, as consequence of the high proportion of households (71%) involved in frequent crayfish harvesting. Local crayfish divers in Njela were the primary suppliers to a third-party company who distributed crayfish to restaurants in a nearby city centre. Divers described how they were heavily dependent on this trade for cash income to purchase daily necessities. Other marine products such as mussels, a common staple food, amounted to R11 113±18 854 per annum amongst all households. Few other NTFP studies in South Africa have been conducted at a coastal site and hence in areas where marine resources are used. This requires more studies to take place in coastal areas. This high variation between sites and studies emphasises the need for local level studies rather than value transfer from previous work.

In contrast, Ludaka had limited access to NTFPs due to the low habitat diversity of the area. Residents in Ludaka, with access to local grass species for grass hand-brush construction and thatch grass only, are potentially impoverished as they are forced to go without the NTFPs available in other villages or purchase the equivalent substitutes which may reduce cash resources. In the same way, if the abundance or supply of NTFPs in Njela and Gogogo is jeopardised, it could have measurable repercussions on the wellbeing of residents in these villages.

The three greatest terrestrial contributors to the total direct-use and trade values in Njela and Gogogo were fuelwood (52%), thatch grass (20%) and indigenous poles (7%). Together these resources accounted for 78% of the gross annual, direct-use and trade value in Njela and 82% of the value in Gogogo. These high proportional contributions are typical of previous studies both locally (Dovie et al., 2002, Paumgarten and Shackleton, 2009, Shackleton and Shackleton, 2004) and further afield (Babulo et al., 2009, Ngwenya and Hassan, 2005).

Relating the annual economic value of NTFPs used in Njela and Gogogo to other means of livelihood income provides deeper insight into their inherent value. One useful comparison is with other income sources in the household. For example, in many cases the state old age pension forms the backbone of the rural household cash economy across South Africa, providing the greatest source of cash income (Ranchhod, 2009). In this way, comparison of NTFP value to state pension values provides a useful yardstick. In Njela and Gogogo, households received a mean of 0.4 pensions, amounting to R640 per month or R7 680 per annum. This represents a mere 20% of the annual total mean direct-use and trade value of NTFPs in Njela and 50% in Gogogo.

Another useful comparison can be made with household expenditure on important goods and services. Maize meal is a staple food in each village, with households purchasing large bags every month instead of growing and grinding their own. A 50 kg bag of maize meal cost R332 in 2016, and would last the average household almost one month. This meant each household spent an average R3 984 on maize meal a year, which is 10% of the NTFP cash equivalent in Njela and 25% in Gogogo.

Therefore, this study complements a broader understanding of rural livelihoods in South Africa, where NTFPs contribute to livelihood security, especially amongst the poorest households, and in their absence, would find it difficult, if not impossible, to replace these inputs or direct household contributions from other sources. Although there was no significant difference found between the wellbeing score of residents and the number or value of NTFPs in this study, which may suggest that they help to maintain rather than increase wellbeing, previous studies provide substantial evidence that NTFPs are most important amongst poorer households (e.g. Paumgarten and Shackleton, 2009, Shackleton and Shackleton, 2006).

In this context, where NTFPs are invaluable to the rural households, EDS were largely perceived as nuisances and did not deter the harvest or use of NTFPs. Ecosystem disservices ranged from insects and thorny or stinging plants to larger mammals, and unlike EDS in other land-based livelihood options, affected those harvesting the NTFP rather than the NTFP itself. Few preventative or coping measures were in place, with households perceiving EDS as infrequent.

## 5.4 Conclusion

There is little doubt that NTFPs play a pivotal role in the lives of participants in this study, contributing to their nutritional, utilitarian, medicinal and cash income needs. The harvesting of NTFPs was pervasive in Njela and Gogogo, the residents of which had access to more biodiverse environments, in comparison to Ludaka, which was located further from a diversity of habitats, and where limited NTFPs were collected. The value of NTFPs was higher than previous studies in South Africa, and almost double the value in Njela than in Gogogo. These high economic values in both villages reflect local conditions of a closer proximity to key NTFP rich patches such as marine ecosystems and remoteness from market centres. Fuelwood and wild fruits were the most widely harvested terrestrial NTFPs, with the highest proportional economic contributions from fuelwood, indigenous poles and thatch grass. This is noteworthy, considering all villages have electricity and there is a trend towards use of alternative construction materials such as brick and zinc. Given the socio-economic context of the villages and the significant cash saving function, it is unlikely that the use of NTFPs will diminish in the near term or that regular harvest will be deterred by EDS.

# CHAPTER SIX: SYNTHESIS

Most ES studies are based on the implicit assumption that ecosystem outputs provide only benefits for humans. However, what this study has illustrated, through an empirical focus on land-based livelihoods along a biodiversity gradient in the Eastern Cape province, is that some ecosystem outputs also undermine livelihoods, in some cases counteracting the contributions of ES. Yet, rural dwellers, who are perhaps the most dependent on local ES and amongst those most vulnerable to EDS, continued to rely on ES and actively engaged in management and other strategies towards both ES and EDS. Thus, management and adaptive strategies were evident for both ES and EDS, despite most livelihoods and ES research focusing on means to optimise or maximise ES. This chapter collates and discusses pertinent themes in this study, along with suggestions for future research or key messages to policy makers discussed where appropriate.

