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LIVESTOCK PRODUCTION AND ANIMAL HEALTH MANAGEMENT SYSTEMS IN COMMUNAL FARMING AREAS AT THE WILDLIFE-LIVESTOCK INTERFACE IN SOUTHERN AFRICA

by

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Submitted in fulfilment of the requirements for the degree

Philosophiae Doctor (PhD)

Faculty of Veterinary Science, University of Pretoria

May 2016

The reality of the close interaction of many lives of both people and animals who share the eastern floodplains of the Zambezi Region, Namibia, where wildlife, livestock, and people coexist across multiple land use systems

In dedication:

Firstly; to my wonderful family: Spouse Renate, daughter Mieke-Marié, and son Markus for all your support, patience, dedication, and especially sacrifices over the course of this research project. I would need to write another thesis to put into words what you were willing to withstand and how much I valued your continued support no matter how hard it became. May this achievement serve you most of all!

Secondly; to my father; Dr Pierre van Rooyen, whom has always been an inspiration and example of how a PhD degree in combination with integrity and a humble spirit can be used to serve a nation's farmers. May we form a strong team now that we are peers - albeit only academically!

***

All that I know now is partial and incomplete, but then I will know everything completely, just as God now knows me completely.

1 Corinthians 13: 12b NLT

***

ACKNOWLEDGEMENTS

Numerous people from various sectors and institutions linked to the livestock production and conservation systems of the Mnisi and Zambezi study areas have assisted greatly in the successful completion of this thesis. All their contributions must be acknowledged. However, I would like to highlight the following people for specific inputs, support, and guidance:

In the Zambezi study area:

- The Millennium Challenge Account funded Project team for all their support, guidance and especially patience:
    - Dr Susanne Thaltwitzer - project coordinator
    - Dr Gavin Thomson – TAD Scientific
    - Dr Mary-Lou Penrith – TAD Scientific
    - Dr Alexander Toto – SATOTO Livestock Projects
- The Farmers' Mentorship Program of the Meat Board of Namibia:
    - Mr Gizaw Negussie – Project manager
    - Mr Hannes von Wielligh – Senior mentor
    - Mr George Sichombe - Mentor
    - Mr Charles Libongani - Mentor
    - The staff at the Meatco abattoir, Katima Mulilo: Mr Berry Manda (Procurement manager), and Mr Obed Kaatura (General manager)
    - The staff at the Directorate of Veterinary Services: Dr Frank Chitate (State veterinarian, ZR), and Dr Justin Yule (State veterinarian, ZR)
- The representatives from various conservation initiatives:
    - Dr Mike Atkinson and his spouse, Shirley: WCS-AHEAD
    - Mr Russel Taylor – WWF Namibia
    - Miss Karine Nuulimba, IRDNC, and several of her field staff based at Katima Mulilo
- Miss Celia da Silva from Business Enterprises, University of Pretoria and her team whom assisted significantly with administration, finances, and logistical arrangements
- Several interpreters assisted during some parts of the project for a day or two when the Mentors were not available. I am very grateful for their assistance. I want to specifically thank Mr Martin Chiza for his assistance in this regard

- Many-a-young boys that were always too keen to help get us out of a sandpit on the floodplains of eastern Zambezi Region

In the Mnisi study area:

- The Mnisi Traditional Authority, its Council, the people of Mnisi, and especially the late Chief P.P. Mnisi for his support in the beginning years of this study
- The team associated with the Mnisi Community Project: Prof Nick Kriek and Ms Marie Watson of the Centre for Veterinary Wildlife Studies
- The survey team: Dr Maxime Madder (ITM), Ms Ellen Vandamme (ITM), Mr Pieter Visagie, Misses McMillan, Mr Sylvester Zimwara, Ms Marie Watson.
- Translators: Mr Pebane (MVS), Mr Justify Fakude, Mr George Ndlovu, Mr Andries Mabaso, Ms Margareth Magagule, Misses Percy Khoza, Mr Philemon Mbunghele, Mr Simon Ngwenya, Mr Harry Mnisi
- Mpumalanga State Veterinary Services: Dr Oupa Rikhotso (State Veterinarian), Mr Solly Mokone (AHT, Ward B3), Mr Jerry Ndlozi (AHT, Ward B1), Mr Gypsy Mathumba (AHT, Ward B2)
- Kruger to Canyons Biosphere Reserve: Ms Marie-Tinka Uys and especially Ms Thandi Mananga for her substantial support and dedication in data processing
- The rangers and management of the Manyeleti and Andover Game Reserves for their support with field work and planning
- Mr Andries Masenge – Department of Statistics, University of Pretoria for all his help with numerous analyses, and especially his willingness to provide guidance and to test various approaches in order to find the best statistical method. In this regard I would like to thank Dr Marien Graham as well for her oversight and continuous advice

General support:

- Significant gratitude is extended to the following organisations for substantial financial support for this PhD study:
    - The Institute for Tropical Medicine, Antwerp – Belgium
    - The University of Pretoria for their PhD Bursary
    - The National Research Foundation of South Africa for their Sabbatical Grant

- Dr Louis van Schalkwyk for inspiration, motivation, and significant assistance with statistical analyses
- Dr Anne Conan, Postdoctoral fellow at the Department of Veterinary Tropical Diseases, University of Pretoria
- The support of colleagues; Profs Darryn Knobel and Anita Michelle, as well as Dr Richard Burroughs, and Heads of Departments; Profs Koos Coetzer, Edward Webb, and Darrell Abernethy
- All the respondents during several meetings and discussions that always met us with enthusiasm, interest and patience –in both the Zambezi and Mnisi study areas
- Misses Sarah Heuer for editing the manuscript
- Postgraduate administration of the Department of Veterinary Tropical Diseases for significant support, especially Ms Rina Serfontein
- My study leaders: Prof Edward Webb, and Prof Koos Coetzer for continued encouragement, guidance and support. Also Dr Maxime Madder for his support in the Mnisi survey.
- My father-in-law, Dr Tom von Moltke, for reminding me that a PhD is more about perseverance than intelligence, mother-in-law, Anita, sister-in-law Marike Visagie and family, as well as brother-in-law, Adolf, and family for all their support
- My mother, Hermine van Rooyen, for continued support, encouragement and especially prayers together with the steadfast support of my siblings, sisters Hermine and Mariette, and brother Pierre, as well as their families
- My Heavenly Father for His constant presence and for keeping all His promises. Without you, my Lord, I would not have succeeded! May this work glorify your Name.

Declaration

I declare that the thesis, which I hereby submit for the degree *Philosophiae Doctor* at the University of Pretoria, is my own work and has not previously been submitted by me for a degree at this or any other tertiary institution.

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J van Rooyen

15 May 2016

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EXECUTIVE SUMMARY

BEEF PRODUCTION AND ANIMAL HEALTH MANAGEMENT SYSTEMS IN COMMUNAL FARMING AREAS AT THE WILDLIFE-LIVESTOCK INTERFACE IN SOUTHERN AFRICA

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Development of transfrontier conservation areas (TFCAs) in southern Africa depends, among other, on the ability of stakeholders to find practical and sustainable solutions for wildlife-livestock integration in the conservation landscape. Due to the presence of buffalo *Syncerus caffer* in most of the TFCAs in southern Africa, foot-and-mouth disease (FMD) has to be controlled in susceptible livestock species sharing the rangelands with wildlife. Conventional FMD control measures act as an additional burden on communal livestock producers and may hamper rural development and wildlife-livestock integration even further. However, commodity-based trade in the form of an integrated approach to the control of both food safety and disease risk along the entire beef value chain has been proposed as a more favourable alternative for ensuring market access for beef produced at the wildlife-livestock interface. Such a non-geographic based approach could allow for trade to continue despite high risk of FMD if appropriate disease risk and food safety measures are implemented by farmers and subsequent role players along the value chain and hence, could promote greater wildlife-livestock compatibility.

The objective of the present study was to analyse beef production, health and trade systems of farmers at the wildlife-livestock interface within foot-and-mouth disease (FMD) protection zones in order to identify challenges, risks and limitations that may limit compliance with proposed commodity-based trade prerequisites as well as value chain participation. Based on the findings of this study a holistic, integrated approach is proposed at the village level that could be implemented to serve as an incentive for equitable participation by farmers whilst 1) addressing the risks and limitations of a farming system, 2) ensuring greater wildlife-livestock compatibility, and 3) promote consistent market access by fulfilling the requirements of an integrated value chain approach based on commodity-based trade standards.

A farming systems approach was used to investigate beef production, health and trade systems in FMD protection zones mainly within the Zambezi Region (ZR) of Namibia, which is situated within the KAZA TFCA (Kavango-Zambezi Transfrontier Conservation Area), but also the Mnisi study area (MSA) in South

Africa adjacent to the Great Limpopo Transfrontier Conservation Area (GLTFCA). A combined qualitative and quantitative approach was used to assess and describe farmers' perceptions in selected study areas about beef production, trade, and wildlife conservation. Secondary data obtained from state veterinary services, the Meatco abattoir in Katima Mulilo, as well as previous studies were analysed and modelled to describe spatial-temporal trends in trade as well as cattle distribution in relation to resource availability.

The results indicate that beef production systems in some of the most remote areas of the ZR as well as in the MSA resemble a typical low-input low-output production system, mainly due to the high level of risk farmers had to cope with and the limited opportunity to offset losses. The major challenges within livestock farming in all the areas studied were animal diseases, grazing competition, predation, stock theft and contact with wildlife, although the importance of each varied between study areas. Herd size effect in the MSA significantly explained the variation in attitude towards trade, production and management of cattle between farmers with below average and farmers with above average herd sizes. In the MSA, home slaughter contributed significantly more to direct household food security in households with larger herd sizes than in households with smaller herd sizes, and in the ZR farmers with smaller herd sizes were discouraged from participation in formal trade.

The attitudes and perceptions of farmers In the ZR towards wildlife and conservation often varied between survey areas as a consequence of the variation in the geophysical properties of the landscape, proximity to conservation areas, as well as the form of the interface with conservation areas. The perceived spatial-temporal movement of buffalo varied between survey areas in the ZR. However, the frequency and nature of buffalo-cattle interaction was generally high and intimate. Most farmers associated buffalo with risk of disease, especially FMD, but some were more concerned about grazing competition and the negative effect on husbandry practises. Farmers readily deployed traditional risk mitigation tactics in the form of kraaling at night and herding at day to control the movement of their animals and to reduce risks. Herding was found to be a potential strategy to specifically mitigate cattle-buffalo contact despite the lack of evidence that an overall strategic approach to herding exist. Although the majority of farmers in the ZR were in favour of conservation and its benefits, the negative impact of increasing wildlife numbers on farmers' attitudes was an indication that the generally positive sentiment was changing and may in future deter conservation efforts.

Indications are that the cattle population in the ZR at its estimated density and distribution had reached the ecological capacity of the natural resource base in the ZR and animal performance and survival was therefore subjected to increased variability in resource availability linked to climate change. The cattle population's existence at ecological capacity and the inability of farmers to offset the loss of condition in the dry season with supplementary feed were reflected in the changes in carcass quality and grades across seasons. However, there was sufficient forage produced in the ZR to sustain animal performance to some extent throughout the year, but those areas with surplus forage existed beyond the assumed grazing range around villages and perennial rivers where most cattle and wildlife concentrate. The future ability of farmers to access such underutilised grazing resources in order to strategically counter the negative consequences of climate change and growing wildlife numbers could be an important coping and risk management mechanism linked to commodity-based trade and sustained animal quality.

Regular FMD outbreaks had a significant impact on the consistency with which the Meatco abattoir in the ZR operated between the years 2007-2011, with negative consequences to both farmers and the abattoir itself. It was found that the formal trade system in the ZR discriminated against farmers with below average herd sizes, and that the disposition held by farmers with smaller herd sizes are most significant in areas further than approximately 55km away from quarantine camps. Vegetation type and possible contact with buffalo or previous FMD outbreaks in the area did not significantly affect market participation nor off-take rates at a crush-pen level in the ZR. The negative effect that distance from a quarantine station had on formal off-take rate and the level of sales to Meatco at crush-pen level, was the most significant in the winter months and crush-pens situated beyond 55km from a quarantine station. The results indicate that the trade range of the Meatco abattoir was less than its trade threshold which contributed to its struggle to sustain throughput and profitability.

Finally the loss of income farmers experienced in both the ZR and the MSA during simultaneous FMD outbreaks in the year 2012 was quantified, as well as the impact it had on livelihoods in the ZR. A commodity-based trade approach may have reduced the impact on farmers' income significantly. However, we farmers are unable to comply with the proposed requirements for mitigating risk and ensuring food safety and quality in such communal systems in the absence of interventions to build the necessary capacity and awareness. It is recommended that at the wildlife-livestock interface such as those investigated in this study, an integrated value chain approach to trade could serve as a catalyst to incentivise and enable farmer participation in holistic, integrated rangeland and livestock management practises that will promote conservation and rural development.

1 Introduction

1.1 Literature Review

1.1.1 Transfrontier Conservation Areas (TFCAs)

An environment in southern Africa in which the interaction intensity between many systems and their different priorities, people and animals is rapidly increasing, is the wildlife-livestock interface. This increased interaction is mainly brought about by initiatives such as the formation of Transfrontier Conservation Areas (TFCAs). Transfrontier Conservation Areas, otherwise known as Peace Parks, are receiving significant attention in southern Africa from policy makers, conservation agencies, and research organisations around the world (see AHEAD www.wcs-ahead.org – accessed 18/10/2015). The development of TFCAs receives this attention mostly due to its significance for biodiversity conservation, as well as due to the complexity of the challenges its development entails in terms of policy alignment, disease risk, land use change and livelihood sustainability (Cumming, 2011). On the one hand, conservation areas need to be more interconnected to improve ecosystem connectivity, which is essential for biodiversity conservation. Thad said, increased connectedness brings land use systems and the resident people and animals into situations with the potential for conflict (Osofsky et al., 2005; Wrobel and Redford, 2010). The main aim of TFCAs is to restore ecosystem connectivity through the formation of corridors and extensive protected area networks that transcend national boundaries, and often encompass multiple land use systems. The vision is for these networks to enable the movement and protection of many isolated yet valuable and often vulnerable animal populations and ecosystems and, at the same time, to create feasible opportunities for sustainable rural development and poverty alleviation (Osofsky et al., 2012; www.peaceparks.org – accessed 27/04/2013; www.environment.gov.za – accessed 27/04/2013). This means that such conservation areas will encompass multiple land use systems mostly associated with extensive rangelands utilised mainly by wildlife but also by livestock. However, the many communities living in and around TFCAs rely on access to natural resources and agro-pastoralism for their livelihoods. Their livestock is regarded as the main source of their livelihoods (Randolph et al., 2007; Rich and Perry, 2011a; Rich and Perry, 2011b; Klerkx et al., 2012) which implies that anything threatening their livestock or the benefit they can gain from keeping livestock is perceived as a threat to their existence.

The interface between rural communities, their animals and adjacent conservation areas can either be in the form of a 'hard' fence aimed at preventing contact between people, livestock and wildlife; or it can be 'soft', allowing for spontaneous interaction between livestock and wildlife sharing the same rangelands (Somers and Hayward, 2012). This interaction can be either mutually beneficial or a cause for conflict (Sinclair and Schaller, 2010; Odadi et al., 2011; Gadd, 2012). Either way, the interaction between people, their domesticated animals and the wildlife at this interface forms the backdrop to the complexity associated with the establishment of TFCAs. Irrespective of the fact that the form of the boundaries between agricultural and conservation areas may vary, the possibility of livestock-wildlife interaction, and specifically contact, still remains. This likelihood of contact and close interaction between wildlife and livestock around conservation areas significantly increases the risk of the spread of important vector-borne and transboundary animal diseases (TADs), such as bovine tuberculosis, corridor disease (*Theileria parva* infection in cattle) and foot-and-mouth disease (FMD) (Sutmoller et al., 2000; Michel and Bengis, 2011; Osofsky et al., 2012). The risk of disease spread between wildlife (particularly the African buffalo *Syncerus caffer*) and livestock and the overall impact thereof, especially on international trade, has led to the introduction of stringent animal health control policies across southern Africa and similar regions. These control measures have had important, multifaceted consequences (Osofsky et al., 2005; Scoones et al., 2010; Gadd, 2012). In the case of FMD, control policies and measures in the form of trade restrictions, movement controls, decreased animal off-take as well as ecologically insensitive fencing have the potential to outweigh the direct negative effects of disease itself on animals (in the case of FMD in southern Africa, for example, see Thomson et al., 2003; Gadd, 2012). Another important consequence of current disease control policies lies in their contribution to the complexity of the challenges faced by the establishment and functioning of TFCAs.

Cumming (2011) explains that the extent and complexity of the human-animal-environment interface in southern African TFCAs are reflected in their size, the number of protected areas, and the extent of the unprotected matrix of multiple land uses. Human population densities and the social and cultural diversity they represent, as well as the wide range of multi-host pathogens that occur in these areas, bring about further dimensions of complexity. The consequences include a threat to the successful development of TFCAs and have therefore triggered the establishment of entities striving to resolve these barriers (see the Animal and Human Health for the Environment And Development (AHEAD) programme of the Wildlife Conservation Society (WCS) and its various working groups – www.wcs-ahead.org ; see also the Peace Parks Foundation – www.peaceparks.org – accessed 18/10/2015).

Income generated from nature-based tourism is a significant contributor to gross domestic product in southern African countries (Osofsky et al., 2012; The Phakalane Declaration, 2012). Tourism is the fastest-growing industry in the world, but it cannot support the envisioned socio-economic transformation of communities living in TFCAs by itself (Thomson et al., 2013). Livestock is one of the most important household assets for a significant number of people living in rural southern Africa, and this is equally true for pastoralists within and around TFCAs (Randolph et al., 2007; Moerane, 2008). In fact, it is argued that the combination rather than the separation of wildlife and livestock-based economic development initiatives will diversify livelihood options for marginalised communities, hence improving their livelihood resilience (Mizutani et al., 2005; Osofsky et al., 2012; Thomson et al., 2013). In order to achieve this, a large barrier in the form of currently deployed disease control strategies, will have to be overcome. Access to better markets, especially international markets, for beef produced in native, often marginalised pastoral areas in Africa is regarded an important step on a potential pathway out of poverty (Randolph et al., 2007; Rich et al., 2009; Rota and Sperandini, 2010). However, the disease control measures currently implemented by most countries in southern Africa, in accordance with international regulations prescribed by the World Trade Organisation and the OIE, can be regarded as one of the major barriers to trade and market access for beef producers at the conservation-agriculture interface.

A comprehensive review of the progress in as well as the challenges or opportunities faced by TFCA development especially in southern Africa, was presented by Andersson et al. (2013). It highlighted the many issues faced during TFCA development and progress, as influenced by the mainly politically-driven process, which has often resulted in the limited conservation and development value of TFCAs in which people at grassroots level have not participated or had an active role. The boundaries of TFCAs and the associated interfaces between protected areas, communities and pastures for livestock have kept on changing, due to a range of drivers associated with a history of typical settler-dominated, capitalist economic forces, mostly with little regard for impacts on the ground, whether ecological or social. A good example has been the erection of disease control fences throughout the region, with multiple impacts on wildlife, livestock and the people living in these areas. This further highlights the fact that human population growth at the wildlife-livestock interface has been highly dynamic, and patterns of migration and rapid population growth contribute to the social complexity of these areas. Added to this is the ever-complicated but very important acknowledgement of the cultural and ethnic diversity of the peoples living in TFCA areas, which has to be dealt with in development approaches, especially in terms of community-based natural resource utilisation models.

The review presented by Andersson et al. (2013) sheds light on the interface itself and its heterogenic nature. The interface between people, livestock and wildlife conservation can be hard and static, such as a fence, or soft and dynamic, ever-changing, based on resource-driven movements of both animals and people. This inevitably results in conflict, in terms of resource use, between people and animals, both domestic and wild. Human-wildlife conflict is therefore a major challenge for TFCAs, because it has a dramatic influence on people's perceptions of conservation and their livelihoods. It can also have a marked impact on wildlife conservation and the protection of species. The review concludes that the current approaches to human-wildlife conflict have been ineffective, because such efforts have lacked sufficient resources, applied inappropriate techniques, and lacked consideration for local peoples' perceptions of risk, as is required for farmer-based solutions. Yet, many opportunities do exist in TFCAs for wildlife-based economic development, and community-based natural resource management models, through which benefits can outweigh the costs of living with wildlife. The review argues that the development of models for the effective integration of wildlife and livestock should be a priority for TFCAs.

Overall, the review of TFCAs (Cumming et al., 2013) shows that opportunities for development for people living at the interface in TFCAs are influenced by global, regional, national and local forces, policies and conditions, for which no single solution or approach exists. The review promotes a paradigm shift: away from efforts to develop communities *through* conservation towards development *for* conservation, in which multi-scale and multi-level approaches should transpire in local initiatives that meaningfully involve and empower people at grassroots level. Effective development and conservation in TFCAs therefore depends on issues of scale being addressed, policy and legal constraints being dealt with, and local level capacity to self-organise and empowerment at appropriate scales being achieved. Thus the current situation, wherein the cost of living in TFCA interfaces, brought about by human-wildlife conflict and the spread of livestock diseases that outweigh the benefits, might be changed (Cumming et al. (2013), P 201).

In conclusion, it is clear that TFCA development faces many challenges of a complex nature, even further complicated by the multiple levels and the scale of the issues at hand. TFCA development aims to integrate matters such as conservation, animal and human health, poverty alleviation, as well as rural development, through diversification of economic opportunities such as agriculture, eco-tourism and beneficiation, and by means of community-based natural resource management initiatives. All of these objectives have an inherent level of complexity brought about by their own evolutionary patterns in terms of the correct approach for today and for particular contexts. This in itself demonstrates the essentially complex nature of the objectives of TFCA development, and will therefore be reviewed in the next section.

1.1.2 Conceptualising complexity at the wildlife-livestock interface

Since the latter half of the 20th century, various traditionally well-defined research fields and scientific disciplines started to broaden their focus so as to become more holistic and interdisciplinary. Examples of this trend are found, for instance, in the evolution of approaches to conservation, agricultural production, rural development, poverty alleviation and disease risk management.

Conservation

In the sixties, conservationists focused their efforts on the management of single species in need of protection, often without the necessary attention being given to the very complex ecosystems in which they existed and the multi-layered effect of an intervention in any one component of an ecosystem (Table 1-1).

Table 1-1: The evolution of conservation and farming systems approaches in recent history. Adapted from Smith and Maltby (2003) and Norman (2002)

Period	Conservation *Smith et al. (2003)*	Farming systems *Norman (2002)*
1960s	Single species management	Pre-determined focus
1970s-1980s	Protected areas	Whole farm focus
1990s	Integrated conservation and development projects	Natural resource focus
2000 and beyond	Holistic, multi-stakeholder, broad-scale approach (Ecoregion-based conservation)	Sustainable livelihoods

The often undesired disruption of ecosystem function due to 'narrow' approaches pushed conservation action to become more and more holistic, featuring broad-scale and multidisciplinary approaches to complex challenges and landscape heterogeneity (Du Toit et al., 2003; Smith and Maltby, 2003). Conservation areas, such as the Kruger National Park, started to recognise the importance of inclusive approaches for surrounding communities, instead of maintaining the traditional focus on what lies within the boundaries of the conservation area exclusively (Du Toit et al., 2003) because ecosystem function and livelihoods on the periphery of protected areas can have a significant impact on ecosystem services beyond the boundaries, and vice versa. This more integrated, holistic approach to conservation and sustainability was also emphasised by the Convention on Biological Diversity, which recently promoted a broader *ecosystem approach* as a strategy for the equitable management of land, water, and other resources in a way that promotes conservation and sustainable use (Convention on Biological Diversity http://www.cbd.int/ecosystem/default.shtml – accessed 30/04/2013).

Farming systems

In agriculture, Norman (2002) and Darnhofer et al. (2012) explain the gradual progression of farming systems thinking (Table 1-1). An initial segregated, predetermined focus, without any sustainable outcome for agricultural production, has evolved into a much more multidisciplinary and integrated approach to farming systems that focuses on sustainable livelihoods and their relation to the socio-economic and ecological context in which they exist. Farming systems research covers a broad range of topics, but always consists of three main characteristics, namely systems thinking, interdisciplinary approaches and participatory approaches to research (Darnhofer et al., 2012). Farming systems research has evolved into an approach that takes the environmental and social context of a farming system into consideration. It has been found that, in order to understand farming practices, a farm cannot be seen in isolation, but rather as a component embedded in a territory, a locale, and a region, with a specific agro-ecological setting, economic opportunities and cultural values (Darnhofer et al., 2012).

Poverty alleviation

Agriculture plays a significant role in rural development and poverty alleviation. A recent approach to and definition of poverty by the WWF suggested that the understanding of poverty has moved away from a very simplistic and heavily criticised 'one dollar a day' measure to something more encompassing (Dudley et al., 2008). Although simple measures are still used, the current emphasis of poverty alleviation tends to be much more holistic and integrated than the 'one dollar a day' kind of thinking. It acknowledges the multiple dimensions of the concepts of poverty and well-being and defines these within the context provided by environmental services as well as cultural, spiritual, economic, subsistence, and political dimensions (Dudley et al., 2008).

The technical sourcebook for Community Driven Development (CDD) of the World Bank (2002) defines poverty not just as a lack of income, but also a lack of voice, empowerment and governance. Based on Nobel Prize-winner Amartya Sen's list of five dimensions in which a deficit constitutes poverty, namely political space, economic space, social space, transparency and protective security, the implication is that poverty reduction should be aligned accordingly (The World Bank, 2002). The World Bank argues that poverty reduction therefore requires processes that help improve people's capabilities and functioning within these dimensions, which will enable such people to take charge of their destinies instead of being at the mercy of higher authorities. Hence, empowerment will increase the incomes of the poor whilst being a form of poverty reduction in itself. Empowerment entails real control by communities over resources, project/programme design and selection, implementation, as well as monitoring and evaluation (Binswanger-Mkhize et al., 2009).

Rural development

The World Bank has been very active in this respect and Binswanger-Mkhize et al. (2009) have reviewed the evolution of community development approaches applied globally since the 1950s (Figure 1-1). Again, the evolution highlights a move away from sectoral approaches to much broader, integrated and participatory approaches to community development.

Timeline of development approaches						Progression of community development
1950s →	1960s→	1970s/80s→	1990s→	2000→	2005→	
-Centralized -De-centralized						
	-Sectoral -Technology led/ 'Green Revolution' -Irrigation development					Consultation ↓
		-Special area / Target group -Area Development Programme (ADP) & Integrated Rural Development Programme (IRDP) -NGOs and Private sector	-Community-based development -Social funds			Participation ↓
				-Community Driven Development (CDD)	-Local & Community Driven Development (LCDD)	Empowerment

Figure 1-1: Timeline of development approaches applied globally since the 1950s (Binswanger-Mkhize et al., 2009)

The crucial development over time of community development approaches has seen a progression away from top-down, central governance systems, towards bottom-up approaches, in which real empowerment of communities is enhanced. Such approaches require governance systems and authority to be decentralised in order for communities to be able to take ownership and responsibility for their own development, in collaboration with local government and stakeholders. This approach is called Local and Community Driven Development (LCDD) and has been successful in many parts of the world, including Africa (Binswanger-Mkhize et al., 2009; Daniel, 2014).

Local and Community Driven Development is based on four core features, which form part of the vision for community-driven development as articulated by the Africa Region of the World Bank (Binswanger-Mkhize et al., 2009):

1. Real participation
2. Improving accountability
3. Technical soundness
4. Sustainability

Real participation towards the actual empowerment of communities at grassroots level is dependent on six critical factors that should be achieved through both political commitment and programme design:

1. Devolution of authority and resources
2. Real participation of primary stakeholders
3. A communication programme that provides a two-way flow of information
4. Co-financing by communities to promote local ownership
5. Availability of technical assistance and facilitation from the private sector and/or higher administrative levels
6. Pro-poor market development, including facilitation of producer/user groups that can federate upward to tap national and global markets

Similarly, Hodge and Midmore (2012) reported in their review of the evolution of rural development that the transformation of rural development since the end of World War II basically followed four predominant models: sectorial, multisectorial, territorial and local (Figure 1-2).

Importantly, Hodge and Midmore (2012) explain that implementation policies became increasingly more complex and integrated as development models became more decentralised and localised. The initial sectorial focus on agricultural commodities was replaced more and more often by models and policies that looked at diversified land use and economic options over and above mere agriculture-based strategies. In order to account for the increased complexity associated with the broader policy approach, the need to become more locally sensitive and specific in the development and governance model arose.

General policy orientation	Main models for rural development	Policy implementation
Agricultural policy	Sectoral	Commodity support
↓	↓	↓
	Multisectoral	Diversification
	↓	↓
	Territorial	Rural development
	↓	↓
Rural policy	Local	Local community development

Figure 1-2: The evolution of rural development policies. Adapted from Hodge and Midmore (2012)

Health and disease control

In the case of disease management, traditional approaches for the control of increased global pandemic health threats, mostly brought about by the emergence of novel and highly infectious (mostly zoonotic) pathogens, had to adapt. Disease prevention and control strategies rapidly evolved: from often unsuccessful and overly costly segregated, individual efforts, into complex and dynamic multidisciplinary and multi-stakeholder approaches (One Health Initiative Taskforce, 2008; Leach et al., 2010; Zinsstag et al., 2011). This more holistic and integrated approach to health threats evolved from the concept of 'one medicine', which acknowledges the link between the health of people and the animals that share their environment (Conrad et al., 2009; Zinsstag et al., 2011). The concept of 'one health' later emerged, which recognises the link between human, animal and environmental health and promotes systematic, multidisciplinary and multi-stakeholder approaches to the health challenges of today (One Health Initiative Taskforce, 2008; Conrad et al., 2009; Zinsstag et al., 2011).

Most recently, the even broader link between one health and social-ecological systems has been described, emphasising the complexity of the components and systems involved in our desire to achieve better health and well-being for all (Zinsstag et al., 2011). Zinsstag et al. (2011) further explain how animal and human health research over the past decade has had to face up to increasingly complex matters insufficiently addressed by, for instance, a basic primary health care approach. They go on to suggest that modern-day health challenges can be addressed only within the complex framework of 'health in social-ecological systems' (HSES). Such a framework provides for the complexity associated with the various systems and their respective components, dimensions, disciplines and scales that are involved in resolving threats to the health and well-being of people, animals and the environment.

In their review of the role of livestock in human nutrition, health and poverty alleviation, Randolph et al. (2007) explain the complexity associated with the role livestock plays in the livelihoods of the poor in rural Africa and elsewhere. They argue that recognition of the complexity of the role played by livestock in household decision making, and the movement away from various misconceptions linked to this role, will enhance the ability of livestock to contribute to human well-being in the developing world. These complex relationships between livestock, health and well-being and the livelihood strategies of the poor must be properly defined and described in order to generate a better understanding, which will lead to more effective and sustainable interventions (Shackleton et al., 2005; Randolph et al., 2007; Wrobel and Redford, 2010; Osofsky et al., 2012).

Holistic Management

Perhaps the synthesis thus far emphasises a fact which had already been described in the 1920s by South African philosopher and statesman Jan Christian Smuts, in his book *Holism and Evolution* (Smuts, 1936). Smuts questioned the trend in science to dissect, reduce and separate matters into disciplinary silos, when in fact they are inseparable and all part of wholes within a greater interconnected whole. He coined the word '*holistic',* which was subsequently included in dictionaries. He explained that the structure of the world is not simply 'stuff', but rather dynamic patterns and arrangements of stuff, which stand in intimate relation to one another, to form wholes with unique characteristics different from that of the stuff they consist of. He argued that the whole is greater than the sum of its parts, as opposed to what the mechanical tradition of science had generally suggested. The whole is therefore the only reality. Everything forms part of wholes within an even greater whole, starting from a cell in an organism through to its spiritual sense, emotions, and values (in the case of a human being). Importantly, Smuts argued that causality or external stimuli on a whole were absorbed and metabolised by the whole, and then became part of the action of the whole.

The work of Smuts was, in later years, instrumental to the development of the holistic management approach of Allan Savory, with a particular global impact on the management of natural resources both in communal farming systems as well as commercial ranches (Savory, 1999). In his approach, Savory argued against multidisciplinary and interdisciplinary approaches to farming systems, suggesting rather a focus on a holistic goal, focusing outwards through a holistic framework of decision making and action in order to reach the holistic goal. Savory's approach would, in the case of TFCA development (to use a self-constructed example), probably argue that all the attempts from all the various disciplinary fields described in this section (disease control, poverty alleviation, rural development, farming systems), as well as all concerned with TFCA development (communities, governments, NGOs, academia), would, at the end of the day, aim for the same goal: to have self-sufficient, healthy and prosperous communities in a TFCA where sufficient room is provided for wildlife to prosper and biodiversity to be conserved for future generations. With such a unifying, *holistic* goal, everyone, regardless of their scientific expertise or affiliation, starts to work outwards systematically, holistically, towards achieving the (holistic) goal.

As can be seen from the aforementioned examples, the focus of various disciplines has undergone a spontaneous evolution over the last several decades. The traditional narrow and exclusive scopes of conservation biology, health sciences as well as agricultural and rural development have broadened to incorporate more inclusive and holistic approaches in which all relevant disciplinary fields and stakeholders are integrated. This trend, which cuts across disciplines and which takes multiple scales into consideration, evidently arose due to the failure of previous silo-based attempts of an overly simplistic nature to effectively resolve emerging issues of increased complexity. Today, this trend can be seen in approaches to emerging infectious diseases and global pandemics, farming systems, conservation of ecosystems and the biodiversity they contain across multiple land use systems, and poverty and rural development amidst conflicting or ineffective policies, unemployment, land degradation and climate change – most of which are relevant to TFCA development (Du Toit et al., 2003; Thomson et al., 2004; Leach et al., 2010; Sinclair and Schaller, 2010; Klerkx et al., 2012).

Summary

Is there any significance to this general trend away from simplistic, fragmented approaches towards more holistic, integrated and multidisciplinary approaches that acknowledge the complexity of the relationships between all relevant factors, disciplines and actors at multiple levels? Based on this review, it can be argued that the significance lies in the fact that, given the complexity of these systems and the interconnectedness of all their components, any one challenge in any one component of a system cannot be sufficiently addressed without appropriate regard for all related components and systems. Furthermore, a general truth in systems thinking theory is that the optimisation of each individual component of a system will not necessarily optimise the entire system (Darnhofer et al., 2012). Whether referring to biodiversity conservation, farming systems, health management, poverty alleviation, or rural development in the southern African context, each is currently defined in the context of other aspects, and by its relation to the elements within a broader system. There seems to be no more room for approaches to important challenges that are simplistic, haphazard and disconnected from the overall context in which they occur (see Sinclair and Schaller, 2010).

Addressing the full complement of aspects and factors that play a role in TFCA development is beyond the scope of this thesis. Given the backdrop of complexity, and the 'holism' of TFCAs, we will begin to zoom in towards that which will form the core of this thesis. We will start by focusing on some crucial matters affecting livestock farmers in the Zambezi Region of Namibia, the centre of the largest TFCA to date: the KAZA. The Zambezi Region will also form the major focus area of the research conducted as part of this thesis. From there we will divert to study the literature regarding major aspects related to disease control, market access and market development at the wildlife-livestock interface.

1.1.3 The Zambezi Region of Namibia

In the Zambezi Region (ZR) of Namibia, as in many rural areas in southern Africa, livestock is considered the most important household asset or source of income in most households (Nyambe, 2013). However, in recent times tourism has become one of the largest and fastest-growing economic sectors in the world, and Africa has seen an annual increase of 12% in international tourist arrivals since 1990 (Muchapondwa and Stage, 2013). Tourism in Namibia, which consists mainly of eco-tourism, contributes 9% of GDP, which is higher than in Botswana and South Africa (Muchapondwa and Stage, 2013).

Namibia has been especially successful over the last two decades in developing community-based conservation initiatives through which rural communities can benefit directly. Since specific legislation was implemented in Namibia in 1996 to promote community conservancies, and the subsequent registration of the first conservancy in 1998, a total of 77 conservancies had been successfully implemented by the end of 2012. These conservancies encompass 19% of the country's surface area (Nuulimba, 2012). In the eastern ZR, a total of thirteen community conservancies had been formally gazetted by 2013 and comprised a total of 3 730 km^2 (35% of the ZR east of the Kwando River). Protected areas, which include three national parks, one forest reserve, and the conservancies, occupy 67% of the ZR surface area. The substantial growth in the development of conservancies is attributed to the significant benefits to rural livelihoods of eco-tourism, and of wildlife utilisation initiatives through such conservancy structures (Nuulimba, 2012). Furthermore, the ZR is situated in the middle of the Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) – a conservation area covering 520 000 km^2, which makes it the largest of its kind in the world[1]. The KAZA TFCA hosts the world's largest elephant population, an estimated 250 000 animals, and seeks to promote sustainable rural and socio-economic development through conservation and tourism initiatives.

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[1] Kavango-Zambezi TFCA: Peace Parks Foundation. http://www.peaceparks.co.za/tfca.php?pid=19&mid=1008 Accessed 14/06/2014.

The rapid increase in protected areas in the ZR, and the presence of large wildlife populations in neighbouring countries such as Botswana, has seen a significant increase in the presence of many wildlife species in recent years within the ZR. Most importantly, from an animal disease perspective, buffalo numbers along the main river systems and wetlands of the ZR increased by approximately 295% from 2004 to 2009 (Chase, 2009). With the majority of the estimated 145 000 cattle in the eastern ZR concentrated along the same wetlands, floodplains, and rivers as the more than 9 000 buffalo (Chase, 2009), substantial interaction between cattle and buffalo is inevitable. African buffalo are endemic carriers of the foot-and-mouth (FMD) virus, which is a potentially highly contagious epizootic disease affecting most large domestic and wild ruminants and which poses a severe disease risk, especially to livestock in and around conservation areas in southern Africa (Sutmoller et al., 2000; Thomson et al., 2003). Strict international convention is widely practised and translated into import/export policy by many countries, in order to limit the spread of FMD through trade in animals and animal products. Such policies are based on guidelines and recommendations provided by the World Organization for Animal Health (OIE) which is the international standards-setting body for such matters, mandated by the World Trade Organization. These practices require that exports are derived from countries or zones within countries that are free from FMD. However, in the context of FMD being endemic, especially in the African buffalo, these geographic-based disease control standards have been argued to be incompatible and impractical in the context of southern Africa's wildlife-livestock interface (Thomson et al., 2004; Scoones et al., 2010).

In the ZR, as in many other areas in southern and eastern Africa, very few hard fences exist and livestock and wildlife generally move freely throughout the available rangelands. There is substantial evidence of high levels of conflict between humans, their livestock and the many species of wildlife in the ZR, in the form of disease transmission, predation, and competition for resources (Bedelian et al., 2007; Butt, 2011; Nyambe, 2013; Caprivi Carnivore Project, April 2013). People in the ZR are poor (mostly earning below US$2/day) and unemployment is high (Nuulimba, 2012; Nyambe, 2013). With most households in the ZR relying on livestock and crops as well as fishing water systems for food security and income, conflict with and damage by wildlife can have a significant impact on their livelihoods. Hence, tension between conservation initiatives and agriculture such as livestock production could force land use to become less diversified, making livelihoods more vulnerable. For example, people may choose to promote livestock production at the cost of conservation initiatives, only to limit their potential livelihood strategies to agriculture that is vulnerable to climate change or disease outbreaks. On the other hand, conservation alone will not be able to sustain the people of the ZR in the short term, let alone alleviate the high levels of poverty. With a strong global and regional demand for beef, livestock owners can benefit significantly from their livestock should they be able to access reliable, formal markets consistently. Strategies that could make wildlife conservation and livestock production more compatible in areas such as the ZR are therefore regarded as essential to ensuring that rural communities optimise their available natural resources and assets in order to diversify their livelihood strategies (Osofsky et al., 2012; Thomson et al., 2013a).

Cattle farmers in the ZR are fortunate enough to have an export-approved abattoir available to them, through which they can access formal beef markets. However, due to the presence of FMD-infected buffalo, the entire ZR is classified as an FMD-infected zone. Cattle owners must therefore adhere to strict control measures in the form of FMD vaccinations, movement controls, and a 21-day quarantine period when they want to sell their cattle to the abattoir. Despite these disease control measures, FMD outbreaks are on the increase, not only in the ZR but in the entire southern African region (OIE Collaborating Center, 2011). During an FMD outbreak no movement of cattle or cattle products is allowed in the entire ZR and the abattoir closes for trade until the outbreak has passed – a period generally lasting a minimum of six months. Cattle farmers who rely on selling their cattle to generate cash for vital household expenses such as food and education are subsequently left with no alternative to waiting until the trade ban is lifted and livestock can again be moved.

In southern Africa the major strategy in place to reduce the risk of livestock contracting FMD from wildlife is the prevention of contact between livestock and wildlife, specifically buffalo, which requires physical separation, almost always in the form of fences. More and more evidence exists that the impact of veterinary cordon fences is detrimental to the integrity and thus the sustainability of natural ecosystems, the wildlife they sustain, and the tourism industry on which they rely (Gadd, 2012; Osofsky et al., 2012). Likewise, evidence shows that veterinary cordon fences can increase the social differentiation and vulnerability of certain marginalised groups at a regional level, and that a closer examination of the trade-offs and consequences of fences in terms of resource access is needed (McGahey, 2011). The financial implications of maintaining these fences are furthermore proving increasingly formidable, and reports of the movement of animals through these fences is generally on the increase.

Disease control measures therefore seem to have a major impact on the livestock-based economy as well as the livelihoods of most residents of the ZR. However, livestock farming and market access are part of the greater complex issues associated with TFCA development. Are there any strategies that can begin to address the impact that disease control measures as well as animal health disease risks have on the progress of TFCA development?

1.1.4 Commodity-based trade: a possible alternative approach

Recently, the OIE has adopted a standard, namely Article 8.7.25 of the Terrestrial Animal Health Code, which is not entirely based on the geographic origin and disease status of, for example, beef. In the context of the wildlife-livestock interface in TFCAs in southern Africa, non-geographic trade standards, such as commodity-based trade (CBT), can provide more feasible disease control strategies that are both safe to importers and fair to producers (Thomson et al., 2004; Scoones et al., 2010). The potential for non-geographic disease control policies to mitigate the barriers to both the development of rural livestock production and wildlife conservation in southern Africa prompted the Southern African Development Community (SADC) to endorse a resolution to promote approaches such as commodity-based trade (The Phakalane Declaration, 2012). CBT requires appropriate disease risk mitigation interventions along the entire value chain, in order to offer a specific beef commodity to a buyer when acceptably low levels of risk can be certified. The geographic disease status of the origin of the commodity is therefore not of importance, and the focus is on the steps taken from the point of production to the point of consumption, so as to manage any potential food health and safety risks. Yet very few, if any, countries have officially adopted this approach in their animal health control policies. Nonetheless, the aspirations of the OIE in its Global FMD Control Programme are clear:

"*It is also possible, and even desirable, for them* [FMD infected countries] *to acquire official FMD-free status for selected priority zones within the country before eventually applying to the OIE for recognition of FMD freedom for the entire country.*" (OIE Editorial, March 2012)

This approach undoubtedly exerts significant pressure on many African countries to invest in the necessary systems and strategies for mitigating FMD-associated risk to the point where FMD-free status can be achieved. Well intended as they may be, these approaches can be detrimental to already fragile interactions between two of Africa's most valuable natural assets – livestock and wildlife. FMD-free status is currently viewed as the only way to truly share in the promising opportunities presented by the global meat trade. Given the (largely unrealistic) aspiration for foot-and-mouth disease eradication in southern Africa (due to the increased presence and movement of buffalo), projects that could test and develop guidelines for the implementation of commodity-based or value chain approaches to disease control are vital. Perhaps of equal importance would be to ascertain the practicability of such an approach within the complex, rural environments characteristic of the wildlife-livestock interface within southern Africa's TFCAs (Cumming, 2011).

Many new approaches and technologies aimed at improving rural agriculture have failed in the past because their full social, ecological, and practical implications and consequences within the context of a specific area have not been comprehended or taken into account (Udo and Cornelissen, 1998; Darnhofer et al., 2012). This is certainly the case in communal crop-livestock production systems, where pure economic feasibility for the implementation of a new technology often does not guarantee its successful adoption or implementation. This is mainly because in rural communities, livestock does not have purely economic value: it is instead part of a more complex socio-economic and socio-cultural system, in which it fulfils multiple roles over and above having monetary value. Thus, conventional livestock commercialisation strategies, aimed mainly at increased trade in these systems, have been criticised (Dovie et al., 2006; Randolph et al., 2007; Vetter, 2013).

But is beef trade alone really the main focus? Beef produced in southern Africa is regarded internationally uncompetitive for various reasons, of which challenges regarding volume, disease control and carcass quality are among the most noteworthy (Scoones et al., 2010; Thomson et al., 2013a). Yet, the rich biodiversity and wildlife heritage within and in between vast protected wildlands in southern Africa is unprecedented and should be regarded as the global competitive edge of the region (Thomson et al., 2013a). In order to truly capitalise on this asset and the prospect of increasing the role a wildlife economy could play in the region, the many people living in or in close proximity to conservation areas must be seen to benefit from such developments (Cumming et al., 2013). With the role livestock still plays at household level in rural communities in and around conservation areas, the decision to expand protected areas will have to align with associated policies and standards that enable livestock production and trade, as opposed to the continuous promotion of separatist strategies. From this perspective, the possible increased compatibility non-geographic based trade standards offer land use systems at the wildlife-livestock interface is promising, because these look to diversity livelihood strategies rather than being limited to one or the other major land use option (Thomson et al., 2013a).

The question is, however, what the practical implications of non-geographic trade standards would be in an area such as the Zambezi Region of Namibia. Thomson et al. (2013b) have described what a value chain approach to disease control (specifically FMD control) along the beef production chain should look like in the ZR. Thomson et al. (2013b) propose an integrated approach to food safety and disease control in which prerequisite programmes and an HACCP (Hazard Analysis Critical Control Point) approach to food safety and quality is integrated with disease control measures along all components of the value chain, from primary production to distribution. The proposal is in line with the aforementioned non-geographic trade standard for FMD control in beef cattle (Article 8.7.25 of the OIE's Terrestrial Code for Animal Health, recently amended and updated to Article 8.8.22). The strategy proposes that farmers should comply with a prerequisite programme, which will address aspects of disease risk management and food safety, as well as the quality of the carcasses entering the value chain. It has been suggested that farmers commit, in the form of a 'farmer agreement', to comply with what can be regarded as good agricultural practices (GAP) in the context of the production system, including strategies such as participation in a mentorship programme that will help with improved animal management and production (carcass quality), as well as herding and kraaling of cattle as a means to avoid contact with wildlife (especially buffalo); and participation in animal health control measures such as dipping and vaccination programmes (Thomson et al., 2013b).

Since the publication of these proposals, no one as of yet has moved ahead in implementing such an approach. This may be partly due to the hesitation of countries to officially adopt the new standard, thereby delaying the necessary provisions for the implementation of such a value chain approach. But perhaps it is also due to the fact that there is much more involved in the implementation of such a model in the context of resource-poor, communal farming communities at the wildlife-livestock interface, especially in sub-Saharan Africa. Are such prerequisite programmes and the implementation of HACCP feasible in the particular context of small-scale farming at the wildlife-livestock interface? What do such prerequisite programmes generally entail and will farmers be able to comply with good agricultural practices? What is required for the introduction and successful implementation of a value chain approach for beef production and trade in a low-skill, resource-poor environment consisting mainly of small-scale and subsistence farmers, so that successful market participation is achieved? Will such an approach address the critical conflicts standing between feasible human-livestock-wildlife integration in a typical TFCA landscape?

Rich and Perry (2011) emphasise some of these concerns despite conceding to the potential of the approach as an alternative method for animal disease control. They describe three limitations of the potential impact of CBT in southern Africa in the immediate future, namely: (1) the *low quality* of the product in many production systems (especially communally produced beef); (2) the need to invest in *risk-management systems along the entire supply chain*; and (3) the need for *improved efficiency and productivity* for most of the African livestock sector. The relevance of these constraints to alternative control policies justifies their inclusion and emphasises the need for further research and development of further alternative control policies.

The following sections of the literature review will therefore consider briefly the main issues limiting production and product quality, as well as the systems and processes necessary to ensure product quality and safety.

1.1.5 Livestock production and beef quality

Natural resource base

The importance of the quality of the product, especially in the case of a very discerning overseas market, alludes to the importance of the availability and quality of natural resources, especially grazing, in the case of livestock production. Sub-Saharan Africa, especially eastern and southern Africa, still bears the most extensive natural rangelands in the world and encompasses semi-arid grassland, savanna, and shrubland (Wrobel and Redford, 2010). The characteristic low and variable productivity of semi-arid rangelands results in a constant state of change or transition, with only brief periods of stability (Scogings et al., 1999; Du Toit et al., 2003; Walker, 2010; Wrobel and Redford, 2010). This characteristic leads to the need for larger, interconnected areas in which wild and domestic herbivores have the space to adjust to temporal and spatial dynamics of available forage – well in line with the objectives of TFCAs that aim to conserve mega-herbivores in need of large landscapes. However, rangelands themselves, not just the wildlife inhabiting them, are threatened by a range of factors, including agricultural intensification, urbanisation, biofuel production, food prices, food demand, poverty, climate change, land degradation and even poor land use policies (Scogings et al., 1999; Wrobel and Redford, 2010). This competition and the options for use of the land among various land users is evident in some important wildlife-livestock interface environments, such as the Kruger to Canyons Biosphere Reserve in South Africa (Coetzer et al., 2013).