Figure 6.1 links the objectives of this study (in squares), to the key themes discussed below (in circles). Broadly speaking, the objectives of this study sought to identify the range of ES and EDS (objective 1), while understanding their effects on human wellbeing (objective 2), their changes over time (objective 3), and the ways in which they influenced behaviour or livelihood strategies (objective 4). The vertical links from key themes to the corresponding objective also provide some logic to the order that this chapter is presented in with key themes grouped together. Further, links between key themes are illustrated by horizontal dashed loops, highlighting the complexity and dynamic feedbacks between key themes.

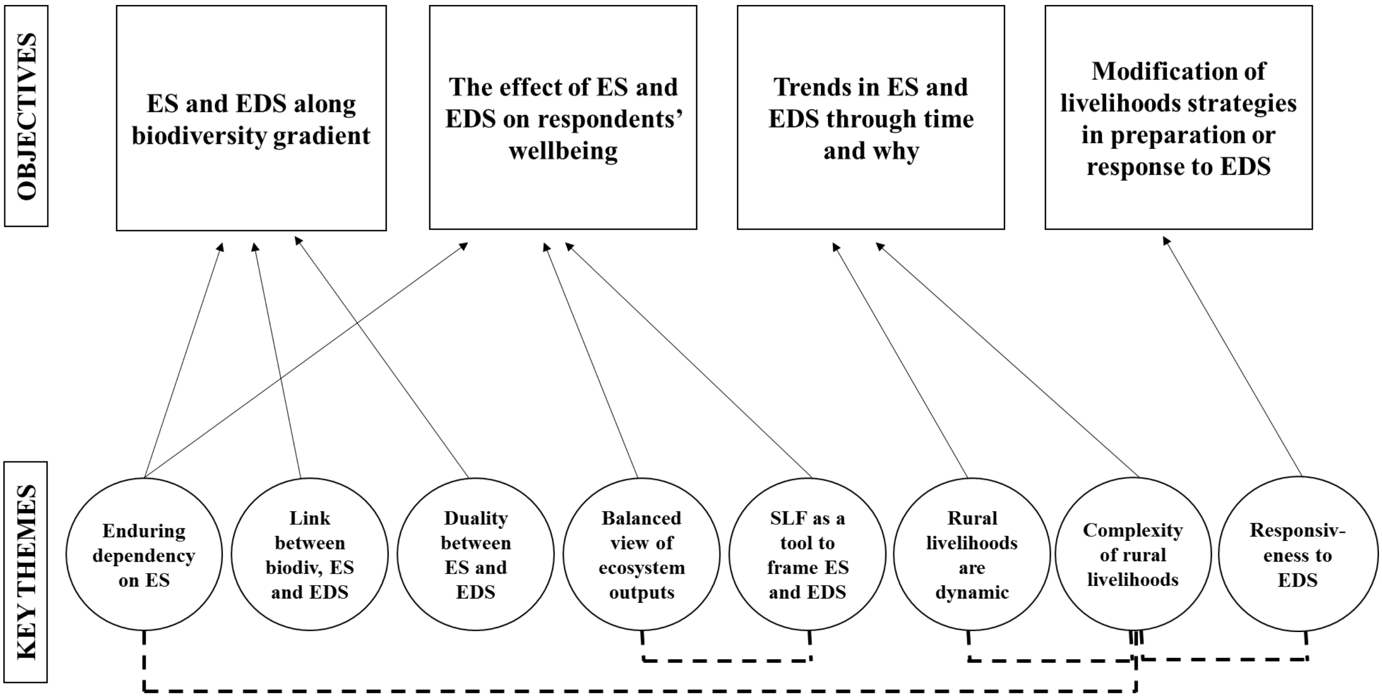



Figure 6.1: Links between key themes and objectives, and interconnections between key themes

## 6.1 Enduring dependency of rural livelihoods on local resources

Despite linkages to urban areas and a steadily increasing dependency on the formal economy, rural dwellers in this study relied on multiple ES from communal systems to fulfil a range of livelihood needs (Sections 3.2.1; 4.2.1; 5.2.1). The degree of use or dependency on each land-based livelihood sector differed across households and communities, determined by the availability, accessibility or proximity to local land-based resources, but also shaped by individual and household links to other livelihood assets and strategies. For instance, the close proximity to coastal zones in Njela, yielded a high reliance on marine resources (Section 5.2.2), while residents in Ludaka, primarily a grassland system, were largely involved in livestock husbandry (Section 4.2.1). The abundance of *V. karoo* encroaching on old fields in Gogogo together with its location along key road networks to neighbouring villages which had no or limited local fuelwood stocks in surrounding landscapes, saw the high involvement of Gogogo residents in fuelwood sales. In this way, land-based livelihoods were clearly shaped by what is locally available to residents. Yet, at a household level there was much variation within each community regarding who made use of which resources, how frequently, in what quantities and whether for home consumption or also for cash income generation through sale. Thus, there was marked evidence of a continuum of reliance from general use of multiple resources by an individual household through to specialist use of one or only a few especially for cash generation (such as selling of agricultural produce, crayfish or thatch grass).