Yet, reviewers of CBT and its feasibility often overemphasise financial indicators and understate or exclude the potential ecological and conservation benefits, which could, if well defined, contribute to its feasibility as an alternative disease control option (Naziri, 2011; Rich and Perry, 2011). CBT has the potential to provide for disease control regulations that are much more compatible with mixed wildlife-livestock production systems and which will allow for more diversified survival strategies whilst, at the same time, biodiversity conservation is promoted (Osofsky et al., 2012). Similarly, the ecological impact of animal build-up (especially during FMD outbreaks) subjected to geographical control measures is often overlooked and could contribute to the degradation and reduced productivity of rangelands (Van Rooyen, 2012). The condition of rangelands in mainly grass-fed communal production systems has been known to influence livestock population dynamics over time – thus affecting their productivity and survival (Van Schalkwyk, unpublished data; (Angassa and Oba, 2007). It can therefore be argued that animal build-up due to inaccessible markets, brought about by unnecessarily stringent disease control measures, could result in a negative ripple effect throughout the entire production chain. Ultimately, the potential for rangelands to be adversely affected during prolonged periods of reduced off-take, such as during FMD outbreaks, is a reality. In these instances, pressured rangelands could negatively affect animal quality and productivity, increase health risks and losses and ultimately reduce the incentive for trade – all of which will have a negative impact on rural development, rangeland health, and ultimately livelihood sustainability.

This link between the natural resource base, animal productivity and health, and disease control at the wildlife-livestock interface must be investigated in order to understand the full impact of policy regimes as well as interventions.

Livestock performance in communal systems

The majority of people on the African continent live in in rural areas, and many depend on livestock as a major contributor to their livelihoods (Kock, 2005). Poverty and food insecurity are rife in Africa, and with the global demand for animal protein sharply rising over the last decade for various reasons (Kock, 2005; Steinfeld et al., 2006), the expectation that livestock could play a major role in poverty alleviation is justified (Randolph et al., 2007; Rota and Sperandini, 2010). Despite this opportunity and vast amounts of livestock, Africa remains a net importer of red meat and is still suffering from low livestock productivity in comparison to the rest of the world (FAO, 2013). Southern Africa is no exception. The latest report of the Food and Agricultural Organisation (FAO) of the United Nations (FAO, 2013), reported a 3.1% growth in beef production in South Africa between 2000 and 2010 and a 1.4% growth in sheep and goat meat production over the same period. South Africa's per capita growth in livestock production outperformed Africa and southern Africa, with an average annual growth rate of 2.8% over the 10 years between 2000 and 2010. Despite this positive growth and increases as high as 50% in red meat exports in 2008/2009 alone, the country was still importing 87.5% more beef than it was exporting in 2009 (FAO, 2013).

The significance of this statistic lies in the fact that the livestock production sector in South Africa, similar to that of Namibia, can largely be divided into two groups: 'commercial' farmers, including emergent farmers; and small-scale or subsistence farmers, generally operating on communally owned land. Approximately 70% of South Africa's land surface is privately owned farmland under commercial agricultural production systems and only approximately 14% is under communal tenure (Palmer and Ainslie, 2006). Yet, between 40% and 50% of the country's livestock population exists in these communal areas (Palmer and Ainslie, 2006; Moerane, 2008; Janeke, 2012). According to Dr Shadrack Moephuli, Director of the Agricultural Research Council of South Africa, livestock production in communal areas, despite large population sizes relative to that of the commercial sector, only contributes an estimated 5% to the national (formal) meat production industry (Janeke, 2012). According to the National Department of Agriculture (NDA http://www.nda.agric.za/ – accessed 02/07/2013), the productivity of communal beef cattle is significantly lower than that of the commercial sector beef cattle in South Africa. For example, the average calving percentage in communal herds is estimated at 40%, as opposed to between 65% and 85% in commercial herds. The pre-weaning and post-weaning mortality rates in communal herds are estimated at 50% and 15% respectively, compared to an estimated 4% and 2% respectively in commercial herds. Furthermore, the communal average weaning weight is estimated to be approximately 150kg as opposed to the approximately 180kg of the commercial sector. Over and above these limitations in performance, diseases, the lack of extension services, restricted market access and insufficient trade channels are further significant barriers to the communal livestock sector's contribution to national production and poverty alleviation (Moerane, 2008; Musemwa et al., 2008; Musemwa et al., 2010; Simela, 2012). Communal farming areas adjacent to conservation areas experience further challenges, in the form of stringent disease control measures, disease transmission risks, as well as human-wildlife conflict situations, to cope with (Moerane, 2008; Musemwa et al., 2008; Musemwa et al., 2010).

Considering the fact that most of the expansion in the supply of livestock products in developing countries is due to increased production (Steinfeld et al., 2006), the communal livestock production sector in South Africa has significant potential for improvement. However, the complexity of communal production systems and the range of challenges they face constrain progress. Compared to the commercial production sector, the communal livestock production system is highly complex, and blanket approaches based on conventional production technology transfer and extension models have generally failed in the past (Randolph et al., 2007; Darnhofer et al., 2012). The multiple uses of livestock and the by-products at household level in resource-poor communities are difficult to value in monetary terms and require an in-depth analysis, preferably by means of a systematic approach. Such an approach is required in order to arrive at the most suitable and sustainable development interventions and strategies to unlock the potential of the sector (Shackleton et al., 2005; Dovie et al., 2006; Randolph et al., 2007).

1.1.6 Prerequisite programmes and HACCP

The 1995 World Trade Organisation Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures makes provision for countries that import food to determine the appropriate level of protection (ALOP) for consumers. 'Food' is defined as any substance, whether processed, semi-processed or raw, which is intended for human consumption, including drinks, chewing gum and any substance that has been used in the manufacture, preparation or treatment of 'food' but excluding cosmetics, tobacco and substances used only as drugs (FAO/WHO, 13-17 March 1997). ALOP is based on a risk management programme, according to a code of hygienic practice for meat, which deals with all foodborne risks and hazards to human health based on the application of HACCP (Hazard Analysis Critical Control Point) (Codex Alimentarius Commission, 1999). The HACCP method is a systematic, scientific tool used to assess hazards pertaining to food safety and to establish preventative control systems in order to limit reliance on end-product testing (Codex Alimentarius Commission, 1999). The HACCP management system is based on seven universally accepted principles (Figure 1-3) through which food safety in all segments of the food industry – from production to consumption – can be addressed.

The analysis and control of biological, chemical and physical hazards, by means of critical controls of critical limits for hazards to all products, materials and processes along the value chain, ensure safe food for the consumer (FDA, 1997). Before HACCP is therefore applied to any sector of the food chain, such a sector should already be operating according to: (1) the Codex General Principles of Food Hygiene, (2) the appropriate Codex Codes of Practice, and (3) appropriate food safety legislation (Codex Alimentarius Commission, 1999).

1. Conduct a hazard analysis
2. Determine the critical control points (CCPs)
3. Establish critical limits
4. Establish monitoirng procedures
5. Establish corrective actions
6. Establish verification procedures
7. Establish record-keeping and documentation procedures

Figure 1-3: The seven HACCP principles

Prerequisite programmes are considered the foundation on which a successful and effective HACCP programme is built (FDA, 1997; Mortimore, 2000; Schmidt and Newslow, 2013). Sperber (2005) argues that without prerequisite programmes HACCP cannot be implemented 'from farm to fork' due to a lack of appropriate critical controls regarding many components of the value chain. In these instances, prerequisite programmes are better suited to deal with food safety hazards; hence a reference to 'Farm to Table Food Safety' as opposed to 'Farm to Table HACCP', which is proposed in food safety control measures (Sperber, 2005).

A prerequisite programme embodies all the appropriate day-to-day practices regarded as important to food safety, such as sanitation practices, management practices, chemical handling and storage practices, pest control, etc. (Sperber, 2005; Schmidt and Newslow, 2013). In food manufacturing these practices are often called Good Manufacturing Practices (GMPs), or Good Agricultural Practices (GAPs) in the case of agricultural production systems (FDA, 1997; Schmidt and Newslow, 2013). Prerequisite programmes differ from HACCP in that they deal not only with a narrowly defined scope of food hazards, but are also concerned with ensuring that foods are wholesome and suitable for consumption (i.e. food quality) (FDA, 1997). Prerequisite programmes should be adapted according to specific conditions or scenarios in order to provide the appropriate platform for an HACCP plan, and it is essential that all prerequisite programmes be well documented and regularly audited (FDA, 1997). This is generally achieved by means of well-defined and well-documented standard operating procedures (SOPs) (Schmidt and Newslow, 2013).

Food safety is therefore not synonymous with HACCP in isolation, but with HACCP in conjunction with prerequisite programmes (Sperber, 2005). An extensive study by Horchner et. al. (2006), which applied an HACCP-based approach to the development of an on-farm food safety programme for red meat in Australia, identified only three critical control points that were required along the value chain. These were for: (1) bovine spongioform encephalopathy (BSE); (2) the prevention of violations of maximum residue limits for agricultural and veterinary chemicals; and (3) infection with *Cysticercus bovis*. Horchner et al. (2006) concluded that the application of a simple set of good agricultural practices on-farm would be effective for ensuring sufficiently low risks pertaining to food safety. Full HACCP plans at the individual producer level were therefore not warranted, as long as appropriate GAP was in place. The study was subsequently able to produce an HACCP-based food safety scheme conforming to the essential elements that underpin the successful implementation and compliance by industry of a food safety scheme: being scientifically justifiable, understandable, and realistically applicable.

1.1.7 Good Agricultural Practices

Good Agricultural Practices (GAPs) are defined by the FAO (2003) as those *'… that address environmental, economic and social sustainability of on-farm processes, and result in safe and quality food and non-food agricultural products'*. Generic guidelines for the development of GAPs for primary production and the subsequent stages of food value chains have been developed by independent international institutions such as the FAO (FAO, 2004) and the OIE (OIE, 2009). The OIE guidelines are aimed at assisting higher-level authorities ('Competent Authorities') who then should assist in the development and implementation of GAP by farmers and stakeholders at grass-roots level, with whom the responsibility for adopting good practices ultimately lies.

The guidelines put forward by the FAO were developed to complement international standards for meat safety and sanitary measures, as documented by, for example, the Codex Alimentarius Commission (Codex Alimentarius Commission, 1999), and the OIE and World Health Organization (WHO) (FAO/WHO, 13-17 March 1997). Although these guideline documents focus mainly on food safety and general hygienic considerations for primary production, they also state the importance of addressing animal health and welfare, socio-economic matters, and environmental issues. This added focus was brought in specifically to prevent GAPs that promote a standoff: between what is sustainable and socially acceptable, and that which is safe and of acceptable quality.

The OIE GAP document provides less detail in comparison to the FAO GAP guideline document and covers less topics of relevance to general GAPs (Figure 1-5 and Error! Reference source not found.).

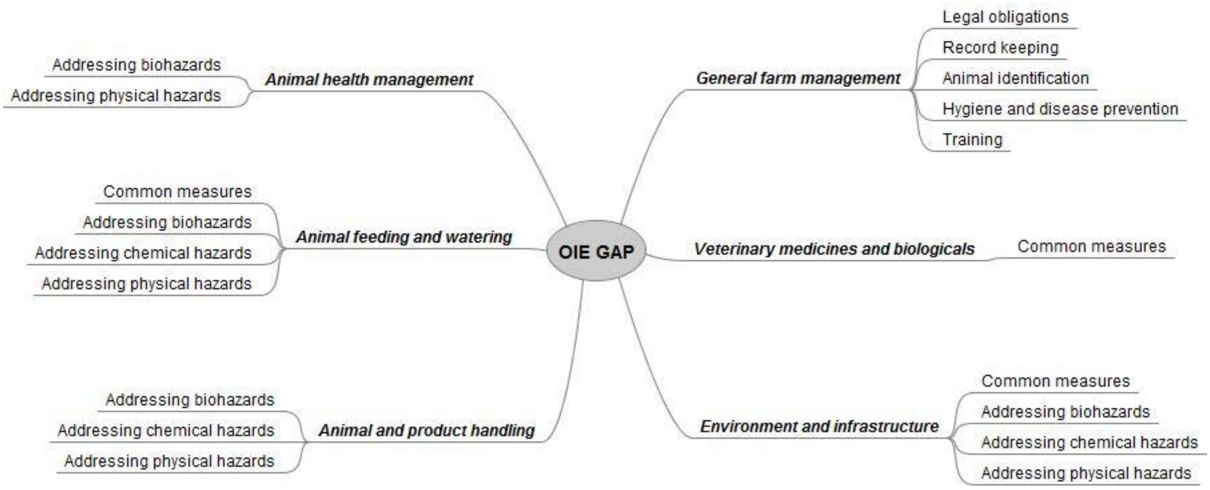

Figure 1-4: Schematic layout of the guidelines for developing GAP by the FAO (FAO, 2004)

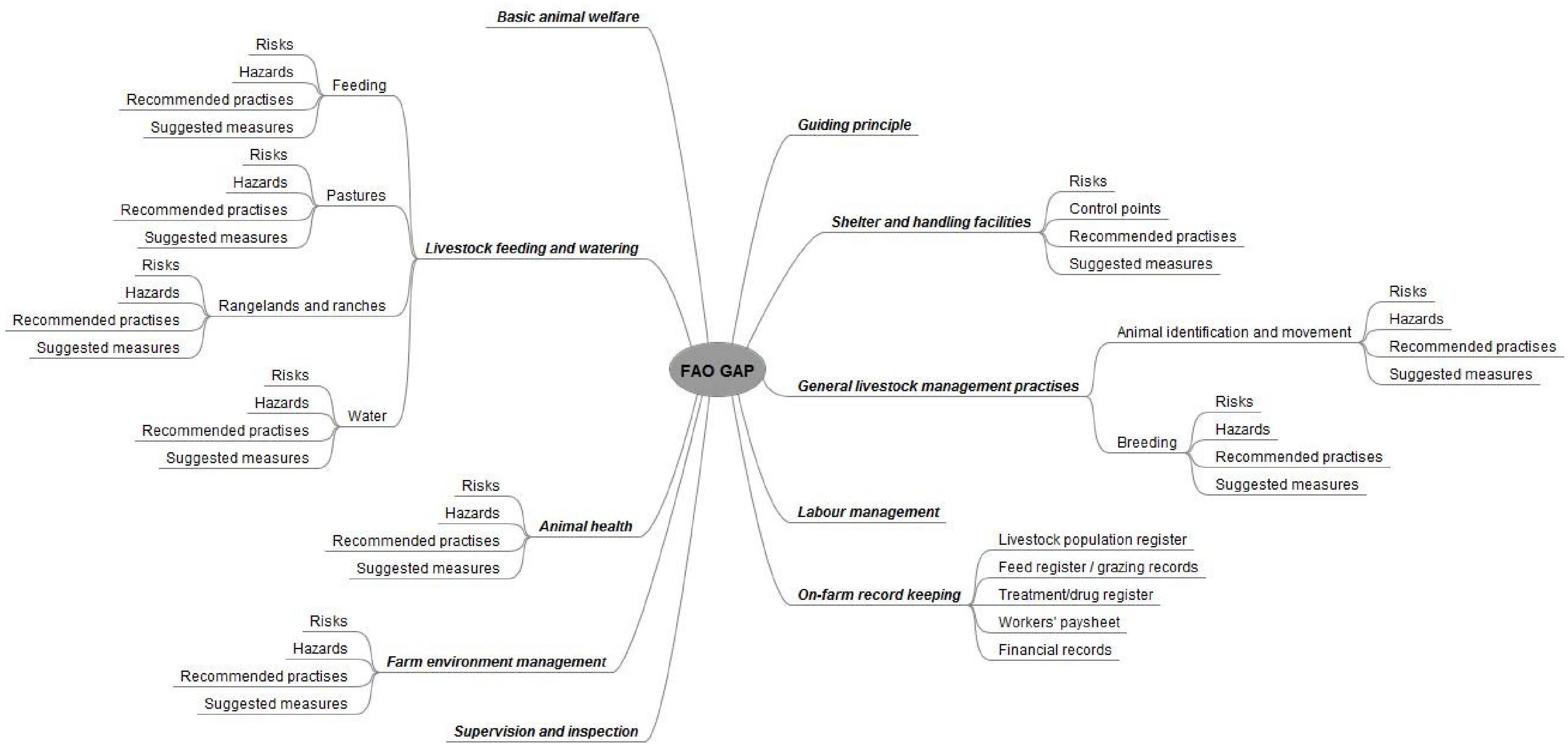

Figure 1-5: Schematic layout of the guidelines for developing GAP by the FAO (FAO, 2004)

The FAO GAP document clearly states that the philosophy behind the guidelines has not been to create elaborate and detailed standards, but rather to outline common-sense practices that will be easy to implement. It therefore contains much more practical detail, applicable to the implementation of GAP, than the OIE GAP guidelines (FAO, 2004).

The important factor highlighted by both documents, however, is that these guidelines have to be adapted and tailored to fit applicable farming systems and the relevant local conditions. In order to achieve this, a multidisciplinary, holistic approach is recommended (FAO, 2004; OIE, 2009).

The FAO GAP guidelines for primary production conclude that the implementation of good practices in the primary production sector necessitate the following processes (FAO, 2004):

- Sensitisation of the primary producers regarding the required practices
- Research to determine what standards should be applicable and to elaborate on a set of standards, in line with the GAP guidelines, that would be both acceptable and practical to the farmers as well as acceptable to the markets they serve
- A series of farmer training initiatives as well as training of all other relevant stakeholders: such training should then be followed by a gradual phasing in of the relevant standards on cooperating farms

A major influence of the FAO GAP guideline document, as well as of the GAP guidelines subsequently developed by the OIE, was the Sustainable Agriculture and Rural Development (SARD) Initiative of the FAO and its partner organisations. The SARD Initiative, in summary, is as follows (Powell, 2006):

"…a multi-stakeholder umbrella framework that supports the transition to people-centred development and works to strengthen participation in project and policy development to achieve sustainable agriculture and rural development. The SARD Initiative links resources, expertise, knowledge and technologies with the demands of rural communities and disadvantaged stakeholders and communicates lessons relating to SARD to promote wider use of existing resources and the distribution of benefits."

The SARD Initiative strives to achieve sustainable agriculture and rural development through fostering relationships at global and national levels, whilst being led by a unique combination of civil society, government, and intergovernmental organisations (SARD Initiative, 2008). The SARD Initiative therefore combines good practice and good policy by working at both global and national levels, and with both governments and civil societies. The SARD Initiative achieves its objectives by focusing mainly on three themes (SARD Initiative, 2008):

1. Securing access to resources for the rural poor
2. Fostering fairer conditions of employment in agriculture and rural areas
3. The promotion of good practices for sustainable agriculture and rural development

1.1.8 Market access, poverty alleviation and rural development

There is an important link between sustainable rural development, poverty alleviation and market access. In the context of LCDD, the World Bank regards pro-poor market development as an essential element of community empowerment. Binswanger-Mkhize et. al. (2009) states that higher income, brought about by improved market access, is an essential form of empowerment. Such market development requires pro-market policies that enhance the capacity of poor people to benefit from participation in provincial, national and global markets. This will only be achieved if good macro-economic and sectoral policies exist, as well as good governance and the enforcement of property rights, which encourage entrepreneurship (Binswanger-Mkhize et al., 2009). The World Bank sourcebook for Empowerment and Poverty Reduction (Deepa, 2002) classifies pro-poor market development according to three categories: access to information, inclusion/participation, and local organisation capacity. Although the macro-economic climate needs to favour job creation and enterprise development, economic growth will not be sustainable if poor citizens are excluded from optimal engagement in productive activities. Pro-poor market development therefore requires bottom-up liberalisation of governance, and resource control, through which poor people can have equal access to economic opportunities. This is often not the case, due to regulatory barriers, lack of information and connections, insufficient skills, limited access to credit providers, and discrimination. A market-oriented approach is therefore recommended and considered crucial in order to avoid unsustainable and ineffective development programmes (Deepa, 2002).

Food standards drive vertical coordination in globalized agri-food chains, and are becoming increasingly important (Swinnen and Maertens, 2007). Swinnen and Maertens (2007) have argued that the increasing importance of high-value agricultural markets, increased and more stringent standards, and modern supply chains can have one of two implications for the poor:

1. They can create important opportunities for enhancing agricultural production and for increasing rural incomes and reducing poverty in developing countries, or;
2. They can impose major challenges for these countries and their most resource-constrained households.

The opportunities mentioned in (1) above are based on examples from various parts of the world, such as south Asia and Africa, where poor households and/or small-scale farmers were contracted to produce for high-value export markets. Rural households can typically be integrated in high-value supply chains by offering household gains in the form of greater productivity, bigger profits and higher incomes. Other benefits may include higher direct income from contracts and wages as well as due to household and farm spill-over effects. (SARD Initiative FAO, 2007; Swinnen and Maertens, 2007)

According to Swinnen and Maertens (2007) the risk of marginalisation, especially for small farmers and poor households, brought about by the requirements of high-value supply chains, poses important challenges in developing countries where there is a substantial heterogeneity in farm structures, and where there is a mixture of large-, medium- and small-scale farms/farmers. Equity by means of ensuring the participation of rural farmers in high-value supply chains and the equitable distribution of benefits is therefore a concern for pro-poor development initiatives. Swinnen and Maertens (2007) proposed that a strategy to overcome factors that negatively influence equitable participation in value chains, by means of, for example, reducing transaction costs and enhancing the bargaining power of farmers, is the formation of farmers' associations.

The aspects mentioned above that contribute to poverty, such as the lack of market access, can cause the poor to become trapped in a cycle of poverty. Poverty traps are defined as those situations that create an environment in which poverty persists despite periodic relief (Carter and Barrett, 2006). Improved access to markets and the improved valuation of the asset base of poor farmers is critical for them to be able to break out of poverty traps (Carter and Barrett, 2006). Similar emphasis is placed on improved market access, and in the role livestock could play in terms of a pathway out of poverty in many developing countries (Rota and Sperandini, 2010).

1.1.9 Value chain development approaches

In order to address the dilemma involved in providing better markets and market access to poor producers, a value chain development approach has been promoted by various pro-poor rural development agencies (see Donor Committee for Enterprise Development (DCED) www.Enterprise-Development.org; ACDI/VOCA www.acdivoca.org and USAID www.usaid.gov – all accessed 18/10/2015). A value chain development approach takes a holistic, market-systems approach to all components and actors along a chosen value chain so as to look for ways to improve participation by the poor. It is argued that markets are the main means through which people participate in economic activity, and that the incomes of the poor will be improved by increasing the turnover/profit of poor entrepreneurs, creating employment, and stimulating economic growth.

Local value chain development is an approach that seeks to integrate the principles of Local Economic Development (LED) and Value Chain Development (VCD) in order to strengthen competitiveness and to promote integration of SMEs into markets (Herr and Muzira, 2009). This approach aims to identify opportunities and constraints of a particular (single) local sector and its associated market integration. The approach aims for the improvement of cooperation between stakeholders of a particular sector by focusing on five triggers (Herr and Muzira, 2009):

1. System efficiency
2. Product quality and specifications
3. Product differentiation
4. Social standards
5. Environmental standards

One of the biggest barriers to market involvement of the poor is the degree to which they are vulnerable to shocks. They are generally unable to mitigate potential risks linked to market participation, due to inadequate financial or social assets (Fowler and Brand, 2011). This situation results in the generally risk-averse behaviour of the poor and often results in the poor responding differently to incentives. Specific attention must therefore be given, when designing and implementing value chain development projects, to the realities and perceptions of the poor (Fowler and Brand, 2011; Fowler, 2012). A crucial aspect in designing pro-poor value chains is the scale at which this is done. Pro-poor value chain development initiatives are often focused on small target groups in a specific context in order to overcome broader market and governmental failures to initiate sustainable market development initiatives[2].

When risk in pro-poor value chain development is considered, particularly in agricultural supply chains, Jaffee et al. (2008) state that an awareness of the multiplicity of risks facing agricultural supply chains is imperative, and caution against 'silver bullet' or 'one-size-fits-all' solutions. In the context of this thesis, which emphasises the importance of management for sanitary and phytosanitary risks along the beef value chain, it is important to acknowledge that such risks are but one component among many

[2] See 'How market development approaches lead to pro-poor impacts' http://dced.net/page/rationale-for-market-development. DCED. Accessed 18/10/2015.

others that value chain participants, especially resource-constrained producers, need to consider. This fact is emphasised by Smith et al. (2000) who demonstrate the significant heterogeneity of risk exposure within east African pastoralist communities. A summary of the main risk categories that should be considered during development is provided in Table 1-2.

Jaffee et al. (2008) emphasise the need to better understand the underlying conditions for the management of risks throughout the value chain. These conditions include the incentives, capacities, and opportunities for management of multiple risks. In their report on a method to analyse the multiple risks along an agricultural supply chain, Jaffee et al. (2008) conclude that a commodity sub-sectoral development strategy that ignores considerations for (multiple) risks and risk management will be incomplete, and therefore propose that a supply chain risk assessment be conducted to supplement contemporary value chain analysis.

Table 1-2: Categories of major risks facing agricultural supply chains (Jaffee et al., 2008)

TYPE OF RISK	EXAMPLES
Weather-related risks	Periodic deficit and/or excess rainfall, extreme temperatures, hail storms, strong winds
Natural disasters (including extreme weather events)	Major floods and droughts, hurricanes, cyclones, typhoons, earthquakes, volcanic activity
Biological and environmental risks	Crop and livestock pests and diseases, contamination related to poor sanitation, human contamination and illnesses, contamination affecting food safety, contamination and degradation of natural resources and environment, contamination and degradation of production and processing processes
Market-related risks	Changes in supply and/or demand that impact domestic and/or international prices of inputs and/or outputs, changes in market demands for quantity and/or quality attributes, changes in food safety requirements, changes in market demand for timing of product delivery, changes in enterprise/supply chain reputation and dependability
Logistical and infrastructural risks	Changes in transport, communication, energy costs; degraded and/or undependable transport, communication, energy infrastructure; physical destruction, conflicts, labour disputes affecting transport, communications, energy infrastructure and services
Management and operational risks	Poor management decisions in asset allocation and livelihood/enterprise selection, poor decision making in use of inputs, poor quality control, forecast and planning errors, breakdowns in farm or firm equipment, use of outdated seeds, lack of preparation to change product, process, markets; inability to adapt to changes in cash and labour flows
Policy and institutional risks	Changing and/or uncertain monetary, fiscal and tax policies, changing and/or uncertain financial (credit, savings, insurance) policies, changing and/or uncertain regulatory and legal policies and enforcement, changing and/or uncertain trade and market policies, changing and/or uncertain land policies and tenure system, governance-related uncertainty (e.g. due to corruption), weak institutional capacity to implement regulatory mandates
Political risks	Security-related risks and uncertainty (e.g. threats to property and/or life) associated with socio-political instability within a country or in neighbouring countries, interruption of trade due to disputes with other countries, nationalisation/confiscation of assets, especially for foreign investors

1.1.10 Concluding remarks

Randolph et al. (2007) conclude their review of the role livestock plays in human nutrition and health and for poverty reduction in developing countries with the following statement:

"An over-arching conclusion is the need for a systems perspective and poverty lens for research on livestock production and health in developing countries."

Randolph et al. (2007) continue to explain that a general lack of knowledge implies the need for carefully designed, empirical research that includes *environmental* and *social* considerations, preferably combined with a *systems modelling approach.* Such an approach will help to untangle the complexity and will lead to the development of practical guidelines and best practices for the design of feasible livestock interventions. In their review of conservation issues associated with wild rangelands, Wrobel and Redford (2010) emphasise the importance of a better understanding of the complex systems associated with rangelands and their inhabitants. The objective will then be to develop approaches to ensure that the resilience of these social-ecological systems will prevail in the face of economic, social, environmental and climate changes (Wrobel and Redford, 2010). In addition, Cumming (2011) reveals the lack of sound spatial and temporal information on biodiversity, land use, and human welfare (including the incidence and prevalence of diseases) in TFCAs throughout southern Africa. In another review, Osofsky et al. (2012) have evaluated the immediate needs, in terms of animal health management and disease control, which may affect the progress of the Kavango-Zambezi (KAZA) TFCA. They conclude that alternative disease control policies are essential for meeting the objectives of integrated multiple land use systems that are both pro-poor and pro-conservation. Furthermore, they emphasise the significant information and knowledge gap in terms of our understanding of diseases with economic relevance in these complex systems. This gap will limit the ability to argue for much-needed policy change, towards a more beneficial disease control regime for our region (Osofsky et al., 2012).

None of these matters can be addressed in isolation, and an integrated, holistic approach is imperative. But, in order to arrive at feasible and sustainable solutions, all the components of these systems must be unpacked, studied and understood. It is clear from the preceding overview of relevant literature that the shortfalls related to the wildlife-livestock interface within the southern African context, pertaining to conservation, livestock production, disease risk and control, trade, poverty alleviation and rural development, are complex and closely interconnected. Any attempt to contribute to our understanding of these systems and networks must therefore not shy away from complexity, but rather use every opportunity as well as newly available scientific methods to unravel it further. Similarly, any attempt at an alternative approach or solution to any of the many challenges faced must also be based on multidimensional evaluations aimed at deriving the best possible solutions or interventions within a particular context.

The importance of contributions to our understanding of the livestock production and health systems at the wildlife-livestock interface and how these may be affected by various policies, as well as their significance to rural development, biodiversity conservation, and disease control, is therefore imperative.

1.2 STUDY OBJECTIVES

The proposed integrated value chain approach of Thomson et al. (2013b) for the management of risks and for meeting the requirements for food safety, FMD control, and to an extent food quality along the beef value chain, provides a good framework for addressing risks as prescribed by the non-geographically based standard in the Terrestrial Code for Animal Health (OIE). However, it does not provide a clear mechanism through which to create and establish an enabling environment at the point of beef production that could successfully address gaps, concerns and skill shortages, which constrain primary producers at the wildlife-livestock interface. Many of the issues discussed in the literature review, often specific and unique to each local community, village or household, can be barriers to complying with the quality and safety standards the market stipulates; hence forming a barrier to equitable participation. The literature review has clearly indicated that an approach looking to take advantage of the non-geographic trade standard for international trade in beef must first analyse the realities of the farmers and their environment at grassroots level. The study and understanding of pastoralists' perceptions, their knowledge and skills, risks, and the gaps, constraints and opportunities of the systems in which they live and farm livestock, are essential to formulating an approach that can feasibly and successfully be used to set producers up for broad-based participation in opportunities provided by non-geographic trade standards, such as the proposed integrated value chain approach. Failing to do so might lead to minimal buy-in from producers or even policy makers, which may in turn result in unfeasible and even unfair requirements for participation in market opportunities, and the opportunity to find solutions at grassroots level that could alleviate the ever-growing animosity between conservation efforts and farming systems may be lost.

This thesis therefore aims to focus on the point of production, which is the first component of the proposed value chain approach of Thomson et al. (2013b), in the context of communal farming systems at the wildlife-livestock interface in and around TFCAs in southern Africa. It aims to analyse the production, health, trade and ecological systems in which communal cattle farmers at the wildlife-livestock interface subsist. The study aims to highlight the perceptions, constraints and opportunities experienced by farmers in the context of their environments, in order to provide further evidence for or against current approaches to disease control and how these relate to the proposed value chain approach of Thomson et al. (2013b). Finally, it aims to use the information and knowledge gained through analysis to propose an integrated, holistic approach at the point of production, taking into consideration crucial factors that may provide a mechanism that would enable communal cattle farmers, both large and small, to participate successfully in the proposed integrated value chain approach in ways that make livestock production and wildlife conservation more compatible.

1.3 Structure of Thesis

The structure and topical content of this thesis is as follows:

- **Chapter 2:** Study areas and methodological approach
- **Chapter 3:** Perceptions regarding livestock health and production at the wildlife-livestock interface
- **Chapter 4:** Perceptions regarding wildlife and conservation at the wildlife-livestock interface
- **Chapter 5:** Spatio-temporal variation of grazers and grazing in the Zambezi Region of Namibia: limitations and influence on rangeland utilisation and carcass quality
- **Chapter 6:** Spatio-temporal analysis of formal beef trade in the Zambezi Region of Namibia
- **Chapter 7:** Herding for Health: An integrated model to community-driven value chain development for beef trade at the wildlife-livestock interface

2 Study Areas And Methodology

2.1 Introduction

For the purposes of the research presented in this thesis study areas had to be in communal pastoralist communities situated at the wildlife-livestock interface in or adjacent to TFCAs in southern Africa. The study areas selected had to be situated within FMD control zones in which market access and the movement and trade of livestock and beef were affected by national and/or international standards and measures associated with the control of FMD.

Two study areas were therefore included in this research:

1) The Zambezi Region (ZR) of Namibia, or previously known as the Eastern Caprivi
2) The Mnisi Study Area (hereafter referred to as 'Mnisi Study Area', or MSA) within the Bushbuckridge Local Municipality, Mpumalanga Province, South Africa

Both these areas are situated in or adjacent to a TFCA with a prominent wildlife-livestock interface in which both cattle and wild buffalo populations occur, and hence both these areas are also situated within FMD protection/infection zones with vaccination. The nature of the wildlife-livestock interface at the MSA is a hard, game proof fence which separates wildlife conservation areas from communal grazing areas. The interface in the ZR is, however, soft, dynamic and diffuse in that wildlife, livestock, and communities share the rangelands without any form of fence/hard barrier in between land uses for the most part.

Research activities within the MSA formed part of the Mnisi Community Programme of the Faculty of Veterinary Science, University of Pretoria, in close collaboration with and financial support from both the Institute for Tropical Medicine (ITM), Antwerp, Belgium and the Faculty itself. Research activities included in this thesis that were conducted in the ZR formed part of a project coordinated by the Meat Board of Namibia to specifically investigate and promote the development of market opportunities for beef producers in the ZR of Namibia (Meat Board of Namibia, 2014). This project was funded by the Millennium Challenge Account – Namibia (USAID). The researcher was involved in both programs since the year 2008 in various capacities ranging from postgraduate student, research coordinator, institutional coordinator, to technical expert. Data collected by the researcher in both study areas is presented in this PhD thesis. All research presented in this thesis was original work by the author and was conducted either individually or as part of a bigger team with support from research assistants, colleagues, and experts.

2.2 Study Areas

2.2.1 Zambezi Region, Namibia

The Zambezi Region (ZR) of Namibia is a very large and diverse area which have been extensively described in the literature review of Chapter 1. Due to the specific objectives of the research planned for this area, one of the most important criteria used for the selection of study sites was the distribution of buffalo in the ZR. The African buffalo *Syncerus caffer* is the endemic carrier of the FMD virus and is considered the most important wildlife species as far as FMD control in southern Africa is concerned (Thomson et al., 2003; Thomson and Bastos, 2004). Buffalo further play an important epidemiological role in the risk posed by various infectious diseases other than FMD to livestock, such as cattle (Michel and Bengis, 2011). Based on the distribution of buffalo from two reports (Du Preez and Naidoo, 2008; Atkinson, 2011), three areas in the ZR were selected for fieldwork; Lizauli and Sangwali areas along the Kwando River near the Mdumu and Mamili National Parks, western ZR, and the Kasika area next to the Chobe River in the far eastern corner of the eastern floodplains (Figure 2-1). The three selected areas were in some of the most remote areas of the ZR furthest removed from infrastructure and the market in Katima Mulilo. The objective of the research that entailed these study areas were specifically aimed at gaining a better understanding of the risks and challenges experienced by cattle farmers possibly in frequent contact with wildlife and far from the formal market. Not selecting study areas in areas not affected by wildlife and possibly closer to the formal market in Katima Mulilo to serve as a control might be considered a limitation of the study. However, quantitative data from most crush-pens throughout the ZR were used in analyses and reported in several chapters. The mixed method surveys of the selected study areas in the remote areas of the ZR were therefore used to help generate appropriate hypothesis that could be tested with quantitative data sets representative of the ZR. , and to gain insight into perceptions of farmers (Curry et al., 2009).

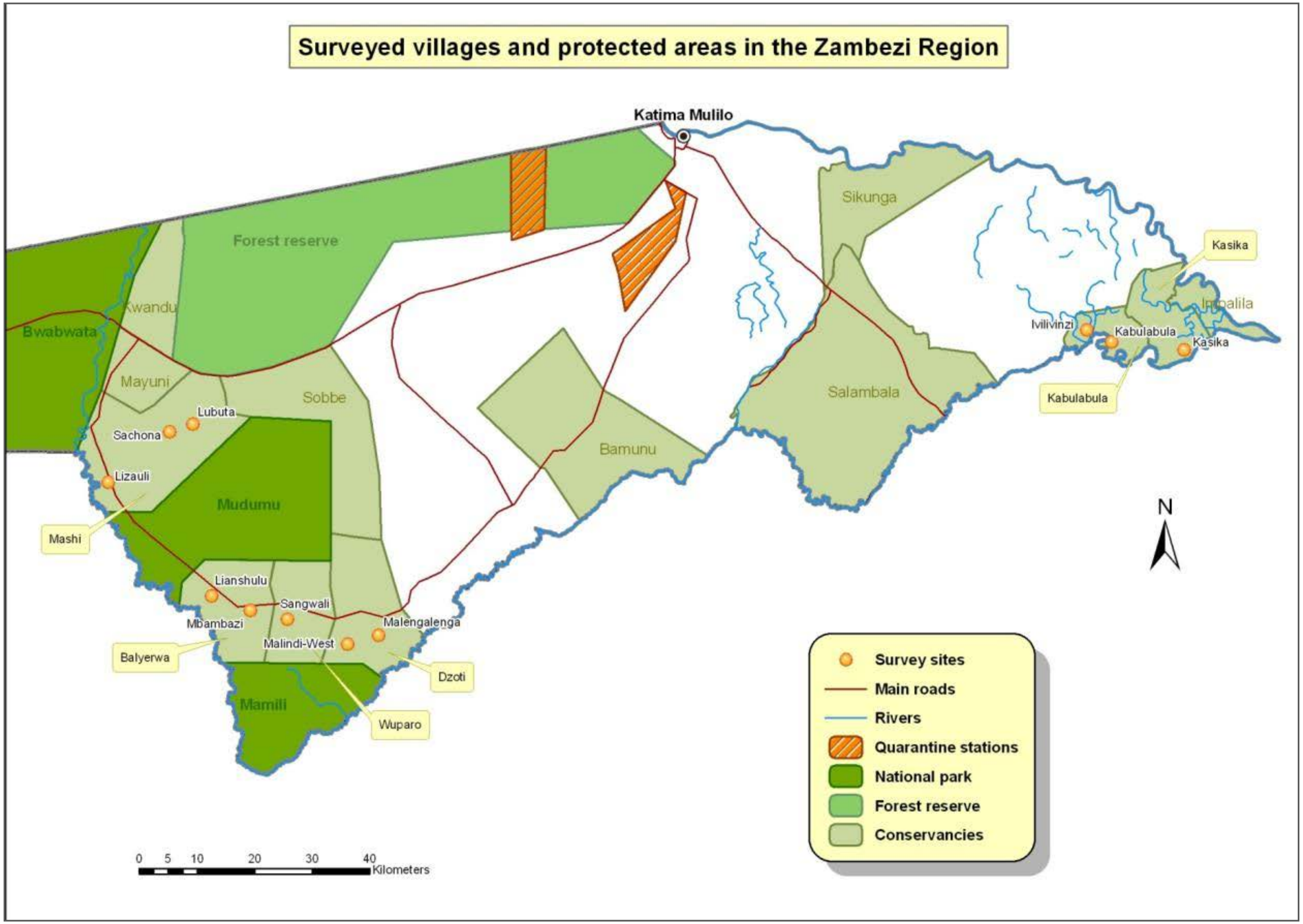

Figure 2-1: The selected survey sites relative to the position of quarantine stations and protected areas in the Zambezi Region, Namibia

Source of conservancy layers: http://www.the-eis.com – accessed May 2014

2.2.2 Bushbuckridge Local Municipality, South Africa

In South Africa, the Department of Rural Development and Land Reform developed the Comprehensive Rural Development Programme (CRDP) to address pressing matters in rural areas which includes underdevelopment, hunger and food insecurity, poverty, unemployment and lack of basic services. The CRDP takes a holistic, multiple stakeholder and participatory approach to matters related to its three main pillars, namely; Land Reform, Agrarian Transformation and Rural Development (Fact Sheet: CRDP www.ruraldevelopment.gov.za – accessed 26 April 2013). Similarly, the Department of Environmental Affairs launched an initiative that will target selected resource-poor communities in rural areas around protected areas to develop and expand a sustainable wildlife economy – addressing the issues of poverty, job creation, business development and sustainable rural development (*8Linked* consultative meeting – Bushbuckridge, April 2013). Both these initiatives by national government have made the Bushbuckridge Local Municipality (BLM), Mpumalanga province a target area for the implementation of related pilot projects and the role-out of these initiatives. This local focus comes on the back of the BLM being identified by the National Government of SA as one of 14 rural poverty nodes in which rural development and economic upliftment must be prioritised (Monitor Group, 2006).

In its profiling evaluation of Bushbuckridge, the Monitor Group (2006) assessed the potential and associated limitations, opportunities and barriers of every possibility for economic development in the area. They identified that, based on the approximately 70,000 cattle in the BLM, the potential for beef production is one of the major opportunities for economic development. However, this potential is significantly constrained by strict movement controls imposed by national disease control measures and the resultant inability of producers to access and benefit from better markets. Ecological constraints in the area were also identified as possible limitations to the potential for beef production (Monitor Group, 2006). Likewise, in his assessment of the constraints to beef production in especially the communal areas of South Africa, Moerane (2008) identified the lack of access to markets due to current FMD control policies as one of the most important limitations to rural development and the beef sector in areas where FMD-associated movement control is implemented. The report by the Monitor Group (2006) further identified that the general lack of targeted activity within agricultural development in the area resulted in considerable income potential from the agricultural sector that remained latent. Evidence in the form of numerous former Development Corporation projects lied dormant throughout the area and therefore contributed to the subsistence-nature of agriculture. The report by the Monitor Group (2006) clearly stated that; *'Targeted interventions could develop subsistence to smallholding activity with creation of slight disposable income; and small holding farmers could move up into a more commercial area, generating stronger inflow of capital into the area.'* The report also identified the commercialisation strategy of the regional Department of Agriculture in which it wants to move farmers up the value pyramid – from subsistence to smallholding to commercial farming (Monitor Group, 2006).

Despite the identified potential for beef production in the BLM profiling report by the Monitor Group (2006), recent reports by the BLM outlining strategies for Local Economic Development clearly regarded the livestock sector as purely subsistence orientated without any potential for development, and therefore did not justify substantial investment in its development (Bushbuckridge Local Municipality, 2009). The BLM LED 2010 - 2014 strategy report (Bushbuckridge Local Municipality, 2009) stated that the development of the livestock sector through formalisation and value-adding initiatives are unlikely to be successful, despite its potential in theory, for the following reasons:

1. The cultural norm for livestock to be valued in terms its savings potential rather than commercial potential, and;
2. The already over-grazed natural resource base

Gaps in terms of the development of the livestock sector in Bushbuckridge as identified in the Local Economic Development strategy (Bushbuckridge Local Municipality, 2009), include;

1. the lack of a vision and specific policy for the livestock sector as well as a land use strategy in which grazing land are allocated and protected from other developments.
2. Lack of technological progress or advancement due to lack of capacity in extension services and the isolated location of Bushbuckridge (lack of Research and Development);
3. Difficulty in accessing and maintaining market share due to the gross lack of extension support.

The restriction of access to markets due to current disease control policies was not mentioned in the report.

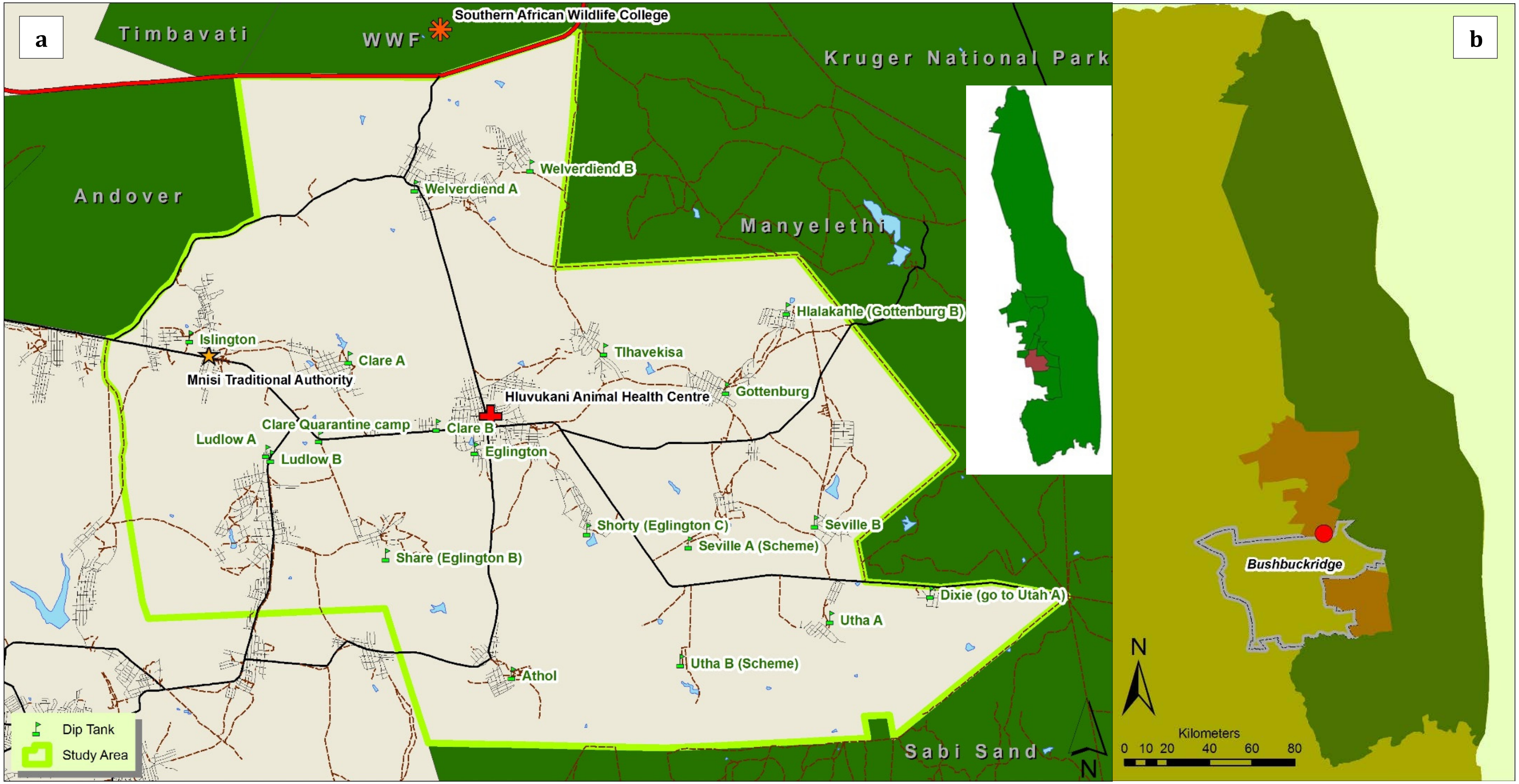

Figure 2-2: A map of a) the Mnisi Study Area and its dip tanks, and b) the Bushbuckridge Local Municipality in relation to the Kruger National Park

A study area in the north-eastern corner of the BLM comprising approximately 15 villages (18 dip tanks) and situated at the wildlife-livestock interface was selected as a focus area for this study. This area falls mainly within the land of the Mnisi Traditional Authority but also includes two villages, Utah and Athol, which falls within land of the Amashangane Traditional Authority. This study area, called the Mnisi Study Area (MSA), covers approximately 30 000 ha of communal land and also includes provincial conservation areas (Manyeleti and Andover Provincial Game Reserves). There are game proof fences separating communal grazing land from conservation areas. Based on state veterinary reports there were an estimated 1300 cattle owners in the MSA which owned approximately 15 000 cattle at the time the study commenced.

The MSA forms the basis of the Mnisi Community Programme (MCP) of the University of Pretoria. The MCP is one of two other initiatives driven by the Faculty of Veterinary Science, UP, in the same area: the Hluvukani Animal Health Clinic and the Hans Hoheisen Wildlife Research Station. Collectively, these three initiatives form what is known as the Mnisi One Health Platform - an international platform for training, research and community engagement at the wildlife-livestock interface. The MCP drives research, capacity building (postgraduate training and community development) as well as community engagement within the Platform. The overall objective of this Platform is to study and better understand the risks and effects/impact of important TADs, zoonoses and emerging and re-emerging diseases within the complex environment presented by the interface between conservation areas, people, their environment and domestic animals. The rangelands not in protected areas within the study site is under communal tenure and land use is mainly governed by village indunas and the traditional authority consisting of the chief (Chief Mnisi) and his council.

2.3 Methodological Approach

2.3.1 Overview

The methodological approach to the research conducted for the purposes of this thesis were multidimensional and varied based on the objectives of each specific chapter. The research wasn't set up as a typical comparative study where the scientific methods used in each study area were standardised in order to scientifically compare differences between study areas by means of comparative statistical analyses. Rather, mixed methods research were used in each study area in order to highlight perceptions of communal beef producers either in general or specific to a particular wildlife-livestock interface setting.

Mixed methods research comprising both qualitative and quantitative methods is increasingly recognised and used due to its ability to capitalize on the strengths of each approach (Curry et al., 2009). Curry et al (2009) states that the pairing of quantitative and qualitative components of a larger study can achieve multiple aims, such as corroborating findings, generating more complete data, and using the results of one method to enhance the insights of another complementary method. Today, mixed method research is recognised as the third paradigm of methodological approaches to research and aims to draw from the strengths and minimize the weaknesses of both qualitative and quantitative research in a single research study (Johnson and Onwuegbuzie, 2004; Denscombe, 2008).

A major attribute of mixed methods research is that it can make use of multiple study designs primarily categorised into *mixed-model* or *mixed-method* approaches (Johnson and Onwuegbuzie, 2004). Mixed-model approaches mixes qualitative and quantitative approaches within or across stages of a research process. Mixed-method research includes a quantitative phase and a qualitative phase in an overall research study (Johnson and Onwuegbuzie, 2004). In this way mixed methods research provides methodological freedom by legitimising the use of multiple approaches in answering research questions instead of restricting or constraining a researcher to a specific paradigm (Johnson and Onwuegbuzie, 2004; Denscombe, 2008). In his review of multiple authors' definitions of the characteristics of mixed methods research, Denscombe (2008) stated that one of the defining characteristics is an explicit account of the manner in which the quantitative and qualitative research methods and findings relate to each other, including an emphasis on the manner in which triangulation was used.