Further, despite the context of increasing modernisation, the cash economy and urban-rural links, residents were still deeply connected to the land and regarded themselves as custodians of extensive land-based knowledge. This was clear through the proportion of households in each village that made use of NTFPs, held some livestock or cultivated crops (with many households doing all of these), as well as the value of the ES appropriated. Participation in land-based livelihoods was viewed, particularly amongst the older generations, as an essential component of rural life, with residents identifying livestock husbandry as an important contributing factor to human wellbeing and linking fuelwood collection as a qualifying factor to becoming a traditional isiXhosa female (Chapter 5.2.1). Whilst not deeply explored in this thesis, land is also revered as sites where ancestors are buried and also where present-day dwellers find means to communicate with their ancestors via sacred sites and traditional rituals (Cocks et al., 2012).

Despite the risks involved in reliance on the natural resource base and the pervasive EDS-induced losses across land-based livelihood sectors, villagers continued to rely on ES as an essential livelihood strategy and, in some cases, a buffer against unexpected shocks or stresses. Indeed, households with a higher economic value in the arable agriculture and livestock sectors enjoyed greater human wellbeing scores (Sections 3.2.1; Section 4.2.1).

This study therefore provides overwhelming evidence to policy makers and decision-makers, that despite participation in the formal economy, rural dwellers are still engaged, albeit to varying degrees, in land-based livelihoods (Sections 6.1, 6.6, 6.7, 6.8). It is therefore in their interest to support land-based livelihoods in varying forms and prevent degradation of land and resources. This may end up saving costs to the state as a healthy and productive environment, despite also providing EDS, supports the provision of goods and services which contribute towards meeting livelihood needs such as housing materials, provision of energy materials, and food, etc.

## 6.2 Links between biodiversity, ES and EDS

The intrinsic link between biodiversity and ES has been widely documented (Diaz et al., 2006), with a congruence between habitat diversity, an indicator of biodiversity, and the yield of a greater range and perhaps abundance of ES (Egoh et al., 2008). Through collecting data on a range of ES which support land-based livelihoods, across a gradient of habitat diversity, this study provided further insight into this. Supporting Dunn's (2010) hypothesis, it showed that areas of greater habitat diversity, like Njela, not only yield a greater number of ES but also more EDS, in comparison to areas located in lower habitat diversity, like Ludaka.

The number of locally identified ES exceeded the number of EDS reported in each land-based livelihood sector across the three villages (Figure 6.2). The number of EDS was greatest in the village with the greatest habitat diversity across each land-based livelihood sector, decreasing along the habitat biodiversity gradient, indicating that it had the greatest number of EDS per ES. However, the number of EDS alone did not necessarily coincide with the magnitude of the loss caused. Calculation of the economic value of potential goods and services lost due to EDS, revealed that a village with fewer EDS, could actually experience losses at a greater magnitude.

This study also found that the greatest economic losses due to EDS were highest amongst the managed or disturbed habitats, i.e. home gardens (Figure 3.5). In contrast, forests, as the least managed landscape, yielded the lowest EDS effects on livelihoods. This corroborates with Dunn (2010) who suggests that the conversion of natural habitats to managed habitats tends to increase EDS in terms of disease prevalence, and therefore ironically make habitats worse for humans in terms of their EDS (Schmidt and Osterfeld, 2001, Vanwambeke et al., 2007). The implications for policy and decision-makers is clear in that a one-sided focus on securing and promoting the contributions of ES to livelihoods and human wellbeing is short-sighted without a clear understanding of how that may alter the variety, frequency or magnitude of EDS and peoples' ability to manage them.

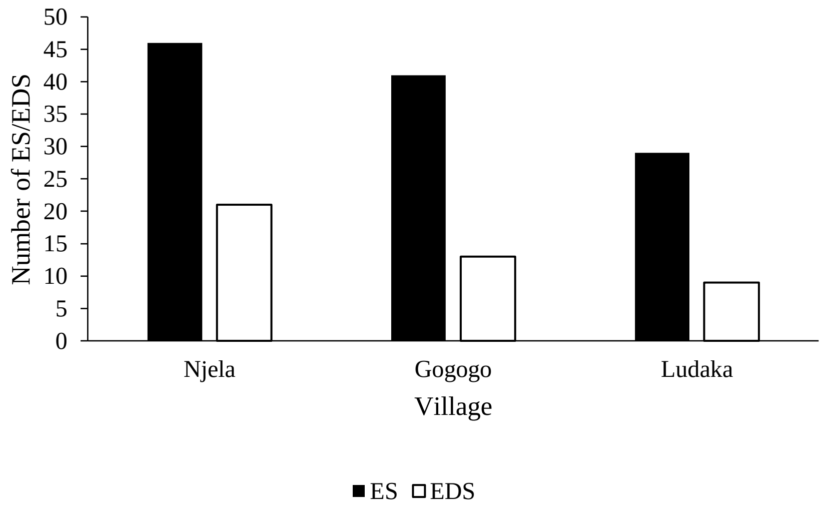



Figure 6.2: The total number of land-based livelihood ES and EDS in each village

## 6.3 Duality between ES and EDS

Although ecosystem functions and attributes are derived from ecological processes, the perceived positive or negative effects are mediated by a set of interconnected factors originating within social and ecological dimensions. The same ecosystem function can be regarded as either an ES or an EDS depending on the point of view of the individual or group considered, and the space and time (Saunders and Luck, 2016, Shackleton et al., 2016, Vang Rasmussen et al., 2017, Vaz et al., 2017). This was evident in the varied perceptions surrounding *L. camara* (Section 4.2.2). For example, one sector of the community, the youth, considered the species as an ES, valued for its aesthetics and the production of seasonal berries. However, other groups, such as cultivators or those involved in livestock husbandry, considered *L. camara* as an EDS, as it encroached into cultivated plots and rangelands and limited production. In this way, perceptions of ecosystem outputs were shaped by perspectives and experiences of the viewer, as the youth, who were not regularly involved in cultivation or livestock husbandry, did not associate *L. camara* with the negative effects that those directly involved with such livelihoods activities perceived.