2.3.2 Data collection: Mnisi Study Area, South Africa

Focused group discussions were conducted in May 2009 with livestock farmers at five dip tanks in the MSA. Dip tanks in the study area were selected based on spatial distribution starting from villages near the Manyeleti fence and then selecting villages further and further away from the fence. This was done specifically to account for the possible variation in perceptions based on location or proximity to a conservation area. Farmers were asked to voluntarily remain behind after a weekly dipping session. The researcher and an interpreter experienced in the local languages (Shangaan and Northern Sotho) asked questions based on a predesigned interview framework that allowed for the major challenges experienced by farmers to be explored in sufficient detail. The findings were reported by Van Rooyen and Vandamme (2009) (Appendix 1).

The findings of the group discussions were used to finalise the quantitative questionnaire survey instrument deployed in the MSA as a cross sectional survey of the MSA (Appendix 3). The questionnaire instrument were tested first at a few dip tanks to the south of the MSA in July 2009. After further changes were made, the final survey instrument was deployed in August 2009 in all the remaining dip tanks within the MSA (n=12). A team of seven surveyors each paired with a trained interpreter were deployed per dip tank per day. One more dip tank was surveyed in February 2010. A total of 140 farmers were surveyed, which were 10.7% of the registered farmers in the MSA (Figure 2-3). The number of farmers surveyed per dip tank ranged between 3 and 25. Respondents were randomly approached by surveyors as they queued with their cattle at the dip tank. The research study was always first explained to the respondent in his/her preferred language and the survey subsequently proceeded only after verbal consent was obtained. Respondents were encouraged to skip sections of a survey or specific questions they perceived to be invasive for whatever reason. No respondent declined from participating although a few did opt to skip certain questions during the survey.

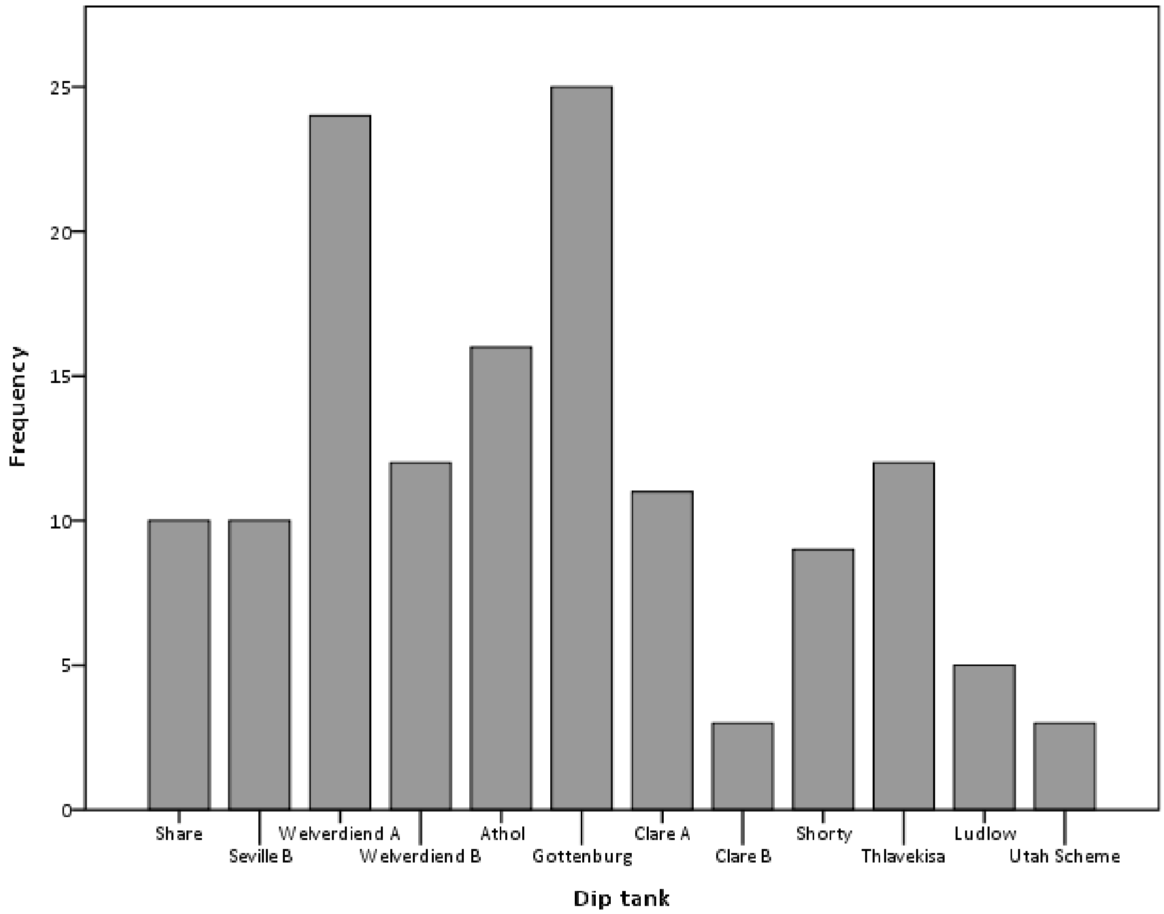

Figure 2-3: The distribution of the number of respondents surveyed per dip tank in the MSA

Surveys were deployed using Personal Digital Assistant devices (HP-iPAQ model 114) installed and programmed with SurveyToGo data capture software developed by Dooblo (www.dooblo.net). The experimental use of this newly developed software service for use in questionnaire surveys in the MSA were subsequently reported in Madder et al. (2012).

Various sources of secondary data were used for the analyses of the MSA data, but primarily consisted of data collected of cattle demographic changes per dip tank by officials of the Mpumalanga Veterinary Services during weekly dipping sessions. The use of secondary data will be discussed in more detail in relevant chapters of the thesis.

2.3.3 Data Collection: Zambezi Region of Namibia

The strategy followed in the ZR to survey farmers in the selected study areas was to use the bi-annual FMD vaccination campaign of the Department of Veterinary Services (DVS), Katima Mulilo (KM) offices, in November 2011 (Appendix 4). During a vaccination campaign cattle owners bring their cattle to the nearest official crush-pen to be vaccinated and recorded. This approach have proved successful in the MSA because farmers come to a specific place on a specific day where they can be randomly approached for interviews. Furthermore, FMD vaccination is compulsory in FMD protection zones and most farmers therefore do visit crush pens or dip tanks when required. A sample size of approximately 20 interviews per selected area in the ZR was planned in order to survey a total of 60 farmers. Paskin and Hoffman (1996) also surveyed sixty farmers throughout the entire ZR but could not have been representative despite the authors claiming they had reached a sufficient level of sampling saturation. In this study sixty interviews were sought from eleven villages. However, due to a miscommunication between officials and farmers very few farmers arrived on the scheduled vaccination day at Lubuta and Sachona villages in the Lizauli area. Yet, the reports by the few respondents that were surveyed in these villages indicated very little if any interaction with buffalo in their areas and subsequently further surveys in these villages were not pursued. At crush-pens, livestock owners were randomly approached and interviewed individually. When too few farmers were located during vaccination homesteads with kraals were randomly approached in the nearest villages. This increased the time spent on each interview significantly because of increased traveling time and surveyors had to participate in customs related to receiving guests at a homestead. On many occasions the household head or designated person was first searched for and called which sometimes took hours before they arrived. These factors ultimately resulted in fewer than planned interviews overall (n=44 instead of the planned 60 interviews) (Figure 2-4; Table 2-1). According to the November 2011 cattle census in the ZR a total of 244 cattle owners existed at the crush-pens included in this study and the 44 interviews therefore covered 18% of the total population.

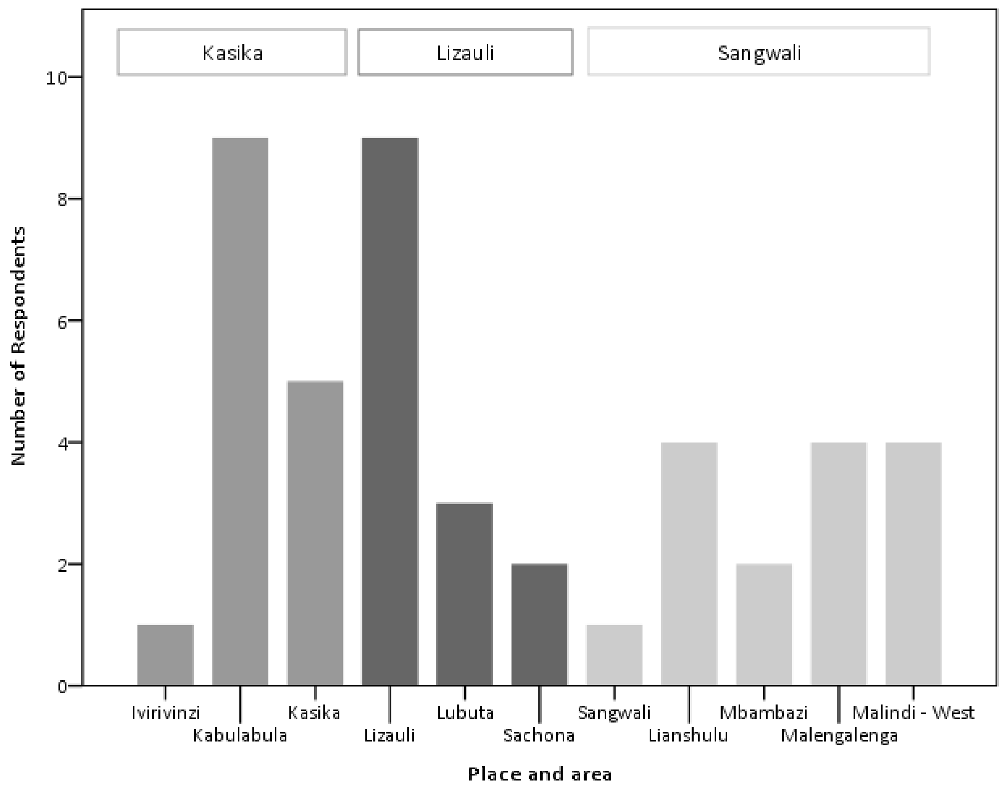

Figure 2-4: The number of semi-structured interviews conducted at each village within selected areas in the ZR

Table 2-1: Number of respondents interviewed per selected sampling area in the ZR

Study Area	Respondents	Percent
Kasika	15	34
Lizauli	14	32
Sangwali	15	34
Total	44	100

At homesteads, the planned individual interviews with the household head often turned more into discussions with multiple participants involving key household members also responsible for cattle husbandry. These were often boys or woman responsible for herding or caring for the cattle in the absence of the household head. The semi-structured survey instrument allowed for sufficient flexibility to effectively deal with such situations. The methodology used for data collection had to be flexible enough to allow for important differences in perceptions and the identification of unique constraints linked to specific areas. A combination of qualitative and quantitative methods was therefore used to collect the necessary information from cattle producers:

- Group discussions were held with Indunas and cattle owners at three villages in the ZR during April 2011. These villages were Linyanti, Kabbe and Singalangwe (Kongola). A fourth at Sangwali was cancelled. These discussions assisted with the preparation for the interview instrument.
- Semi-structured interviews with livestock owners in the selected areas in November 2011.
- Approximately 20 additional interviews with key informants where necessary and possible at various occasions up to April 2014. These included Meatco officials, mentors of the Namibian Meat Board Mentorship Program, herdsmen and cattle owners from other areas not included in selected sites of this survey.

No major ethical considerations were applicable in ZR surveys since very little private or sensitive information was requested from participants. In the ZR, mentors of the Farmer Mentorship Program of the Meat Board of Namibia mostly served as translators and interpreters during interviews. They were experienced interpreters and were familiar with terms used in livestock production and health management. In the few instances that other interpreters were used due to the unavailability of mentors, they were properly briefed and inducted on the principles of interpreting during a scientific investigation. The interpreters also acted as guides when visiting crush-pens and villages in remote areas in the ZR. Local customs were always honoured when homesteads or respondents were approached. Verbal consent for participation in an interview was always obtained before interviews and during interviews in the odd instance where potentially sensitive information was requested (such as the monetary value of animals bought or sold). Only in one instance did a cattle owner which was approached for an interview choose not to participate for personal reasons. In some instances respondents chose not to express their views or opinions over specific topics (such as their view of their local conservancy). Female cattle owners were targeted where possible in an attempt to achieve appropriate gender representation in the views recorded. Five (11%) women were interviewed during the random selection at crush-pens or in villages in the ZR and several more in subsequent interviews. Eighty six percent of participants in the semi-structured interviews in the ZR were cattle owners and 14% were family members responsible for the cattle. In the MSA 31% of the respondents were woman and 85% were the household heads. The remaining 15% were designated representatives of the household head.

2.3.4 Spatial Analyses

All information pertaining to trends of sales at the Meatco abattoir (KM) was obtained from the procurement office of the abattoir. All mapping and GIS related analysis were conducted using ArcGIS's ArcMap version 9.3 and associated software packages, such as Spatial Analyses Tools. Distance calculations between crush-pens and quarantine stations were conducted using Hawth's Analysis Tools[3] for ArcGIS; Spatial projection: WGS 1984 UTM 34S. Most GIS layers were either created during the study or downloaded from reliable open access resources in which instances it was referenced. Crush-pen point locations were mostly obtained from a data base with spatial reference data of the Department of Veterinary Services, Namibia. Additional point locations were individually obtained using either a GPS or Garmap Southern Africa Topographical Map version 2011.2 in MapSource (Garmin MapSource version 6.16.3). Some spatial data for specific crush-pens were obtained from the WAHID Interface [4] of the OIE (World Organization for Animal Health).

2.3.5 Summary of materials and methods per chapter

Chapters 3 – 4 in this thesis focuses on both study areas to large extent. Subsequent chapters, however, largely focuses on the ZR and only refer to the MSA where relevant.

Chapters 3 and 4 applied mixed qualitative and quantitative methods aimed at describing important perceptions of beef producers within their specific landscapes. In the MSA the environment and systems in place lent itself to a quantitative approach by means of a representative questionnaire-based survey which covered a range of topics related to natural resources, livestock husbandry, production and health, trade and conservation. The same approach in the ZR would have required a very large survey effort which was deemed unnecessary for this study. Rather, the opportunity to target livestock producers in the ZR which had a high probability of regular contact with buffalo and difficulty in participating in the formal market system, were utilised. This provided the opportunity to use a more qualitative approach across several locations in the ZR to get a better understanding of the perceptions of wildlife-livestock interactions and the risks associated with it as well as pastoralists' sentiment

[3] Hawth's Analysis Tools: http://www.spatialecology.com/htools/overview.php

[4] World Animal Health Information Database (WAHID) Interface: http://www.oie.int/wahis_2/public/wahid.php/Wahidhome/Home

towards conservation efforts in the area. An analyses of similar matters in each area but, importantly, also matters specific to each area were included in the survey.

Chapter 5 used spatial-temporal analyses in combination with mathematical modelling to ascertain the relationship between grazing variability and fluctuating cattle numbers have on animal performance in the ZR. Estimated levels of forage production and both cattle and wild herbivore numbers were used as the main input variables in the analyses conducted.

Chapter 6 focused on the formal trade system in the ZR for which annual cattle census and abattoir procurement records of various institutions were analysed. Analyses focused on highlighting the limitations and effects limited market access as well as animal movement control had on the formal beef trade in the area.

Chapter 7 draws from all the data across the various chapters and combines several approaches to rural development, SPS norms and standards and commodity-based trade into a novel model that addresses the multiple requirements of CBT, TFCA development, wildlife-livestock compatibility, and poverty alleviation. The socio-economic impact of a recent FMD outbreak had on livestock producers in the ZR were included to provide further context to importance of the suggested model presented in the chapter. Importantly, the value of the mixed method approach taken in this thesis culminates in that results of both qualitative and quantitative approaches in previous chapters were used to substantiate the model presented.

Each chapter was written largely as an individual study in the format of a typical publication. There is therefore some level of overlap, especially in introductions to each chapter.

2.4 Statistical Procedures

A combination of descriptive and inferential statistical analyses were used in this thesis. Inferential statistical methods included both parametric and non-parametric approaches. All statistical procedures and models were described and referenced where relevant in each chapter. Most statistical analyses were conducted using IBM SPSS version 23 as well as Microsoft Excel, Microsoft Office 2010.

Statistical significance were tested at a 95% confidence interval, unless stipulated otherwise.

2.5 Research Approval

The research presented in this thesis were conducted under protocol V055/13 which was approved by the Research Committee of the Faculty of Veterinary Sciences, University of Pretoria (Appendix 1).

3 PERCEPTIONS AT THE INTERFACE: BEEF PRODUCTION

3.1 Introduction

The multiple roles that livestock, and cattle in particular, play in the households of rural pastoralists have been well documented, both globally (Randolph et al., 2007; Herrero et al., 2013; Smith et al., 2013) and in southern Africa (Scoones, 1992; Shackleton et al., 2000). Cattle generally contribute both directly and indirectly to household income and are often considered the most valuable household asset owned by poor pastoralists (Smith et al., 2013). The role and value of cattle in a pastoralist community is highly complex and easily underestimated, because the multiple contributions of cattle to the farming systems of the developing world are mostly not market related, and are thus difficult to quantify in purely economic terms (Shackleton et al., 2000; Randolph et al., 2007).

The significance and scope of cattle's contribution to and role in households in communal farming systems can vary significantly between areas, even within the same country or region, as these aspects are influenced by a range of socio-ecological and socio-economic/political factors (Barrett, 1999; FAO, 2002). Similarly, the interactions among and between conservation systems, livelihoods and agro-pastoral systems at the wildlife-livestock interface in and around TFCAs in southern Africa are also diverse, and the factors that influence livelihoods and the nature or extent of wildlife-livestock interactions vary significantly from one interface setting to the next (Cumming, 2011; Andersson et al., 2013). Invariably, these complex and diverse interactions will contribute to the multiple factors influencing livelihood strategies and their associated livestock production systems in such areas. One of the major consequences of wildlife interaction (notably that of the Cape buffalo) with livestock in southern Africa is an increase in livestock health risks, especially in terms of transboundary animal diseases such as foot-and-mouth disease (FMD) (Kock, 2005; Cumming, 2011; Michel and Bengis, 2011). FMD outbreaks and the associated control strategies have been shown to have a significant impact on poor, livestock-dependent communities in the developing world (Sinkala et. al., 2012; Jibat et al., 2013).

The opportunity presented by recently accepted non-geographic based trade standards for beef produced in high-risk FMD areas (Article 8.7.22 of the TAHC, OIE) to access international markets more readily despite the FMD status of the region of production, has been embraced by conservation agencies and regional trade structures such as the Southern African Development Community (The

Phakalane Declaration, 2012). It is understood that the new trade standards offer disease control scenarios and solutions to national animal health services, especially those in communal cattle production systems in and around TFCAs, which will be more economically feasible to implement, will reduce the impact of outbreak situations for poor farmers in particular, and will be more compatible with wildlife conservation efforts. There is also an expectation of improved access to high-value international beef markets for producers at the wildlife-livestock interface who are currently restricted by conventional disease control measures (Thomson et al., 2004; Osofsky et al., 2012; Cassidy et al., 2013; Thomson et al., 2013a).

In order to capitalise on this opportunity, an integrated value chain approach to disease control and sanitary and phytosanitary (SPS) food safety measures, to be implemented along the beef supply chain, is proposed (Thomson et al., 2013b). This approach suggests that disease risk and food safety be managed through the implementation of prerequisite programmes and critical control points, by means of an HACCP system 'from farm to fork'. Although there is mention of interventions that deal with productivity and the quality of beef produced, a concern raised by some is that the implications of such a commodity-based approach to beef trade may well be hampered by the poor quality carcasses, low animal productivity and weak animal health and production support systems typical of most communal farming systems in southern Africa (Rich and Perry, 2011). Policies and development aimed at unlocking the opportunities presented by alternative disease control and animal trade standards, such as commodity-based trade (CBT), must therefore be approached holistically. Over and above technical perspectives, rural development and pro-poor objectives that are cognisant of the perceptions and aspirations of local farmers and various land use systems are also a priority (Scoones et al., 2010; Thomson et al., 2013a). Understanding the farming systems, including the risks and constraints experienced by local producers, is critical to the successful development and implementation of interventions such as prerequisite programmes and value chain development for market access (Udo and Cornelissen, 1998; FAO, 2011; Fowler, 2012).

In light of the proposal by Thomson et al. (2013b) which suggests that commodity-based trade interventions are best approached through a system in which disease control and food safety standards are integrated from primary production onwards along the value chain, a good method by which to start such an intervention would be to ensure an understanding of the perceptions around and conditions of targeted farming systems at the local level. TFCA development is faced with the significant challenge of disparate policies across national boundaries, and is further complicated by significant variation at the local level between communities and interface settings. The objectives of this chapter are therefore to: 1) describe the production systems and associated constraints in the study areas, mainly based on the perceptions of farmers themselves, and 2) gain a better understanding of the influences that the nature of the wildlife-livestock interface as well as the presence or absence of a formal market outlet have on the perceptions and activities of beef producers in TFCAs. Special emphasis will be given to an investigation into the effects of herd size and how this relates to the perceptions of farmers. The outcomes are discussed in the context of considerations for the development of appropriate prerequisite programmes, aimed at the development of a value chain intervention based on the principles of non-geographic trade standards for improved beef trade from FMD control zones.

3.2 Methodology

3.2.1 Study areas

Selected communities and cattle farmers in the Zambezi Region (ZR) of Namibia and the Mnisi Study Area (MSA) in Bushbuckridge, Mpumalanga, South Africa, were surveyed for the purposes of this chapter. Full details and the description of each study area are discussed in Chapter 2 of this thesis.

3.2.2 Data collection and analysis

The data collection methods and procedures are explained in Chapter 2. Mixed qualitative and quantitative methods were used, and consisted of semi-structured interviews in the ZR and more structured, questionnaire-based surveys in the MSA. Rather than using a ranking approach to determine priority perceptions in many questions of the surveys in the respective study areas, a listing approach was followed. Rather than asking respondents to 'rank' responses according to what they perceived to be important or less important, free listing has been proved successful in similar studies in that challenges generally listed first by respondents were considered most important (de Garine-Wichatitsky et al., 2013). Secondary data obtained from local state veterinary services were used to a limited extent in both study areas. The study design was not one of a typical comparative study where research methods were standardised at both study sites in order to test for statistical significant differences or similarities. Rather, different methods were used which were deemed appropriate for the specific setting and the study objectives, which did not in all instances coincided. Yet, both study areas were included in results and discussions in order to highlight similarities and differences where applicable. This was regarded important given the fact that the interface between the two study areas differed despite similar attributes in the form of land tenure, farming systems, and disease status.

Predominantly descriptive statistics were used to elaborate on results from both study areas. Verbatim statements by interviewees in the ZR were included to emphasise particular perceptions or nuances. Where necessary or possible, non-parametric statistical models (Man-Witney and Kruskal-Wallis) were employed to test for significant differences between response frequencies or mean herd size between response categories. IBM® SPSS® Statistics version 23 (IBM Corporation © and its licensors 1989, 2015) as well as Microsoft® Excel (Microsoft Office 2013) were used for statistical analyses.

3.3 RESULTS

3.3.1 Herd size and composition

Herd size

A summary of the descriptive statistics of the herd sizes, as recorded after the information was provided by respondents in each study area, is provided in Table 3-1. The mean herd sizes according to the respective government cattle census records in each study area are provided as a reference point in order to interpret the data collected in the surveys. The mean herd size in the ZR at inspection point level was 50 animals, whereas in the MSA the mean herd size at inspection point level was 16 animals. The median herd sizes in each overall study area were smaller than the mean, due to the skewed herd size distributions. The median herd size was 43 animals in the ZR and 11 animals in the MSA. The mean and median herd size according to respondents in the ZR was 57 and 35 animals respectively, whereas in the MSA it was 15 and 9 animals respectively. In the ZR the herd size of the respondents ranged between 6 and 334 animals, whereas in the MSA it ranged between 1 and 133 animals.

Table 3-1: Descriptive statistics of the herd size distribution (number of animals) at inspection points as well as of the respondents in both the Zambezi Region (ZR) and the Mnisi Study Area (MSA) as recorded in the year the surveys were conducted in each study area

Area (Date)	n	Mean	Median	SD	Min	Max	Sum
*Inspection points**							
ZR (Nov'11)	113	50	43	25	3	153	
MSA (Aug'09)	16	14	11	11	8	56	
Respondents							
ZR (Nov'11)	43	57	35	70	6	334	2,467
MSA (Aug'09)	140	15	9	17.5	1	133	2,107

** Mean herd size calculated as: Total cattle per inspection point / Total owners per inspection point.*

Herd composition

The average herd compositions in both study areas are provided in Figure 3-1. Bulls made up 4.9% and 13.9% of the herds in the ZR and MSA respectively. The herds on average consisted of 16.1% oxen in the ZR, whereas oxen made up 7.8% of herds in the MSA. In the ZR, heifers and cows together made up 60.4% of the herds, whereas in the MSA cows made up 42% and heifers 23.1% of the herds, which gave a combined total (cows and heifers) of 65%.