In some cases, the same ecosystem function or species were perceived by the same individual or group to simultaneously provide ES and EDS at different times (Lele et al., 2013). For example, *V. karroo* established on old fields was considered by some as an ES, through the provision of fuelwood (Section 5.2.1), but also an EDS, as the prolific growth on old fields was considered to foreclose opportunities of reactivation of cultivation on these plots and reduce growth of thatch grass (Section 4.2.2). Similarly, edible weeds were considered by cultivators as an ES, providing tasty, nutritious and cultural foods, but also an EDS, as without regular management they were perceived to reduce crop yields (Section 3.2.2). It is also evident that households which were more dependent on the formal economy and therefore less dependent on land-based alternatives such as wild herbs and fuelwood, held differing views on *V. karroo* and weeds. In this regard, the balance between ES and EDS was mediated by the contextual factors of the household, the perspectives and experiences of the viewer, which are embedded in local cultures, values, norms and perceptions (Lyytimaki, 2015, Lyytimaki et al., 2008). Indeed, management of ES should be cognisant of the interchangeability of ecosystem outputs between ES and EDS, and in cases where the management objective is to reduce the EDS, it may simultaneously reduce ES.

## 6.4 Consideration of ecosystem outputs in a balanced manner

There has been much research and policy attention on securing ES for human wellbeing. However, an overwhelming majority of studies have failed to recognise and incorporate the obvious fact that ecosystems also generate EDS (Shackleton et al., 2016). If this study had assumed an inherently one-sided view of ecosystems, through recognition of ES only, it would have failed to identify the complex feedbacks between ES and EDS which often interacted to determine local ways of doing things or governed the allocation of resources such as time and money. It too may have failed to recognise how livelihoods are ever-changing, consistently modifying or adapting to EDS-driven effects, or the ingenuity and resourcefulness displayed by households in the face of shock. Further, the economic valuation of ES goods and services only would fail to portray the substantial potential value of goods and services, if not for EDS-induced losses. Therefore, through the inclusion of EDS, this study provides a balanced picture and a more realistic depiction of land-based livelihoods in the area.

The empirical data revealed the very real delivery of EDS across land-based livelihood sectors, which in some cases were responsible for the loss of more than half the potential value of ES harnessed. These are fine-grain figures reflecting household or village level, but once scaled to municipal or even district regions, could amount to substantial losses. In the context, of growing food prices and high unemployment, this overwhelming evidence supports Shackleton *et al.* (2016) who note that the investment and management of EDS, may yield for ES than the management of ES, and consequently for livelihoods. For example, an investment in adequate dipping facilities, which would respond to communities' calls for stronger biochemical dip and efficient dipping systems, may increase the resilience of livestock against the pervasive and potentially fatal bont tick. This may increase the magnitude of goods and services that livestock provide to rural households but also support the savings mechanisms that livestock provide. Further, an investment in more technical measures to deter birds from raiding maize fields in Ludaka, may result in a return of up to 92% of the potential value of a maize field. By consequence, these strategies may build the overall resilience of livelihoods through asset building and thereby increase the adaptive capacity of households in times of future unpredictable shocks and stressors.

The recognition of EDS also contributed to a deeper understanding and fuller picture of the functioning of rural livelihoods (Schaubroek, 2017), as empirical evidence pointed toward EDS influencing daily decisions and livelihood strategies. Households that were involved in crop cultivation, were more likely to spend their time guarding crops, particularly during early planting and cultivation seasons, than completing other household chores. Households were also more likely to harvest crops simultaneously and dry them for later consumption, than harvesting when needed. A balanced picture also provided insight into the future of land-based livelihoods across villages, with discussions around EDS highlighting that the poor nutritional value of the dominant sour grassland may serve as a driver of the declining the role of livestock husbandry in local livelihoods in this region (Section 4.2.2). The pervasive spread of *V. karroo* was also perceived to foreclose opportunities of field reactivation in the future (Section 4.2.2).

Therefore, this study paves the way for future empirical ES studies, providing extensive evidence to support the investigation of both positive and negative ecosystem outputs simultaneously. This balanced approach will serve to better understand the inherent complexity of ES and their interaction with multiple other factors and produce a more detailed picture of ES across sectors which aid management decisions and potentially the development of policy.