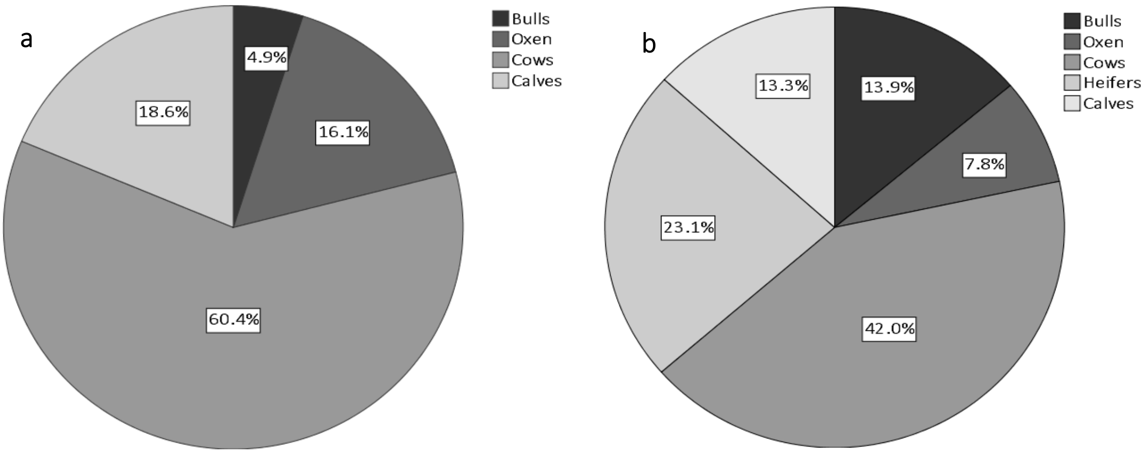

Figure 3-1: Mean herd composition (percentage) according to respondents in each study area a) Zambezi Region (ZR) (n= 44); b) Mnisi Study Area (MSA) (n=140)

The cow:calf ratios were 3.2 : 1 in both study areas, but should be higher in the ZR considering that heifers were included in the number of breeding cows. The breeding female (cows and heifers) to bull ratio was 12.3 : 1 in the ZR and 4.7 : 1 in the MSA.

Calving season

Respondents in the ZR were asked to give an indication of the time of the year in which their cows generally calf. Six respondents indicated that their cows calved at any time of the year, whereas the rest of the respondents (n=38) listed specific months. According to the respondents the main calving season extended from September to Moofarch, with most respondents listing November (n=30) and December (n=31) as months in which their cows most frequently calved (Figure 3-2).

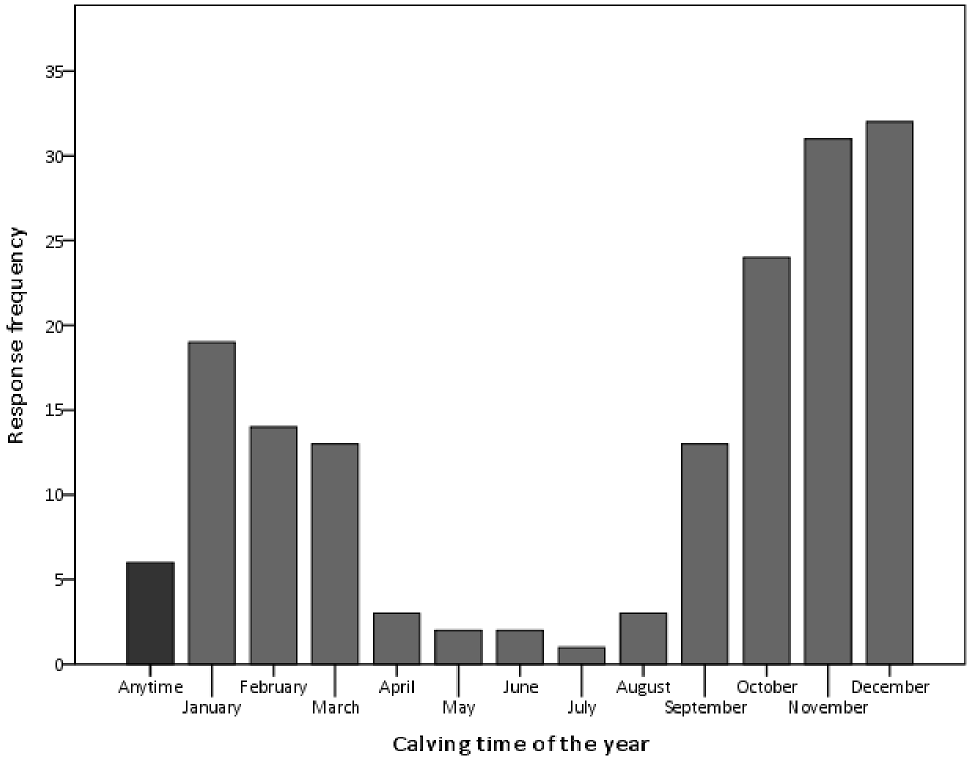

Figure 3-2: The number of respondents whom have reported calvings per month in the Zambezi Region (n=44)

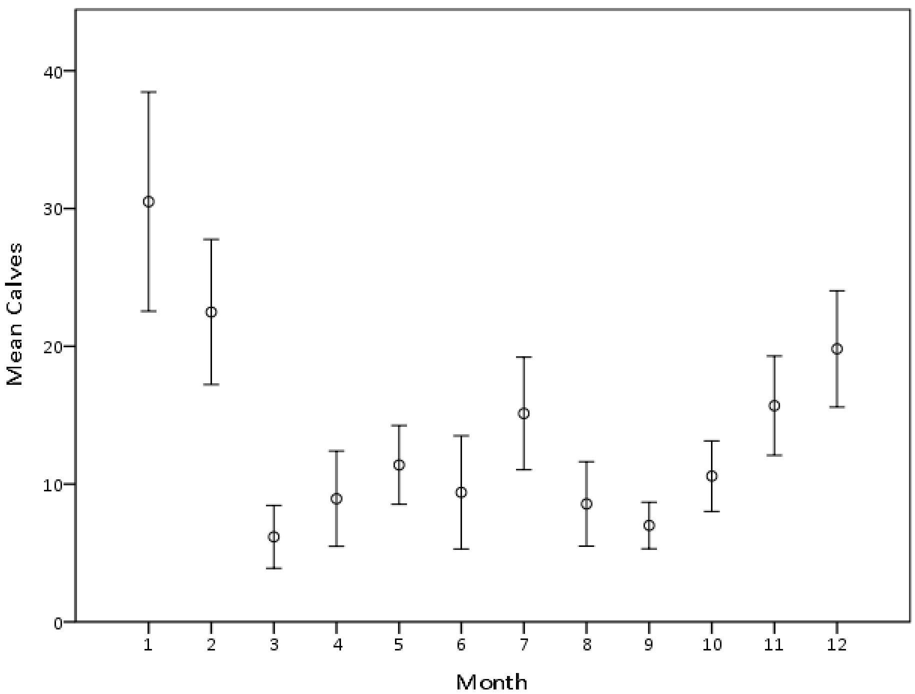

Figure 3-3: The mean number of calves recorded in dip tank registers per month in the MSA over the period 2006-2008 at 16 cattle inspection points. (Error bars: SE ±2; Months 1-12 = Jan-Dec)

In the MSA, the main calving period runs from November to February, with a slight increase in the number of calves in July (Figure 3-3). A total of 85% of the respondents in the MSA indicated that they prefer all their cows to calve during a specific period of the year. Only 10% did not prefer this and the rest were unsure. Of the 123 respondents who did prefer their cows calving simultaneously, a further 85% preferred them to calve in summer. Seven respondents said that it was immaterial as long as they all calved together, whilst three said they preferred it to be in winter. Of the 123 farmers who did prefer a specific calving season, 73% felt that feed availability (nutrition) was the most important reason for wanting to concentrate their calving season at a particular time of year. Another 14% of the responses indicated water availability to be important as well. Reasons such as marketing benefits (9%), well-being of the cow (8%) and maintaining animal condition (7%) were also cited as important.

A range of reasons was given by the 15 farmers in the MSA who did not prefer a calving season. The most prominent reasons were market advantages (4 respondents), it being unnecessary (4 respondents), and other reasons such as the people having milk shortages, not being able to orchestrate events due to camp shortages, lack of knowledge, and general lack of adequate grazing. Market advantages to not having a specific calving season are due to the fact that young animals will reach market readiness more randomly throughout the year, thereby providing options in cases where an animal needs to be sold.

3.3.2 The role of cattle at household level

Reasons for keeping cattle

A summary of the reasons cattle owners gave for keeping cattle in both study areas is provided in Table 3-2. In the ZR, keeping cattle as a means of making a living, or because they represent 'the livelihood' of a household, was the main reason given by 50% (n=22) of the respondents. When talking about the link between cattle and their livelihoods, farmers in the ZR typically made comments such as "[cattle are our] *only means of livelihood*" (Interview 20), or "*It's* [cattle] *our source of livelihood – education, food, everything if you are not working*" (Interview 23). Twenty of the respondents (46%) indicated that cattle were kept for commercial interests, such as start-up capital for a new business through income from sales.

Table 3-2: A summary of the reasons given by livestock owners for keeping cattle in the Zambezi Region (n=44) and Mnisi Study Area (n=140)

Reason	Zambezi Region		Mnisi Study Area	
	Freq. (%)	Total response (%)	Freq. (%)	Total response (%)
Livelihood	22 (50)	25		
Education	16 (36)	18		
Draught power	15 (34)	17	23 (16)	9.9
Commercial interests	20 (46)	22.5	52 (37)	22.4
Consumptive use			21 (15)	9.1
Savings ('bank')	4 (9)	4.5	104 (74)	44.8
Emergency fund	6 (14)	9	10 (7)	4.3
Wealth/Status	2 (5)	2	4 (3)	1.7
Tradition/Ceremonies	1 (2)	1	10 (7)	4.3
Other	1 (2)	1	8 (6)	3.4
Total		100		100

Keeping cattle to help with the financing of education was mentioned specifically by 16 respondents (36%). The keeping of cattle as a source of draught power was mentioned by 15 respondents (34%). Four respondents (9%) said that they kept cattle to serve as a bank (savings) and six (14%) kept cattle to assist with emergency cash. Two respondents said that they kept cattle to serve as a symbol of wealth or status, whilst one respondent mentioned that he kept cattle for traditional or ceremonial purposes.

In the MSA, 104 respondents (74%) said that they kept cattle to serve as a bank (Table 3-2). A further 52 respondents (37%) said that they kept cattle for commercial interests, such as selling them for income. Keeping cattle to provide draught power was a reason given by 23 respondents (16%), whilst 21 respondents (15%) said that they also kept cattle for the consumption of cattle-derived products, such milk and meat, in the household. Cattle were kept as part of tradition and for use in traditional ceremonies by 10 respondents (7%), followed by reasons such as keeping cattle as a symbol of wealth or status (n=4, 3%), and miscellaneous reasons (6%) which included three respondents who felt that they kept cattle because it was their cultural tradition.

A percentage of the overall proportion in each response category relative to the total number of responses in each study area is also provided in Table 3-22. The overall percentage of all the responses per category, per study area provided a value with which the relative weight of each category in each study area could be compared. In the ZR, 25% of the responses indicated that cattle were kept as a main source of livelihood, whereas none of the respondents in the MSA mentioned livelihood support specifically as a reason for keeping cattle. On the contrary, the biggest reason for keeping cattle in the MSA was for them to serve as a bank or means of financial savings (~45%). Only 4.5% of the total responses in the ZR indicated that keeping cattle to serve as a bank (savings account) was important. Both areas indicated a similar priority in terms of cattle being kept for commercial interests with a total of 22.5% and 22.4% of all responses in the ZR and MSA respectively. Assistance with expenses for education made up 18% of total responses in the ZR but was not mentioned at all in the MSA as an important reason to keep cattle. Keeping cattle for draught purposes constituted 17% of the total responses in the ZR versus 10% of the responses in the MSA. No respondents in the ZR mentioned that cattle were kept specifically to support household consumption of cattle-derived products, whereas in the MSA the consumption of cattle-derived products constituted 9% of the total responses. Keeping cattle as a symbol of wealth and status received similar priority in both areas, constituting 2% of total responses in each study area. Cattle as a source of cash in an emergency constituted 9% of total responses in the ZR whereas in the MSA it constituted 4% of total responses. Keeping cattle for traditional ceremonies made up a total of 6% of the responses from cattle owners in the MSA, whereas in the ZR it only constituted 1% of responses overall.

Respondents in the ZR were asked whether cattle were considered their main source of income. All but one owner indicated that cattle were regarded their main source of income. Twelve respondents (27%) stated explicitly that cattle were their only source of income. Statements such as "*If they die, we die*" (Interview 20) or "*…even to start a business, you must first sell cattle*" (Interview 10) were voiced to explain what cattle meant to respondents in the ZR. Most of the respondents who emphasised cattle as being their only source of income also explained that they were unemployed. Several respondents explained that despite some other form of income, such as a pension (Interview 18), or fishing (Interview 20), or selling crops (Interview 16), cattle were still their main source of income. The fact that there was only one respondent who said that members of his household do receive salaries and cattle are therefore not their main source of income, made it clear that this was the exception rather than the rule (Interview 21).

In the MSA, respondents were asked to state their main source of income as part of a structured questionnaire. Only 8% of respondents (n=138) regarded (livestock) farming activities as their main source of income, whereas 52% considered their government pension as their main source of income. Only three of the respondents who mentioned that they regarded farming as the main source of their income were also eligible for a pension (Age 60 and above for women, and 61 and above for men, since 1 April 2009[5]).

Cattle goods and services at household level

In order to better understand the role played by cattle in households, the respondents in both study areas were asked to explain what their cattle were mainly used for and the extent to which they used cattle-derived products at household level. In total, 91% of the respondents in the ZR (n=40) indicated that they used cattle for draught power (Figure 3-4). Cattle used as a source of milk for the household was mentioned by 38 of the 44 respondents (86.4%) and the provision of meat at household level was mentioned by 36 of the 44 respondents (82%). Selling cattle was mentioned by 48% and cattle used for ceremonial purposes was mentioned by only 25% of the respondents.

Respondents who indicated draught power as a household service usually mentioned it first (83%), whereas milk was usually mentioned second (47%) or third (37%). Meat was mostly mentioned third (47%) or fourth (42%) whereas those who said cattle sales were an important factor mostly mentioned it first or second (38% each). Ceremonial use was mostly mentioned second (46%) or third (27%).

In the MSA, 61% of the respondents (n=88) said that they milked on average ~ 4 of their own cattle per day (SD ±2.93). Only 12% of the respondents who milked their own cows sold some of the milk to other people. Furthermore, 72% of the respondents (n=104) indicated that they did sometimes slaughter their own cattle. Of those who did, 89% used the meat for household consumption, 20% sold some of the meat locally, 17% used the meat for traditional ceremonies, and a further 7% donated some of the meat.

[5] Department of Social Development, Republic of South Africa. http://www.dsd.gov.za/ Accessed October 2015.

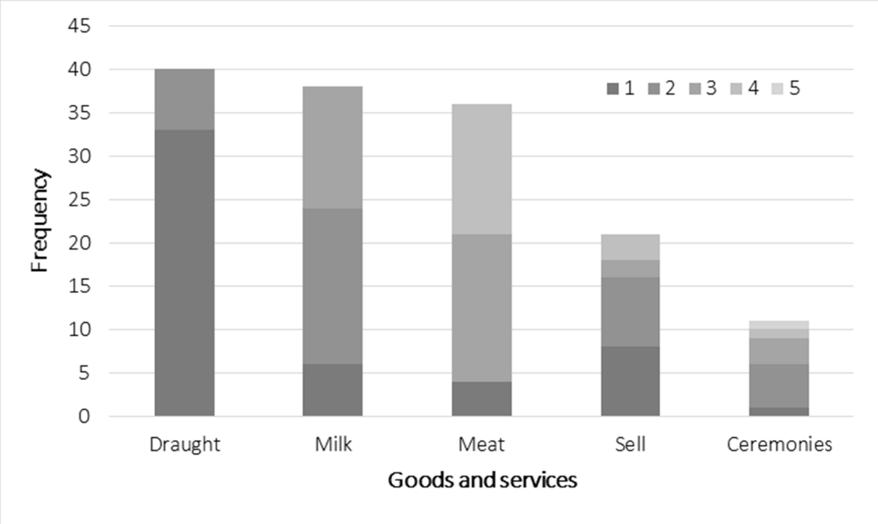

Figure 3-4: The frequency of respondents in the ZR who used cattle or cattle-derived products at household level with the order in which specific goods and services were mentioned

In the MSA, 36% of the respondents indicated that they did not do anything with the hides that they obtained from slaughtered cattle. Many farmers (37%), however, indicated that they used raw cattle hides themselves: for making ropes (5%); 4% gave them away, and 5% used them for making clothing. A further 3% threw them away, whilst one respondent said he made drums from the hides. Only 6% of the respondents sold cattle hides locally; others simply fed them to the dogs.

In the MSA, 51% of respondents did not use any cattle for traditional purposes. However, 44 respondents (31%) indicated that they used a total of 81 cattle for ceremonial purposes (Table 3-3) for which bulls were the most popular (n=39). Twelve respondents reported that they gave a total of 77 cattle as gifts, of which oxen (40) followed by cows (30) were the most popular. Nineteen respondents reported that they used a total of 46 cattle for lobola (bridal payment), for which cows were the most popular (26), followed by bulls (17). Of all the animals used for these various purposes, cows were used most (67), followed by oxen (66), bulls (59), calves (16), and heifers (2). Calves were most often used for ceremonial purposes (11). A total number of 210 cattle were used for these purposes by the respondents in the survey (n=140).

Table 3-3: The use of cattle (nr of animals) for traditional and ceremonial purposes, as well as gifts per cattle type in the Mnisi Study Area (n=140)

Description	n	Bulls	Oxen	Cows	Heifers	Calves	Mean (S.E.)	Total
Cattle use								
Used for lobola	19	17	0	26	2	1	2.42 SE 0.509	46
Used for ceremonies	44	39	23	8	0	11	1.84 SE 0.293	81
Gifts to relatives	12	3	40	30	0	4	6.42 SE 4.522	77
Used for other reasons	7	1	3	3	0	0	1.75 SE 0.750	7
Total		59	66	67	2	16		210

3.3.3 Cattle production and health: risks and challenges

Major perceived constraints

Respondents in the ZR were asked to state what they considered to be the most important constraints to cattle farming experienced in their area. All responses were categorised and summarised according to the frequency of responses per category as well as the sequence (order) in which particular categories were mentioned by respondents (Figure 3-5). This was done in an effort to provide some insight into the level of importance each challenge was accorded, because this was not a quantitative survey.

Disease as a major challenge experienced by cattle farmers in the ZR was mentioned by the most respondents (75%) and when mentioned it featured first 55% of the time and second 30% of the time. Predation was reported second most often (41%) by farmers in the ZR followed by grazing shortages/competition (30%), wildlife contact (23%), flooding (18%), miscellaneous reasons (14%), and lastly market-related problems (2%). When mentioned, grazing and flooding were mostly mentioned first as well (69% and 63% respectively) whilst predation and wildlife mostly featured second when listed (39% and 60% respectively).

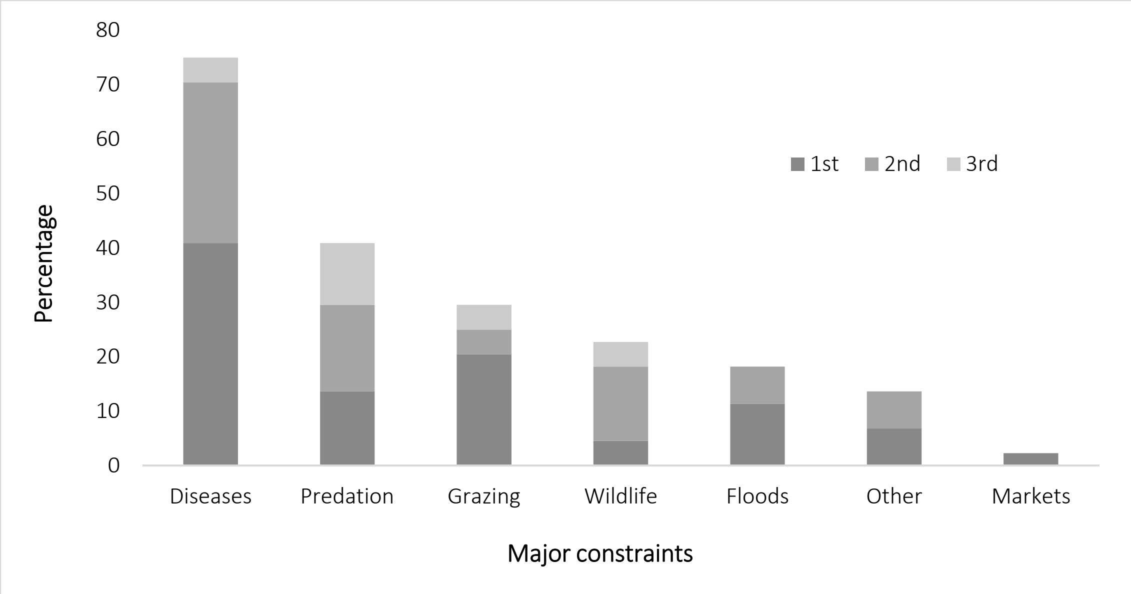

Figure 3-5: The constraints and challenges in cattle farming mentioned by respondents (%) in the ZR, and the sequence in which each constraint was mentioned (n=44)

Ticks (29%), FMD (15%) and lumpy skin disease (LSD) (12%) were the **animal health** problems mentioned most often by farmers in the ZR when they elaborated on the health challenges they experienced. However, the farmers from the floodplains around Kasika and Kabulabula did not mention ticks at all – except in the context of when they had to move their cattle to upland areas before annual floods. Personal observations at the time of the survey confirmed that cattle on the flood plains had much lower tick burdens and generally seemed to be in much better condition than cattle from the woodland areas in Sangwali and Lizauli.

For the farmers from Kasika, flooding was the problem; an issue which was not mentioned by farmers from the other areas. An important reason that floods were considered a major constraint to farming in Kasika was that the woody, upland areas where they relocated to during floods had many ticks and poor grazing – both unfamiliar characteristics in their usual floodplain environment. Various respondents mentioned significant cattle losses during the periods that they had to move to upland areas and even pointed to this as the reason that some had ceased cattle farming all together. FMD, wildlife and internal parasites (liver fluke) were mostly mentioned when the Kasika farmers spoke about diseases in their areas. Conversely, in the woodland areas ticks were considered a major limitation to cattle farming. Diseases associated with ticks were a major concern in other woodland areas as well (Sangwali and Lizauli) as well as wounds, abscesses and the cost of dipping. LSD was the disease mentioned most often as a disease transmitted by ticks. Black quarter disease, gout, anthrax, lung sickness, nagana transmitted by tsetse flies and stomach disorders were among the other diseases mentioned by respondents.

Grazing shortages or grazing competition was one of the constraints to farming that ranked high both in frequency and sequence in the ZR. This was particularly true for farmers in the woodland and savanna regions of Sangwali and Lizauli. Although most respondents did not elaborate on why they thought grazing shortages were a major constraint, a few individuals mentioned reasons such as grazing areas being too small, too many animals being kept, poor rainfall, competition with wildlife, poor quality grazing, and bush encroachment. One respondent (Interview 41) from Malengalenga mentioned that some farmers left for cattle posts with boreholes in the upland areas, leaving the others behind along the river with insufficient grazing and the need to deal with all the predators. Two respondents (Interviews 16 and 18) mentioned that the late dry season, specifically August to November, were the most critical months in terms of grazing.

Predation was the other major threat mentioned by respondents from every selected area in the ZR (Table 3-4). However, the specific predator species varied between the areas. On the floodplains next to the Chobe River respondents from the Kasika area were mainly concerned about crocodiles. Four of the five respondents from Kasika mentioned crocodiles as the only predator that posed a threat. However, only one of the nine respondents from Kabulabula, also on the Chobe River, mentioned crocodiles as well. Of the respondents in the Sangwali and Lizauli woodland areas in proximity to the Mudumu and/or Mamili National Parks, eleven mentioned hyena as the biggest challenge in terms of predation and ten respondents mentioned lions. Only two mentioned wild dogs as a being a problem. All except one of the respondents who mentioned hyena also mentioned lions. Four respondents from these areas mentioned crocodiles as well. One respondent from Lizauli mentioned that he is close to the park (Mudumu NP) and at 16h00 in the afternoon '*…the hyenas come!*' (Interview 33). Another respondent from Malengalenga mentioned that hyena are a problem out in the bush, but that lions even come to the kraal at night (Interview 41).