## 6.5 SLF as tool to frame ES and EDS

The SLF provided a useful framework with which to frame ES and EDS in rural livelihoods, illustrating the complex links between multiple livelihood components to determine livelihood outcomes. The modified SLF (Figure 1.2), presented in section 1.6, highlights how the ecological context generates both ES and EDS which either support or undermine livelihoods. For example, the harvest of ES such as fuelwood or thatch grass for trade generates an extra source of cash income to support the household, thereby potentially increasing their resilience or ability to withstand shocks or stresses. On the other hand, ecological functions or processes also deliver EDS, such as ticks, which undermine livestock health and, in some cases, result in livestock death. Not only did this reduce the available livestock-related goods and services but also eliminated the savings or safety-net mechanism that livestock offered, therefore exacerbating the households' vulnerability. In some cases, the effect of EDS were greater than the contribution of ES, such as crop-losses by birds in cultivated plots in Ludaka. This meant the household would be forced to direct scarce cash resources to buying food that they anticipated harvesting from cultivated plots, or go without. In other cases, households drew on kinship networks or other institutional arrangements to get access to food highlighted within the 'transforming structures and processes' box within the SLF.

Institutions were vital in shaping livelihood outcomes and supporting or undermining livelihood assets. For example, in this study, the role of local institutions in managing thatch grass collection periods was vital in ensuring sustainable thatch harvest. However, in other cases, institutions, or the lack thereof, exacerbated vulnerability or undermined livelihood outcomes or human wellbeing. This was seen through the slow disintegration of state-run dipping systems, giving rise to compromised livestock health. Livelihood assets and transforming structures then interact to determine conditions of livelihood and levels of human wellbeing. The resulting levels of human wellbeing fed back to the ecological context, determining how the environment was used. Although not highlighted as a particular finding in this study, much literature points towards poorer households or those with lower human wellbeing scores to be more reliant on the environment.  In this way, it is evident that both ES and EDS play a significant role in shaping livelihood outcomes and influencing levels livelihood assets, livelihood strategies and resulting human wellbeing levels. Therefore, this study provides empirical evidence of the need to recognise in future research that natural capital generates both ES and EDS which interact with other core components of the SLF to shape livelihood outcomes.

The SLF also highlights the value and contribution of mixed methods research to ES and EDS research. Quantitative data, generated by the household survey questionnaire, was essential in providing measures in a common empirically grounded scale with which to position ES and EDS and indicate the contributions or losses of ecosystem outputs. Simultaneously, qualitative data generated in focus group discussions and PLA activities, allowed for nuanced connections between ES and EDS and produced descriptive narratives to interpret and enrich quantitative findings. In combination, these two methodological approaches worked together to generate a comprehensive investigation of the role of ES and EDS in rural livelihoods.

## 6.6 Livelihoods and contexts are dynamic

A pervasive finding in this research, consistent with previous work on rural livelihoods, was processes of dynamic change. Although residents adhered to a set of norms and traditions consistent over time, livelihood trajectories consisted of long-term trends interspersed with short-term interjections, interacting to determine how people relate to local landscapes and the ES and EDS they use or experience, giving rise to behaviour modifications, and determining how people invested their time and money. Long-term trends, illustrated by trendlines and timelines, showed an overall decreasing reliance on local ES, yet this trajectory was interrupted by multiple short-term interjections. For example, the introduction of an external crayfish co-operative (Section 5.2.2) saw a spike in crayfish harvesting over the last few years, generating important cash income for some residents in the coastal village. Similarly, the recent introduction of bont ticks (Section 4.2.2) saw widespread stock losses amongst livestock owning households and served as a motivating factor behind fewer households engaging in livestock husbandry. In this way, the long-term trajectory was evident but was interrupted or interspersed with short-term changes in pattern.

Findings from this work illustrate that communities are part of ever-shifting livelihoods. They are in constant flux, involving perturbations and shifts of people and resources. For example, field abandonment stimulated changes in cultivation patterns, now occurring alongside the household in a home garden, and brought crop pests closer to the homestead. Simultaneously, widespread deactivation of fields in the majority of villages in the region gave rise to increased bird-related crop losses amongst the remaining field cultivators in Ludaka. This stimulated livelihood adaptation measures such as modified planting strategies, in which all fields were cultivated at the same time. Other trends emerging from field abandonment were pervasive bush encroachment, which is likely to limit the potential to cultivate in the future, and restrict livestock movement and access to rangeland and resources. Changes in fire regimes, as a result of declining herd sizes and bush encroachment, saw an increase in ticks and a decrease in palatable rangeland for livestock. In this way, it is evident that change is a constant factor, with residents having to continually readapt and cope whilst seeking to manage a milieu of issues that they may not have faced in the recent past.

The ever-changing context also challenges local and higher-scale institutions to be both forward thinking and adaptive. It indicates that the best that such institutions might seek to achieve is to support the development of adaptive capacity, resilience and resourcefulness of local communities and households rather than provide static, usually top-down, programmes and interventions.

## 6.7 Complexity in rural livelihoods

In this study, empirical data were presented in separate chapters according to each land-based livelihood activity in an effort to examine livelihoods in necessary depth. However, this should not undermine any understanding of the real and inherent complexity of rural livelihoods and the ecological systems in which they are vested. The complexity of coupled human-nature systems is evident in the dynamic and multi-dimensional links between livelihood sectors, between ES, between disservices and between both ES and EDS. Synergies between livelihood sectors are seen in the connections between a) arable agriculture and livestock in the use of cattle for ploughing and manure as fertiliser or the use of crops in livestock sectors such as dried maize to feed poultry, b) between NTFPs and arable agriculture in the use of poles for fencing or tool handles, and the high density of wild herbs in cultivated areas or c) between NTFPs and livestock with the use of poles for livestock enclosures, traditional medicines to treat ill animals, and so on.