Table 3-4: The frequency of specific large predator species mentioned as posing a risk by respondents from selected focus areas in the ZR (n=44)

Predator	Hyena	Lion	Crocodile	Wild dog
Frequency (%)	11 (25%)	10 (23%)	9 (20%)	2 (5%)

Contact with wildlife was also one of the most important constraints mentioned by respondents in the ZR. Issues regarding contact with elephant and buffalo were mentioned most often in all the areas, in relation to these species sharing grazing and even mixing with cattle. This was perceived a risk for the transmission of diseases by most respondents. Elephant were mentioned in relation to the problems they cause in the cropping season but also as carriers of diseases. Buffalo were always mentioned in relation to the diseases they were perceived to carry and could transmit, because they shared grazing areas with cattle. One farmer from Malindi West mentioned that hippopotamuses were a concern to him, in that they were competing for grazing with cattle and they were a cause of crop damage along with elephant and buffalo (Interview 6).

A lack of **market access** or market-related problems was specifically mentioned only once by a farmer in the ZR as being a major constraint.

In the MSA, farmers were also asked what they experienced to be the major challenges in cattle farming in their area by means of structured questionnaires with an animal health focus. For each challenge given farmers were also asked to rank the challenge in terms of one of five categories of importance (extremely important, very important, important, relatively important, and of minor importance). In an attempt to gain more insight into specific response categories, more than one category was listed and surveyors could add additional categories not covered in the fixed survey form. In the MSA, limitations in terms of available natural resources outweighed any other challenge (Figure 3-6). Nutritional limitations were the challenge mentioned most often by farmers (41.1%), followed by a lack of water (34%). Disease was regarded as a major challenge to cattle farming in the MSA by 33.3% of the farmers, followed by stock theft (28.4%) and drought (23.4%). Ticks and dipping-related problems (17.7%), uncontrolled veld fires (9.9%), wildlife-associated problems (4.3%) and lastly market access (2.8%) were the least mentioned challenges in the MSA.

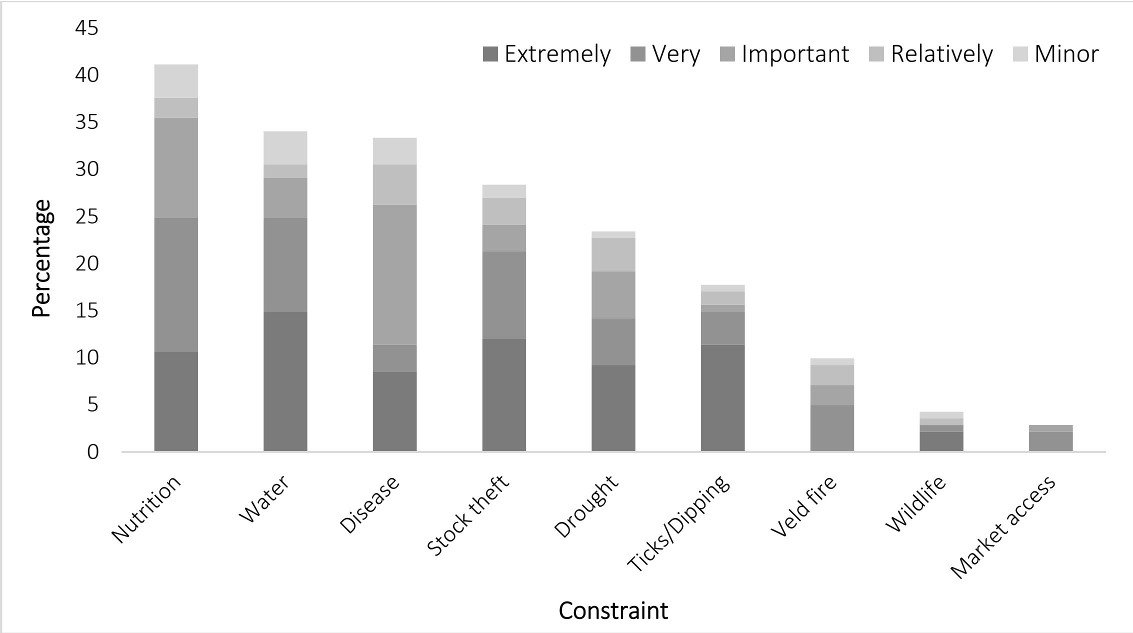

Figure 3-6: The major constraints and challenges in cattle farming according to the percentage of responses by respondents (n=141) in the Mnisi Study Area (MSA) and the level of importance for each constraint

Respondents in the MSA most often referred to ticks and dipping as well as water shortages as being an extremely important problem (64% and 44% respectively). Nutritional problems were most often considered to be a very important problem (35%) whereas disease was mostly referred to as an important problem (44%). Drought was mostly considered to be an extremely important problem (39%) to those who mentioned it, whilst stock theft was mainly considered to be an extremely or very important problem (43% and 33%, respectively) by those who mentioned it. Veld fires and wildlife were regarded as extremely important challenges by 50% of those who identified them.

When asked specifically about grazing availability in the MSA, 48% of the respondents said that they did not have sufficient grazing available for their cattle. The main reasons for insufficient grazing were not enough grazing land available (42%), and that there were too many cattle (34%). However, 10% of the respondents said that the grazing shortages were limited to winter only. Several other reasons were mentioned by some respondents for the shortage of grazing, such as drought (9%), too many crop fields and houses (7.5% each), as well as veld fires (3%).

When the respondents in the MSA were specifically asked about water availability for cattle in general, 60% of the respondents said that they did not have enough water for their cattle whereas 40% said they did. Furthermore, 64% of the respondents said that they had to fetch water for their cattle at certain times.

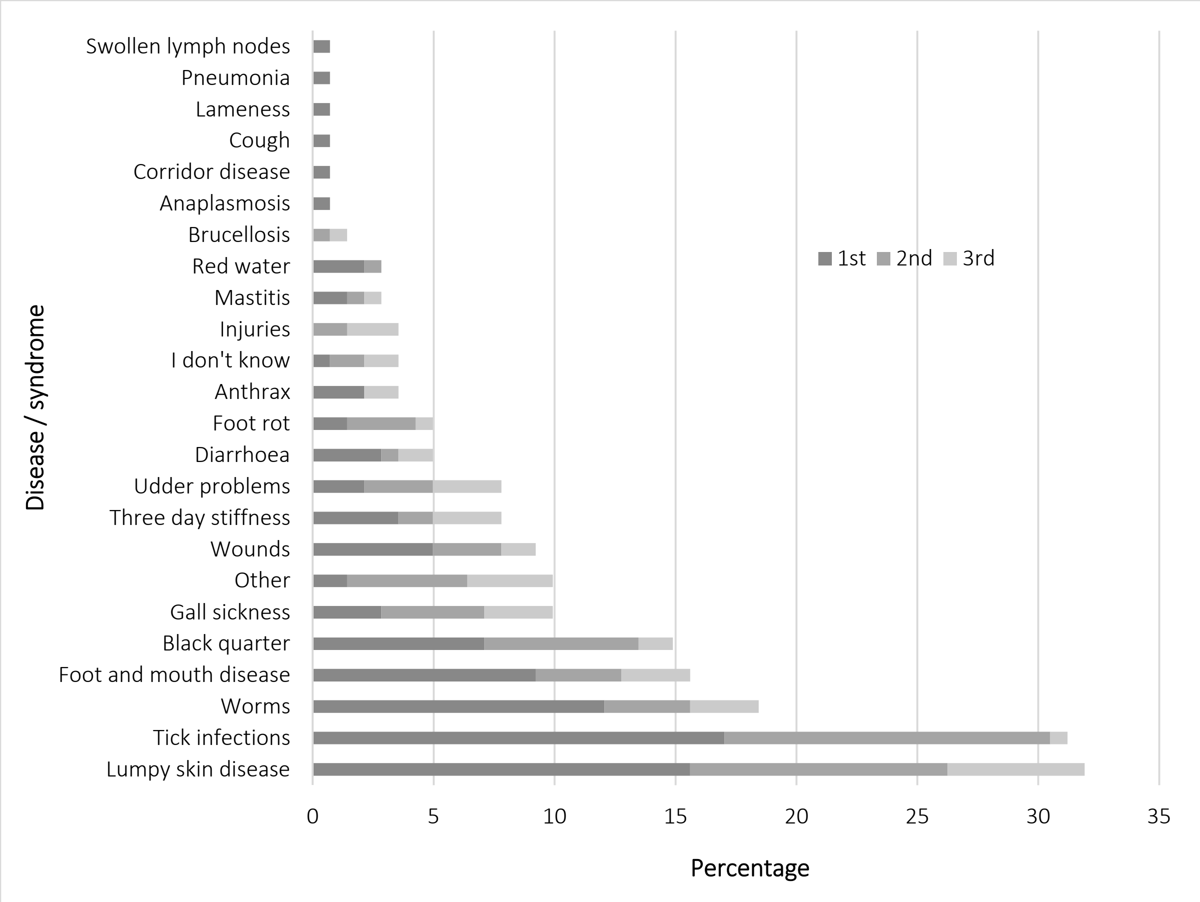

Figure 3-7: The percentage of respondents in the MSA who listed specific health problems in order of importance

Of the respondents who said they experienced problems with water for their cattle, 75% said that this was only in winter or late winter and a further 26% said it was only during droughts. However, 12% of the respondents said that they always experienced water problems.

In the MSA, most respondents overall (65%) did not think there were any specific animal health problems. The diseases that were mentioned by the respondents in the MSA as being of major concern, were LSD (32%) and tick infections/burdens (31%) (Figure 3-7). Tick infection was the disease mentioned by most as being the first most important problem (17%), followed LSD, which 15% of the respondents felt was first most important. Worms (18%), FMD (15.6%), and black quarter (black leg) (15%) were the third to fifth most common diseases mentioned. Gall sickness, miscellaneous diseases, wounds, three day stiffness, and udder problems were all mentioned by between 5 and 10% of the respondents, with the rest being mentioned by less than 5% of the respondents. Worms, FMD, and black quarter were considered most important diseases by respectively 12%, 9% and 7% of the respondents.

3.3.4 Cattle mortality rates

Thirty five (80%) of the 44 respondents in the ZR reported cattle losses due to either mortality or animals that physically went missing during 2011. The eight respondents who did not have cattle mortalities during 2011 remarked that they had, however, the previous year, mostly from predation. According to the respondents in the ZR, a total of 156 animals were lost by farmers over the course of 2011 (n=35). This equates to an average exit rate due to mortality or related losses of 4.6 animals per owner for the year and an 80% probability that a respondent will lose at least one animal in the year. The overall mortality rate was 6% of the total owned cattle population in the ZR.

Table 3-5: Number of herd exists during 2011 due to mortality or related causes as reported by respondents in the ZR (n=30)

Category	No. of Respondents (%)	Mean losses	Std Deviation	Min	Max	Sum (% of total)
Bulls lost	5 (11%)	1	1	1	2	7
Oxen lost	10 (23%)	2	1	1	5	16
Calves lost	6 (14%)	5	7	1	18	28
Cows lost	18 (41%)	2	1	1	5	41
Heifers lost	6 (14%)	1	1	1	2	8
Undefined	4 (9%)	6	3	2	8	22

Table 3-6: Perceived causes of herd exists other than trade or own consumption by respondents in the ZR and impact on owners

Cause of herd exit	No. of Respondents (%) (n=147)	No. of animals (%) (n=140)	Mean exits / owner (n=46)
Crocodile	5 (11)	10 (6.8)	2.0
Hyena	9 (20)	20 (13.6)	2.2
Lion	2 (4)	3 (2.0)	1.5
Disease	20* (43)	83 (56.5)	4.2
Missing	6 (13)	26 (17.7)	4.3
Unknown causes	4 (9)	5 (3.4)	1.3

* Significant ($P<0.05$)

The probability of losing a cow was the highest (41%) with eighteen respondents losing, on average, two cows per owner (Table 3-5). Ten owners lost on average two oxen per person, and six respondents lost on average five calves per person, which meant calf mortality had the highest impact within herds where this did occur. A total number of 22 animals lost by farmers could not be classified accurately by the owners.

The respondents in the ZR who reported mortalities were given the opportunity to explain what the reasons for their animal losses were. Of the 156 cattle mortalities reported for the year, 140 incidents were linked to specific causes as perceived by the respondents (Table 3-6) and a further 16 could not be accounted for. The most important reasons given were diseases (56.8%), and predation (35%). Disease as a perceived cause of death was significantly higher than any other (P=0.004). Cattle exits due to animals that went missing and mortalities due to unknown reasons were mentioned by 13% and 9% of the respondents respectively. Hyena (20%), crocodile (11%) and lion (4%) were mentioned in terms of predation-related exits. Twenty six cattle went missing among six owners (4.3 per owner) which was higher than the 4.1 deaths per owner due to disease. Still, disease-related exits affected 20 of the 44 surveyed respondents and disease was linked to the deaths of 83 cattle in total.

Table 3-7: The main reasons for cattle losses as well as number of cattle lost by respondents per reasons given in the Mnisi Study Area (MSA)

Reason for exit	N	Mean		Std Deviation	Sum (% of total)
	Statistic (%)	Statistic	Std Error		
Disease	41 (23.8)[a]	3.1	0.4	2.6	126 (27.6)
Drought	37 (21.5)[AB]	3.6	0.3	2.0	134 (29.4)
Stock theft	29 (16.9)[a]	2.8	0.4	2.4	81 (17.8)
Abortion/Still birth	12 (7.0)	2.0	0.3	1.1	24 (5.3)
Injury	11 (6.4) [b]	1.7	0.2	0.6	19 (4.2)
Dystocia	10 (5.8)	1.5	0.2	0.5	15 (3.3)
Miscellaneous	9 (5.2)	1.8	0.1	0.4	16 (3.5)
Predators	8 (4.7)	2.4	1.2	3.5	19 (4.2)
Unknown	8 (4.7)	1.6	0.3	0.7	13 (2.9)
Old age	7 (4.1)	1.3	0.2	0.5	9 (2.0)

A-a ; B-b = significant differences (P<0.05)

In the MSA, respondents reported cattle losses due to disease (24%), drought (21.5%), and stock theft (17%) over the previous 12 months (Table 3-7). The rest of the respondents ascribed cattle losses to abortions or still births (7%), injuries (6.4%), calving complications (6%), miscellaneous reasons (6%), predation (4.7%), and unknown causes (4.7%). However, the highest number of cattle lost were due to drought (29.4%) which was followed by diseases (27.6%), and stock theft (18%). The mortality rate in the MSA over the reporting year was 21.6%.

3.3.5 Animal quality and improvement

The perception of the quality of the cattle owned by the respondents in the ZR was tested, and revealed that 43% believed that they owned good quality animals. However, 32% of the respondents felt that their animals could be improved. Improved grazing was mentioned by most respondents in the ZR (six) as a way in which they thought their animals' value and condition could be improved (Table 3-8). Better bulls and crossbreeding were the improvement steps mentioned second most by respondents (four each). Many respondents explained that they did practise crossbreeding mainly by buying Brahman-type bulls to breed with their Sanga-type cows. Supplementary feeding and improved access to medicines and knowledge were other opportunities mentioned.

Table 3-8: Activities and interventions through which respondents in the ZR felt they could improve animal quality

Improvement step	No. of Respondents
Improved grazing	6
Cross breeding	4
Better bulls	4
Supplementary feed	3
Access to medicine	2
Breed improvement	2
Don't know	2
Knowledge	2
Improved management	1

In the MSA, 73% of the respondents reported that they considered Nguni-type or indigenous cattle to be the dominant breed in their herds (Figure 3-8**Error! Reference source not found.**). A further 26% said their herds consisted mainly of mixed breeds, followed by 12% who said they consisted mainly of

Brahman-type (12%), Afrikaner-type (6%), or Bonsmara-type (2%) cattle. Four respondents were not sure what type of cattle they had. However, when asked what type of breed they preferred, 37% said they preferred Brahman-type cattle, 24% said Nguni-type cattle whilst 17% said they preferred Afrikaner-type cattle (Figure 3-8).

In the MSA 28% of the respondents said that they used specific bulls for breeding whilst the rest (71%) did not use any specific bulls for breeding purposes. In total, 60% of the respondents were satisfied with the quality of the bulls that were generally available for breeding in the communal rangelands, whilst 40% were not satisfied.

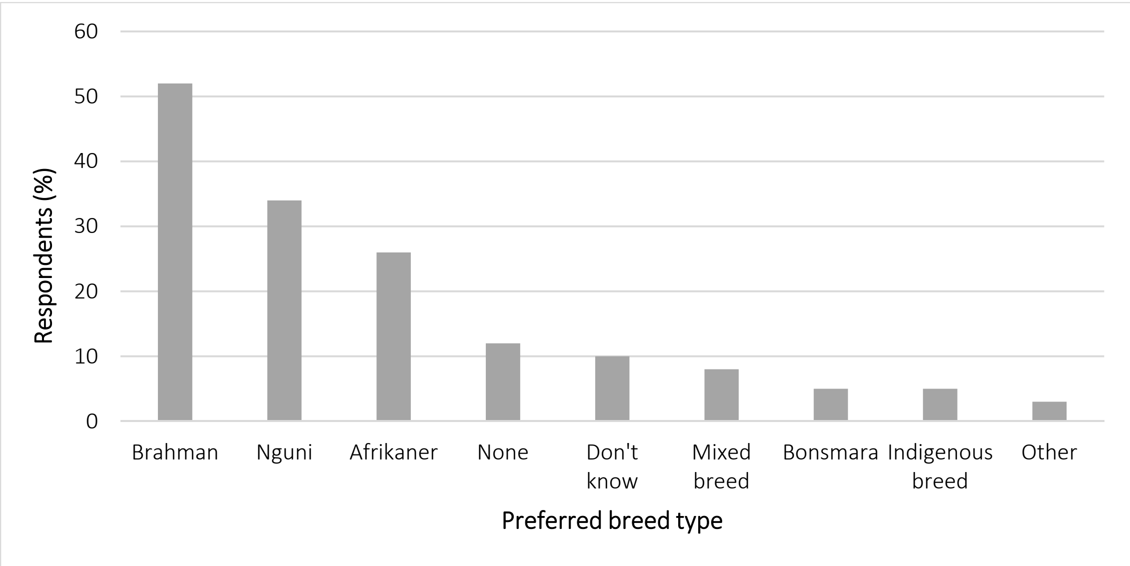

Figure 3-8: The breed types respondents preferred in the Mnisi Study Area (n=140)

When respondents in the MSA were asked whether or not they gave their cattle supplementary feed, the response was equally divided between 'yes' (50%) and 'no' (50%). The biggest reason that respondents were not able to provide supplementary feed was the costs associated with it (n=36) and availability (n=15). Six respondents also said that they did not have enough knowledge about what to supplement when. Of the farmers in the MSA, 54 (38.8%) did wean their calves whereas 84 (60.4%) did not wean their calves. Of those who did not wean calves, 41.7% said they did not because of a lack of knowledge about weaning and 22.6% said that they did not think it was necessary. Of the respondents, 6% said that nose rings were too expensive, or not available (4.8%) and 2% said they lacked the ability to make use of them due to camp infrastructure; 2% also said that it was unnatural to wean. Yet, 82% of the farmers who did not wean said that they would like to wean if they were able to.

In the ZR, 27.3% of the farmers (n=12) did wean their calves whereas 72.7% (n=32) did not. The main reasons given by the farmers for not weaning their calves were that they either lacked the knowledge to know what to do (28.1%) or that it was not necessary because the cattle weaned calves naturally (28.1%). Others said that they did not have the resources to do so (12.5%) or because they felt it deprived the calves from growing (6.3%). Of the farmers who did not wean calves, for 9% this was due to either empathy for them or because they did not have the infrastructure; and 3% said they did not wean because they wanted the cows to continue to lactate for milking purposes. Yet, when asked, 65.9% of the farmers in the ZR said that they would like to sell weaners if they would get a premium for them. However, 27% would not sell weaners and 4% said that it depended on the price.

3.3.6 Extension and skill development

The Meat Board of Namibia initiated a farmer mentorship programme (FMP) in the Zambezi Region in an effort to assist red-meat producers in terms of improving carcass quality and increasing market participation. The programme was initially implemented with a small group of randomly selected farmers in some areas of the ZR, and respondents were asked if they thought they could benefit from such a programme. A total of 95% of the respondents in the ZR were in favour of such an initiative, with only one respondent not being in favour, because she first wanted to see the benefits it brought to the participants (Interview 13). Some respondents specifically commented that they would like to see such a programme that included everyone, and not just some farmers. They also emphasised that it must be sustainable and ongoing (Interview 43). Others said *"Yes – that is what we want!"* (Interview 12), and *"Yes – we need more teaching to learn"* (Interview 25).

In the MSA, 54% of the respondents said they did not receive any guidance or advice on how to farm with cattle, and of those respondents 95% said that they would welcome more guidance and advice on farming. Of the 45% of the respondents who said that they did receive guidance and advice, most (n=50) said they received advice from the local animal health technicians, whilst only three respondents said they received assistance from livestock production extension officers. Twelve respondents said they received advice from other local farmers.

3.3.7 Trade and marketing

Market participation and trade levels

Only 46% of the respondents in the ZR sold any of their animals between January and mid-November 2011. Of these farmers, 57% sold only one animal during this period. One farmer was able to sell 110 animals to the Katima Mulilo (KM) Meatco abattoir – which equals the daily abattoir intake. A total of 179 animals were sold by 21 cattle owners. The mean off-take rate for all 44 respondents was 3.8%, which increased to a mean of 8.1% per owner for those who did sell one or more animals.

The biggest reason given by respondents for not selling any cattle in the ZR was that their herds were too small. One farmer specifically stated that he does not sell before he has a herd of at least 60 animals (Interview 21). At that stage he had only 24 animals. Either cattle losses incurred or sales during previous years were most frequently mentioned as reasons for having insufficient herd sizes to facilitate trade. Another reason often given for not selling was the fact that there was no need to do so, or no urgent matter that necessitated an animal to be sold.

Most respondents who had sold animals in 2011 sold cattle in local, informal markets (63%), even though the largest percentage of the cattle sold was sold to the Meatco abattoir in Katima Mulilo (81% of the total number of cattle sold by 16% of the respondents) (Table 3-9). The biggest distinction between selling to local markets or farmers, and to Meatco, was in the number of animals sold at a time. On average only two animals per respondent were sold locally compared to the 21 sold on average per person to Meatco. If the one farmer that sold 110 cattle to Meatco was excluded from the calculation, the average number of cattle sold to Meatco by the six remaining owners was still between 5 and 6 animals per person. One farmer from Kasika specifically explained that he only sells to Meatco if he has 4 or 5 animals available to sell at once (Interview 4). The total off-take rate due to trade was 7.2%.

Table 3-9: Descriptive statistics of market access and trade level as reported by respondents in the ZR

Market	No. of respondents (%)	Mean	Max	Sum
Local farmers	14 (63%)	2	11	33
Meatco (abattoir)	7 (16%)	21	110	145
Agents	1 (5%)	1	1	1
TOTAL	22 (100%)			179

In the MSA where formal market access is sporadic, only 46.4% of respondents sold at least one animal during the reporting period (August 2008 – August 2009) whilst 53.6% did not sell any cattle whatsoever. Of those who did sell at least one animal, 24.3% sold one or more cows and 20% sold one or more bulls. Furthermore, 9% of respondents sold one or more oxen, whilst one or more heifers were sold by 3.6% of the respondents in the MSA. Of the respondents who did sell at least one animal over the reporting period, 51% were satisfied with the prices they received for their cattle, whilst 47% were not satisfied.

In the MSA, the structured survey instrument of a representative sample of the cattle-owning population allowed for the quantification of the number of cattle sold by type and by market (Table 3-10*)*. Farmers in the MSA sold only in the informal market where most cattle were sold to other farmers (43%), followed by local butchers (40%), and other undefined informal markets outside the study area (17%). The highest average price per animal was received for sales to other local farmers, at an average price of R4 142.86 per animal across all types. Butchers paid on average the second highest prices (R3 781.40) followed by other markets (R3 518.18). Despite the most cattle being sold to other farmers, more farmers sold to butchers (n=45) but on average only 1.8 animals per owner. The average number of cattle sold to other farmers was three cattle per owner, followed by an average of 3.3 animals per owner sold to other markets. Cows made up the bulk of cattle sales (32.8%), followed by bulls (29.4%), oxen (21.6%), and heifers (16.2%). Nobody sold any calves. Bulls and oxen were mainly sold to local butchers, whereas cows and heifers were mainly sold to local farmers. The highest average prices were received for heifers (R4425.76), followed by oxen (R4193.18), bulls (R3868.89), and lastly cows (R3751.00). However, due to the volume sold, cows contributed the most to income, followed by bulls, oxen and lastly heifers. The total off-take rate in the MSA due to sales was 9.7%.

Market preference and barriers to access

Respondents in the ZR were asked if they had ever sold to Meatco (because only seven of the 44 respondents reported sales to Meatco in 2011): 43% of the respondents (n=19) indicated that they had done so, as opposed to the 36% that had never sold to Meatco before. Five respondents specifically stated that it was their preferred market whereas six said that it depended on whether circumstances allowed them to sell to Meatco, barring which they just sold locally. At least two indicated that they used to sell to Meatco but that this was no longer the case, as they no longer had enough cattle.