In some cases, livelihood sectors or ecosystem components interacted reciprocally and formed complex feedback loops. An example includes the non-linear feedbacks between declines in the extent of fields and the concentration of bird pests in the few remaining fields (Section 3.2.2), or declining fields and changing land-use types through rapid bush encroachment on abandoned fields (Section 4.2.2), or a decrease in involvement in arable agriculture due to the risk involved as a result of crop pests (Section 3.2.2). Multi-dimensional feedback loops were also influenced by contextual and institutional factors (Liu et al., 2007), such as the prioritisation of education amongst the youth with the rise of democracy and therefore fewer young men to herd livestock, which disincentivised livestock husbandry as a livelihood sector. This also illustrates how local conditions can be shaped by larger-scale processes or decisions. The result of decreasing numbers of livestock owners resulted in the disintegration of local livestock institutions which were traditionally responsible for implementing the annual burning of rangeland. This resulted in an institutional vacuum giving rise to a lack of rangeland burning, which was consequently associated with an increase in the growth of *Aristida junciformis*, an unpalatable and non-nutritious grass species which harboured bont ticks, which cumulatively led to further livestock-related health problems.

Feedbacks were not always immediate, and for some there was a clear a lag between institutional and policy-related decisions and actual effect. This was evident in the slow phasing out of livestock-extension support through the provision of weakened dip to the decentralisation of dipping systems to local residents. Evidence provided in trendlines and timelines showed extensive reliance on dipping facilities for livestock health in the past, but with the rise of bont ticks and dysfunctional or inconsistent state dipping system, it has eventually resulted in the ubiquitous trend of poor livestock health across villages. Another lagged effect was the introduction of social grants, and the slow decrease in reliance on NTFPs, particularly amongst the youth. This brings to light the dynamic nature of social-ecological systems, and the importance of understanding livelihoods through time rather than static snaps at a single point. The use of trends and interviews with the elderly were crucial in this regard. It also behoves authorities to recognise the links between livelihood sectors and their complex links to larger-scale dynamics if they wish to devise and adopt policies or strategies to support rural livelihoods and human wellbeing.

## 6.8 Responsiveness to EDS

Rural households were accustomed to risk, frequently facing livelihood stresses and disturbances, originating from both biophysical and socio-economic spheres. Reduction in the potential yield or loss of ES as a result of an EDS represented just one of these challenges. Yet, most of the households displayed an ability to a greater or lesser degree to persist through change, shocks and stressors and learn from or adapt to challenges. Residents also demonstrated great resourcefulness in their attempt to buffer against losses. This correlates with a growing body of literature which highlights the ingenuity displayed by individuals and communities in precarious conditions in developing countries, who are often faced with inadequate insurance or safety nets but work within their resources to respond to stress or shock (Kihila, 2018, Thomas et al., 2010, Thomas and Twyman, 2005). Most residents did not wait to see how an event would affect their livelihoods but were active in their attempts to manage EDS, both in anticipation of an EDS or in the period following an EDS. These have previously been broadly classified as *ex-ante* and *ex-poste* risk management strategies, respectively (Ellis, 2000b).

In most cases, households were engaged in proactive or *ex-ante* preventative actions. This was seen in the positioning of scarecrows or dogs in cultivated plots to deter larger crop pests (Section 3.2.2), the addition of biomedical products to the water troughs of chickens in an attempt to prevent the onset of disease (Section 4.2.2), or the application of biomedical products to livestock to prevent disease (Section 4.2.2). Diversification of livelihood strategies was also a pervasive *ex-ante* strategy, involving the allocation of time and money into a series of livelihood activities as a way of reducing overall risk to EDS. Diversity also existed within land-based livelihood sectors with mixed-cropping systems in cultivated plots, the harvest of multiple types of NTFPs and, amongst livestock owners, diverse herds.

These pre-emptive strategies served to increase the robustness of the antecedent conditions, building resilience in the system to buffer against EDS. In this way, resilient communities are able to handle external changes or surprises (Levin, 1999), learn from disturbances and stress and find opportunities for renewal. In some cases, pre-emptive strategies became ingrained in livelihoods, with households adapting to EDS by integrating management strategies into daily rituals. These include the planting of a hedge or long-leafed plants along the homestead boundary to prevent chick predation by birds of prey (Section 4.2.2), the wearing of long-sleeved clothing to prevent irritation while collecting NTFPs in forests (Section 5.2.3), saving seed from the previous season's harvest in anticipation of crop loss (Section 3.2.2) or the reduction in cultivation of specific crops susceptible to invertebrate pests (Section 3.2.2). Individually such strategies might seem quite small or trivial to an outside observer, but the multitude of these small actions demonstrates adaptation, i.e. a longer-term, rationalised change in behaviour or practice in response to identified drivers, to optimise the probability, quality or quantity of certain future benefit flows or limit the probability, nature or magnitude of certain risks, such as EDS (Ellis, 2000b). In cases where *ex-ante* risk management strategies were unsuccessful or in cases where an unanticipated EDS affected a major source of survival, reactive or *ex-poste* coping mechanisms were implemented to aid household survival following the event. An example of this included the sale of fuelwood to compensate for crop losses in Njela (Section 3.2.2). This strategy can be considered as an informal safety net that provides short-term benefits to households with poor assets but was limited in the ability to sustain livelihoods or enable households to adapt to long-term EDS-related changes.

Building resilience through preventative or coping strategies also occurred over multiple scales – at the household level, such as application of biochemical treatments to crops (Section 3.2.2), and at a community level, such as the simultaneous planting of maize in fields in Ludaka (Section 3.2.2) or livestock sharing institutions to enable herd growth for those without cattle (Section 4.2.2). Residents also showed evidence of self-organisation, an essential component of resilience (Berkes et al., 2003), illustrating tight feedback loops in response to change through the monitoring and detection of an emerging problem (Levin, 1999). For example, culling an entire flock of chickens at the onset of chicken disease to avoid losing the whole flock to the disease rendering the poultry useless to the household.

This section has illustrated how villagers responded to multiple EDS which ranged across numerous livelihood sectors from livestock health and land encroachment to health-related issues. As a result, these EDS span various state departments and therefore require interaction and problem solving across state departments such as the Department of Agriculture, Forestry and Fisheries, the Department of Rural Development and Land Reform, etc. This would then provide institutional support to the grass-roots level, and state departments would together, in an integrated fashion, address issues nested within complex rural livelihoods.

6.9 Conclusion

It is evident that ES play an important role in rural livelihoods, contributing to the satisfaction of a variety of household needs and wellbeing. Yet, this research also highlighted the pervasive presence of EDS across land-based livelihood sectors which undermined and shaped livelihoods to varying degrees. The inclusion of EDS changed the common picture presented in many ES studies because EDS-induced losses often reduced ecosystem benefits by more than half of their potential economic value and were responsible for shaping livelihood strategies and practices. Still, it drew multiple commonalities with other ES studies, highlighting the complexity and inherent dynamic nature of ecosystem outputs and the ingenuity of rural dwellers in responding to EDS in their quest for survival or to improve wellbeing. It too recognised that with an increase in ES, so too is there likely to be a corresponding increase in EDS. Therefore, this empirical research draws attention to the importance of achieving a balanced view of ecosystem outputs by recognising EDS alongside ES.

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## APPENDIX

Appendix 1: Ecosystem service and disservice household survey

| | |
|---|---|
| Questionnaire No. | |
| Date of interview | |
| Village name | |

| **Section 1: Ecosystem Services** |
|---|

### 1.1 Home gardens

1.1.1 Do you currently cultivate a home garden? (Y/N)

1.1.2 Do you currently cultivate a field? (Y/N)

1.1.3 Do you purchase fertilizer? (Y/N) What was the cost? ________________

1.1.4 Do you use cattle dung? (Y/N)

**1.1.2** Crop details:

| Name of crop | Month first harvested some? | Month crop finished? | How often did you harvest per week? | Approx. how much did you harvest each time? | Local price per unit? |
|---|---|---|---|---|---|
| Maize | | | | | |
| Cabbage | | | | | |
| Beans | | | | | |
| Spinach | | | | | |
| Potato | | | | | |
| Carrot | | | | | |
| Onion | | | | | |
| Banana | | | | | |
| Peach | | | | | |
| Tomato | | | | | |
| S/Pot | | | | | |
| Imifino | | | | | |
| Guava | | | | | |
| G/Pepper | | | | | |
| Mango | | | | | |
| Orange | | | | | |
| Pumpkin | | | | | |
| Beetroot | | | | | |
| Lemon | | | | | |
| Butternut | | | | | |
| Brinjal | | | | | |
| Avocado | | | | | |
| S/Cane | | | | | |
| Other | | | | | |

## 2.2 Livestock

### 2.2.1 Poultry

| How many chickens do you own? | How many chickens did you have this time last year? | How many did you sell or slaughter per month/year? | How many died by disease, eagle or monkey in the last year? | What was the price of medication? |
|---|---|---|---|---|
| | | | | |

| What is the local price of a chicken? | How many eggs do you collect per week? | What is the local price for eggs? |
|---|---|---|
| | | |

### 2.2.2 Cattle

| How many cattle do you own? | How many did you own this time last year? | How many do you sell or slaughter per year? Or when last did you do sell/slaughter a beast? | Do you use cattle to plough? [Y/N] |
|---|---|---|---|
| | | | |

| Do you collect cattle dung? [Y/N] | If so – how often? | How much do you collect? | What is the unit price? |
|---|---|---|---|
| | | | |

| How many cattle have you lost to disease in the last 12 months? | Do you attempt to prevent cattle disease? [Y/N] | What is the cost of the prevention medication per year? | In the last year have you bought any treatment to treat cattle disease? [Y/N] | What is the cost of treatment per year? |
|---|---|---|---|---|
| | | | | |

### 2.2.3 Goats

| How many goats do you own? | How many did you own this time last year? | How many do you sell or slaughter per month/year? Or when last did you do sell/slaughter? |
|---|---|---|
| | | |

| How many goats did you lose to disease in the last 12 months? | Did you attempt to prevent disease? [Y/N] | Cost of prevention medication per year? | In the last year have you bought any treatment to treat a disease? [Y/N] | Cost of treatment per year? |
|---|---|---|---|---|
| | | | | |

**3. Forest**

| Ecosystem Service | Frequency? (per week/month/year) | Quantity each time? | Unit? (bucket, load, sack) | Local price per unit? |
|---|---|---|---|---|
| Fuelwood | | | | |
| Poles | | | | |
| Thatch | | | | |
| Wild fruit | | | | |
| Hand brush | | | | |
| Water | | | | |
| Bushmeat | | | | |
| Wild herbs | | | | |
| Honey | | | | |
| Walking stick | | | | |
| Sand | | | | |
| Reeds | | | | |
| Palm leaves | | | | |
| Mushrooms | | | | |
| Clay | | | | |
| Other | | | | |

## 4. Ocean

| Ecosystem Service | Frequency? (per week, month, year) | Quantity each time? | Unit? (bucket, load, sack) | Price per unit? |
|---|---|---|---|---|
| Cray Fish | | | | |
| Mussels | | | | |
| Limpet | | | | |
| Red bait | | | | |
| Fish | | | | |
| Oysters | | | | |
| Octopus | | | | |
| Sea water | | | | |
| Sand | | | | |
| Umqwabub | | | | |
| Ingumba | | | | |
| Other | | | | |

## Section 2: Ecosystem Disservices

### 2.1 Monkeys

| Have you experienced monkeys in your home garden in the last year? [Y/N] | If yes – what proportion of your crop was lost? | How often do monkeys raid your garden? | Did you attempt to prevent it from happening? [Y/N] If yes – what? | Has the incidence of monkeys changed or determined the type of crop you grow? |
|---|---|---|---|---|
| | | | | |

### 2.2 Bush pigs

| Have you experienced bush pigs in your home garden in the last year? [Y/N] | If yes – what proportion of your crop was lost? | Did you attempt to prevent it from happening? [Y/N] | If yes – what? |
|---|---|---|---|
| | | | |

### 2.3 Invertebrate Pests

| Have you experienced any invertebrate pests within the last year? [Y/N] | If yes, what proportion of your crop was lost? | How often do invertebrate pests occur? | Did you use any preventative ointment? [Y/N] | How often did you buy ointment last year and what was the price each time? | Has the incidence of invertebrate pests changed or determined the type of crop you grow? |
|---|---|---|---|---|---|
| | | | | | |

### 2.4 Weeds

| Are weeds a problem in your home garden? | If yes – what do you do to manage them? | How many hours a day/ week does this take? |
|---|---|---|
| | | |

### 3. Invasion

| Do you think Lantana is increasing in the communal land surrounding the village? [Y/N] | Do you perceive this to be good, bad or both? | **If good why? Or If bad why? (can tick multiple)** | | | | |
|---|---|---|---|---|---|---|
| | | 1. Take over paths and prevent access | 2. Reduce the amount of grassland for grazing | 3. Reduce the amount of thatch available | 4. Take over houses | 5. Other |
| | | | | | | |

| Do you think Acacia karoo is increasing in the communal land surrounding the village? [Y/N] | Do you perceive this to be good, bad or both? | **If good why? Or if bad why? (can tick multiple)** | | | |
|---|---|---|---|---|---|
| | | 1. Increase amount of fuelwood available | 2. Take over grassland for cattle to graze | 3. Drying up the land | 4. Impede access |
| | | 5. Provide fodder for goats | 6. Provide a space for criminals to hide | 7. Other | |
| | | | | | |

**4. Grass**

| Do you think the amount of thatch grass available in this village has increased or decreased over time? [increased/decreased] | Please provide a reason for your answer? | Do people burn grass in this village? [Y/N] | Please provide a reason for your answer? | Do you think the grass is in this village is suitable for livestock? [Y/N] |
|---|---|---|---|---|
| | | | | |

**Section 3: Household Socio-Economic Variables**

**3.1 Type of House:**

| Majority of structures on the property are constructed out of mud and thatch | Majority of structures on the property are constructed out of bricks and cement |
|---|---|

**3.2 Hedging of Property and Field:**

| Field has hedge for more than 40% of boundary. [Note if alien or indigenous species] | Property has hedge for more than 40% of boundary. [Note if alien or indigenous species] |
|---|---|

**3.3 Appliances: (not interested in the amount of each, just tick)**

| Fridge | Stove | Hi-Fi | Microwave | Television | Vehicle | JoJo Tank |
|---|---|---|---|---|---|---|

**3.4 Income Generating Activities:**

| Income generating activity | Number of people in the HH | Rank (Top 2) |
|---|---|---|
| Full time job | | |
| Grants (identify type of grant):<br>• Old age pension<br>• Disability<br>• Veterens<br>• Foster<br>• Child grant | | |
| Piece jobs | | |
| Skill that they sell or make things (electrician, dress maker, builder, thatcher) | | |
| Does anyone collect anything from the environment and sell it? If yes – what? (thatch, firewood, med plants, shell fish) | | |
| Does any sell farm livestock or crops? | | |

**3.5 Household Size: Adults** (18+ years) **_____________**and **Children** (>18) _________________

**3.6 Age of Household Head: _______________________________**

**3.7 Education of Household Head (How many years did you spend at school):** _________________

**3.8 How long the household head has lived in the village:** _________________________________