Table 3-10: A summary of the sales of the respondents in the MSA, by animal type and market type including mean prices received in the year 2009

Description		Bulls	N	Oxen	N	Cows	N	Heifers	N	Calves	N	Mean	Total cattle (%)	Total value
Feedlot	Animal	0	0	0		0		0		0				
	Price	0	0	0		0		0		0				
Auction	Animal	0	0	0		0		0		0				
	Price	0	0	0		0		0		0				
Butcher	Animal	43	21	13	7	24	16	1	1	0	45	1.8	81 (40)	
	Price	R3766.67	21	R4500	6	R3531.25	16		1	0		R3 781.40		R306 293.16
Other farmers	Animal	14	6	10	5	38	15	25	3	0	29	3	87 (43)	
	Price	R4333.33	6	R4200	5	R3966.67	15	R4750	2	0		R4 142.86		R360 428.66
Other	Animal	3	3	21	2	5	3	7	3	0	11	3.27	36 (17)	
	Price	R3166.67	3	R4000	2	R3166.67	3	R3900	3	0		R3 518.18		R126 654.61
Total (%)	*Animal*	*60 (29.4)*	*30*	*44 (21.6)*	*14*	*67 (32.8)*	*34*	*33 (16.2)*	*7*		*85*		*204*	
Mean	*Price*	*R3868.89*	*30*	*R4193.18*	*13*	*R3751.00*	*34*	*R4425.76*	*6*					
TOTAL VALUE		R232 133.44		R184 500		R251 316.81		R146 050						

2

The 16 respondents who indicated they had never sold to Meatco before were asked to explain their reasons for choosing not to sell to Meatco. The biggest reason given was the number of cattle they had to sell at a time in order to balance the costs related to the transport of the animals to the quarantine station. Of the responses received, eleven farmers (61%) indicated that either the numbers they had to sell or the transport costs to the quarantine station or a combination of the two factors were the reasons why they did not sell to Meatco. Here again farmers explained that they could not take only one or two animals at a time to the quarantine camp. Farmers explained that they had to sell at least five cattle to cover the losses incurred during transport, which were mainly related to a loss in animal condition (weight loss reduces carcass yield, hence income) and the payment of herdsman who trekked with the animals on foot to the quarantine camps and who had to look after them during the 21-day quarantine period.

In terms of sales, 44% of the respondents were generally satisfied with the prices received when cattle were sold in the ZR, without specifying a market. However, 40% were not satisfied with the selling prices they received for their cattle. Farmers who felt the market prices were unsatisfactory merely reported that these were "too low" or that they had to sell due to an emergency, which resulted in less bargaining power. In two separate interviews, farmers compared the prices they received at the Meatco abattoir with that of family and friends selling to the abattoir in Kavango. They both said the prices in the ZR were lower than in the Kavango and blamed the need for transport to the quarantine stations or the 'red line' (FMD infection zone) for the lower prices in the ZR. Farmers satisfied with the prices were happy either with Meatco's standard prices or with the negotiation process towards an acceptable price when cattle were sold to local buyers.

In the MSA, 53% of the respondents were satisfied with the market access they experienced when selling cattle, whilst 41% were not satisfied and a further 6% said that they were unsure. There was a significant correlation in terms of farmers who said they kept cattle to serve as a bank and who were also satisfied with market access (Cross tabulation: Chi-square, $P=0.037$). However, there was no significant link between farmers who said they did not sell any cattle or kept cattle for commercial reasons, and those who said they were satisfied with market access (Cross tabulation: Chi-square $P>0.05$). Some farmers in the MSA have said that they think auctions where buyers from local butcheries as well as approved abattoirs can come and buy cattle, will be beneficial in the area. This perception has resulted due to the fact that for a period of time such auctions did indeed take place in the area, but ground to a halt when the main buyer no longer sourced in the area. The question as to whether farmers would prefer local auctions to take place was therefore included in the survey in the MSA: 85% of the respondents said that they would prefer local auctions to take place, whilst 10% did not prefer auctions and a further 5% were unsure. Of those who said that they would prefer a local auction, 68% said that they prefer auctions because of the opportunity to receive better prices for their cattle due to improved bargaining power. A further 16% said that advantages related to distance and transport were the most appealing to them, whilst 13% said that the increased number of buyers at an auction would be beneficial.

Procurement

In total, 32% of the respondents in the ZR said that they had bought cattle during the year, whereas 68% had not purchased any cattle. Most of the cattle bought were sourced from farmers in the area and were female animals bought to replace animals or to increase herd sizes. Prices the respondents reported having paid for heifers and cows bought from local farmers ranged between N$2000 and N$3000 each. A few farmers did buy or exchange cattle for oxen, whilst some acquired a breeding bull for their herds. One farmer in particular said that he was planning on buying a Brahman bull (Interview 21). One farmer bought 23 heifers from a local farmer for N$3000 each (Interview 16).

In the MSA, 83% (n=116) of the respondents indicated that they had not purchased any cattle in the last 12 months. The 17% that had bought cattle mostly sourced these from local farmers (86%) with only one farmer indicating that he had purchased an animal at a distant auction. The majority of the animals bought were cows (13 cows bought by 9 people) followed by heifers (11 bought by 7 people), bulls (2 bought by 2 people), and calves (5 bought by 3 people). Of the farmers who had made purchases in the MSA, 71% were satisfied with the prices they had paid when they bought animals, whilst 21% were not and a further 8% were unsure.

3.3.8 Herd size effect

Cattle keeping

In the ZR there was no significant difference between mean herd sizes of cattle owners in relation to the various reasons they kept cattle. In the MSA, however, the mean herd size of respondents who said they kept cattle for commercial interests was significantly larger (P=0.016) than those who kept cattle for other reasons (Table 3-11). Furthermore, there was no significant herd size differences between farmers who said that they milked their cattle and those who did not milk their cattle. However, the farmers who said that they sold some of their milk did have a significantly larger mean herd size than those who did not sell their milk.

Table 3-11: A summary of the variables that had a significant herd size difference between farmers who either had a positive or negative response on a question

Variable category	Variable	n	n (Positive Response)	P value	Mean herd size Response Yes	Mean herd size Response No
Keeping cattle	For commercial interests	140	52	0.016	17.8	13.4
Cattle uses	Do sell own milk	140	17	0.001	24.8	11.6
	Slaughter own cattle	140	104	0.001	17.6	8.8
	Use meat for household	100	89	0.01	18.6	9.3
	Trad. ceremonies & gifts	140	72	0.016	17	12.8
Constraints	Market access	141	4	0.002	62.7	16
Animal quality	Have a breed type	140	88	0.016	17.8	13.4
	Do wean calves	140	54	0.004	20.1	12.1
	Use specific bulls	140	39	<0.001	21.1	12.7
	Bull quality is poor	100	60	0.037	17	9.8
	Unsure if want calve season	140	6	0.01	16.1	5.33
Extension	Farming advice	140	63	0.041	19.3	11.7
Trade	Did sell cattle	140	75	<0.001	21	10
Mean (across all categories)					22	11.3

Similarly, farmers in the MSA who said that they did slaughter their own cattle sometimes had a significantly greater mean herd size than those who never slaughtered their own cattle. Furthermore, of the farmers who did slaughter their own cattle, the farmers who did so for consuming the meat in their own households had a significantly larger mean herd size than farmers who did not use slaughtered cattle for home consumption. The farmers in the MSA who said they had not used any of their cattle for any cultural purposes or as gifts had a significantly smaller mean herd size than those who did use cattle for such purposes. There were no significant differences between the mean herd sizes of farmers in the ZR who indicated differing uses for their cattle.

Risks and challenges in cattle production

In the ZR, there were no significant mean herd size differences in relation to the various challenges and constraints farmers mentioned experiencing in cattle production. In the MSA, only respondents who said market access was a major problem to them had a significant larger mean herd size than those who did not consider market access a major constraint (P=0.002; µ17 vs µ12.8). The mean herd sizes of farmers who indicated any of the other constraint categories indicated no significant differences. There were no further significant differences in the mean herd sizes of farmers who indicated that they either did or did not have sufficient grazing and/or water in the MSA.

Animal quality and improvement

In the MSA, the farmers who did not have a predominant breed type in their herds had a significantly smaller mean herd size (n=88, P=0.016) than those respondents who had a predominant breed type in their herds (µ herd size: 13.4 vs 17.8 respectively). When farmers were asked if they preferred a particular breed type, none of their choices had a significant correlation to herd size.

The use of livestock management techniques and technologies to improve animal or carcass quality in the MSA did indicate a strong correlation to herd size. Farmers who weaned their calves had a significantly larger mean herd size than farmers who did not wean (P=0.004; µ20.1 vs µ12.1). Farmers who indicated that they used specific bulls for breeding purposes also had a mean herd size that was significantly larger than farmers who did not use a specific bull for breeding purposes (P<0.001; µ21.1 vs µ12.7). Similarly, farmers who were satisfied with the quality of the bulls generally available for breeding in the communal herds had a significantly smaller mean herd size than farmers who were not satisfied with the overall bull quality (P=0.037; µ9.8 vs µ17).

Farmers in the MSA who indicated that they did not know whether or not they would want a specific calving season had a significantly smaller mean herd size when compared to farmers who either did or did not prefer a calving season (P=0.01; µ5.33 vs µ11.4 & µ16.08).

There was no significant difference between the mean herd size of the farmers who did or did not provide supplementary feeding to their cattle in the MSA. The farmers in the MSA who said they received some kind of advice or extension service related to livestock production, had a significantly larger mean herd size than farmers who said they did not receive any farming advice from anybody (P=0.041; 19.3 vs 11.7).

Trade and marketing

The only significant herd size correlation in the ZR was between farmers who indicated that they sell to Meatco and those who said they do not sell to Meatco. Farmers who said they sell cattle to Meatco had a mean herd size of 177, which was significantly larger (P=0.002) than the mean herd size of those who did not sell to Meatco (µ herd size of 38).

In the MSA, there was a significant difference between the mean herd sizes of farmers who said they had sold at least one animal over the previous 12 months and those who had not sold any animals. The mean herd size of farmers who did sell cattle was 21 animals, which was significantly larger ($P<0.001$) than the herd size of farmers who did not sell any cattle (μ herd size = 10 animals). There were no significant differences between mean herd sizes of farmers who either did or did not buy any cattle in either of the two study areas, or in the perception of price satisfaction between market participants when either buying or selling in either of the study areas.

Overall herd size effect

The mean herd size of all the respondents in the MSA who responded either negatively or positively to the questions that were significant in terms of herd size difference was 22 vs 11.3 respectively (Table 3-11). The difference between the means of the two groups (below or above the overall mean herd size) was approximately 10/11 animals. The population mean herd size of the 140 respondents in the MSA was 15 animals. When plotted with the population mean herd size as the reference line (0), the mean herd size of almost all the affirmative responses with a significant difference was above the population mean herd size of 15 animals. Similarly, almost all the negative responses were situated below the mean population herd size. The graph therefore identifies a profile of attributes for which there is a significant probability that farmers in the MSA either have or do not have based on an owned herd size above or below the overall population mean herd size (Table 3-12).

The survey in the ZR was less conducive to quantitative analysis because of its qualitative nature. Only one variable had a significant herd size effect in the ZR, which was in terms of farmers who either did or did not sell cattle to Meatco.

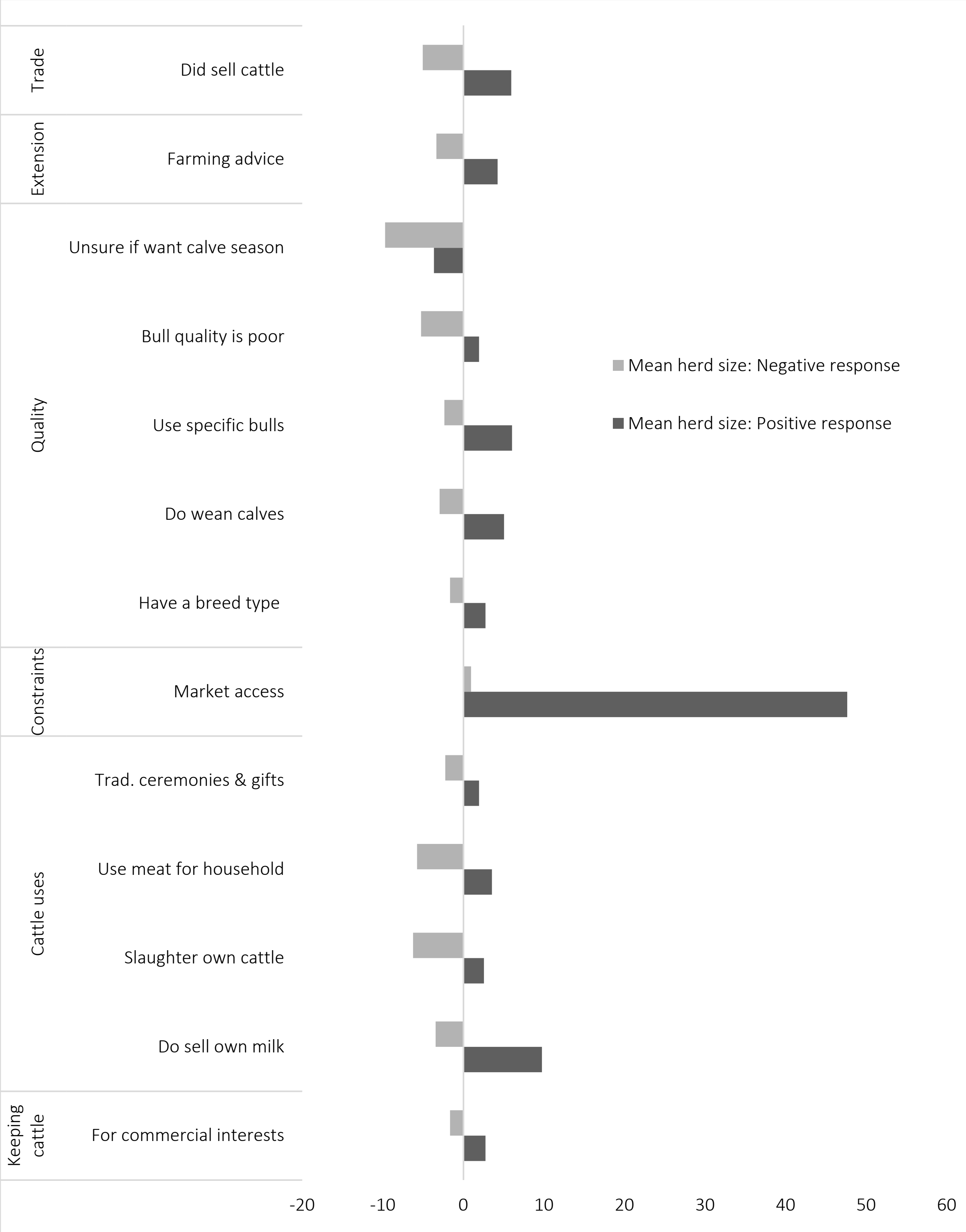

Figure 3-9: A summary of the variation of the mean herd size above and below the mean herd size of the sample (n=140) for each variable tested that did have a significant mean herd size difference between positive (Yes) and negative (No) responses

NOTE: Market access (under 'Constraints') was a herd size effector within a subset of farmers who indicated they did sell cattle – a group that already showed a significantly larger mean herd size.

Table 3-12: The profile of attributes with a significant probability that a farmer will or will not have based on mean herd size

Variable category	Likelihood profile: µ herd size below 15 animals	Likelihood profile: µ herd size above 15 animals
Keeping cattle	Do not keep cattle for commercial interests	Keep cattle for commercial interests as well
Cattle uses	Do not sell the milk from their own cattle	Sell some of the milk they get from their cattle
	Do not slaughter their own cattle	Slaughter their own cattle and use some of the meat for household consumption
	Do not use their own cattle for traditional ceremonies or as gifts to others	Use their own cattle for traditional ceremonies or as gifts to others
Constraints	Might consider lack of market access to be major constraint	Consider a lack of market access to be a major constraint
Animal quality	Do not necessarily have a particular dominant breed type	Generally do have a dominant breed type in the herd
	Do not wean their calves	Wean their calves
	Do not use a specific bull for breeding	Do use a specific breeding bull
	Do not regard bull quality of bulls in the area as poor	Regard the quality of bulls in the area as poor
	Not committed to having a calving seasons	Interested in having a specific calving season
Extension	Do not seek farming advice	Seek farming advice
Trade	Do not sell cattle	Do sell cattle

3.4 Discussion

Herd size

In both study areas, the reported herd sizes closely reflected the mean herd sizes and therefore suggested that the samples were representative in terms of the distribution of herd size. In the ZR the mean herd size was approximately 24 animals lower than was reported in a previous study in the area (Paskin and Hoffmann, 1996). Although not based on a large sample size, Paskin and Hoffman (1996) felt that their study was representative of the area. This suggests that the mean herd size in the ZR has decreased since the mid-1990s. Since the cattle population is currently at its largest in recorded history (see Chapter 5), one can conclude that the drop in herd size is due to an increase in owners in proportion to the number of cattle per herd. However, Nyambe (2013) reported otherwise and found a significant drop in the number of cattle owners with small herds, and an increase in owners with large cattle herds, between 2003 and 2007 in the ZR.

A similar apparent trend in shrinking herd size can be seen in the MSA. As the number of cattle has increased, more people are also seen to become cattle owners. Dovie et al. (2006) reported a sharp increase in cattle owners over a ten-year period in Thorndale, a village in the MSA study area. This was in conjunction with a large increase in the number of cattle at the inspection point (Seville B) where the total number of cattle recorded at the inspection point was approximately 300 animals in 1999. In 2009, the stock register at the same inspection point reflected a 12-month mean number of 724 animals and 50 cattle owners (mean herd size of 14.5 animals).

Herd composition

The herd composition parameters in both study areas were similar to the findings of previous studies in the same areas (Paskin and Hoffmann, 1996; Dovie et al., 2006) and typical of communal systems elsewhere in southern Africa (Barrett, 1999; Schwalbach et al., 2001). The composition reflected the diversity of roles that cattle play at household level. This was evident in the switch in the proportion of bulls and oxen between the areas. Both areas had a reported herd composition of approximately 21% or 22% males. However, in the MSA the majority of male animals were bulls whereas in the ZR these were oxen. Draught animals are extremely important to households in the ZR, which rely largely on them for crop production and transport (Teweldmedhin and Conroy, 2009), and the herd composition therefore reflects this need. The lower number of oxen in the MSA reflects the reported lower importance of draught animals to farmers in the MSA.

The ratio between breeding females and bulls was more favourable in the ZR than in the MSA. A low cow-to-bull ratio will limit the productivity of a herd; in the commercial sector a ratio of between 20 and 30 cows for each bull is the norm. Low calving percentages are also typical of low-production communal systems (Janeke, 2012). The calving percentages in both areas were lower than the 40% that has been proposed as a 'norm' for communal systems (Scholtz and Bester, 2010b).

The role of cattle at household level

Overall, the reasons for keeping cattle and the role of cattle at household level reflected the findings of previous studies in similar systems (Shackleton et al., 2000; Shackleton et al., 2005; Dovie et al., 2006; Scholtz et al., 2008; Smith et al., 2013). Although farmers kept cattle for largely similar reasons in both study areas, the actual emphasis on why they were kept and the roles they played did vary between the study areas. In the ZR cattle were seen to be the very essence of the livelihoods of the people, in that they contributed to every aspect of their existence. This was different in the MSA, where cattle were mainly kept to serve as a 'bank' or savings mechanism, and where only one respondent referred to cattle as essential to his livelihood. The origin of this reasoning can further be seen in the difference in what people considered to be their main source of income at household level in the two study areas. In the ZR all but one respondent considered cattle to be their main source of income, whereas in the MSA income from pensions was seen to be the main source of income for the majority of respondents. A previous study also found that, for the majority of households in the ZR without a formal income, livestock and to a large extent crop farming, and where possible the harvesting of natural resources such as wood and fish, automatically became the main source of income in the region (Nyambe, 2013). Furthermore, a study conducted in 2001 found, in a similar area north of the MSA, that only 30% of the cattle owners reported that more than 75% of their household income originated from cattle. Thus cattle are often kept mainly for financial security and supplementary cash income in similar systems in South Africa (Schwalbach et al., 2001). Keeping cattle for financial interests such as cash income from sales was reported second most frequently in both study areas and at the same proportional frequency. Additionally, keeping cattle for emergencies was proportionally more important in the ZR than in the MSA, where traditional functions were again more important than in the ZR (tradition being the least frequent role fulfilled by cattle in this region). In the MSA 51% of the respondents used cattle for some kind of traditional use: mainly in ceremonies, to pay *lobola* and as gifts. A further major difference in the reasons cattle were kept was in terms of consumptive use. Although most farmers in the ZR did report milk and meat for the household as being provided by cattle, nobody mentioned it as a primary reason for keeping cattle. This was in contrast to the MSA, where 9% of the respondents mentioned keeping cattle for the consumptive goods they provided to their households.

The significant contribution of cattle goods and services at the household and community levels in both study areas, in terms of milk, meat and draught power, was consistent with reports from similar systems and confirmed the importance of cattle to household and community food security as well as indirect income (Dovie et al., 2006; Randolph et al., 2007; Musemwa et al., 2008).

Production and health risks and constraints

An important finding was the fact that in both study areas a lack of market access was mentioned least by farmers when asked to indicate and explain the major challenges they experienced. Market access was not considered a major constraint; rather, disease and predation in the ZR and lack of grazing and water in the MSA were viewed as being the primary obstacles to farming cattle. The relevance of these constraints was substantiated by the number of cattle losses incurred due to these factors. Natural resource limitations were less of a concern in the ZR, where vast savanna and grass plains are prevalent, and where most of the respondents lived near perennial rivers. However, wildlife roam the freely within the region, and large predators inhabit both the study areas. In the MSA, grazing was limited and each village had a strictly designated grazing area where all cattle from the village were allowed to graze. These areas were significantly smaller than the vast grazing areas available in the ZR: this factor will be discussed in more detail in further chapters.

Water in the MSA is restricted to earth dams, which are often limited to one or two per village. Farmers explained that these dams regularly ran dry in the late dry season (or even earlier during years when rainfall was below average) which had a major impact on their animals. Stock theft seemed to be a major constraint in the MSA but was not specifically mentioned during the interviews in the ZR, although substantial levels of stock theft do occur further north, closer to the Zambian border (according to personal communication with cattle owners from these areas as well as mentees of the Meatboard Mentorship Programme). Stock theft has been reported to be a major cause of stock losses in the informal farming sector in South Africa, with a major impact, especially on the poor (Scholtz and Bester, 2010a).

Generally, perceptions related to cattle disease and the farmers' levels of concern in this regard were in accordance with that of previous studies in similar systems (Paskin and Hoffmann, 1996; de Garine-Wichatitsky et al., 2013; Mashebe et al., 2014). It is important to note that FMD was not regarded as the major disease risk in either of the two study areas, as opposed to tick-related problems, which were viewed as more problematic in both areas. Most of the other health issues mentioned by respondents, such as lumpy skin disease and parasitic diseases, have been indicated in these areas before, and were similarly regarded in the present study, clearly having a significant perceived impact on animal health (FAO/WFP, 2009; Mashebe et al., 2014).

In the ZR, buffalo-related problems were significant and mentioned frequently by those farmers who had an issue with wildlife contact, and were clearly associated with disease risk in general. Farmers' perceptions regarding this matter are important in the context of this study, and will be discussed in later sections wherein the factors of market access and the effects of buffalo-cattle contact are dealt with more specifically.

The possible confusion between 'disease' and 'predation', especially since hyena were most commonly implicated in losses due to predation, needs to be acknowledged. Hyena are scavengers and will readily target animals that die from a disease or injury in the rangelands. By scavenging on a dead animal they are likely to be wrongfully blamed for the death of the animal. However, hyena are very capable and successful hunters as well, and a few individuals could easily bring down even adult cattle. Furthermore, when asked, the farmers seemed convinced that these predators were the cause of death and some farmers even explained how they had heard their animals being caught by, among other predators, hyena. Large predators throughout the ZR are being monitored by the Caprivi Carnivore Project[6], a collaborative effort between conservancies, the Ministry of Environment and Tourism (MET), and several conservation organisations. The initiative makes use of satellite collars and camera traps to monitor the movement of (mostly) hyena and lion, both within and outside of protected areas.

The Caprivi Carnivore Project has found that lion populations in the protected areas are steadily on the increase and that more predation of livestock, especially in the vicinity of the Mamili National Park, has occurred in recent times (Caprivi Carnivore Project, April 2013). Furthermore, the monitoring of a resident hyena clan in the Mudumu National Park has confirmed that members of the clan frequently wander deep into adjacent conservancies and even in close proximity to villages. The home range of the Mudumu clan extends far beyond the park boundaries into human settlement areas, both to the north and south of the park. However, it was also found that most livestock that were preyed upon by hyena were animals that wandered unattended, close to the park boundary – far from human settlements. This was substantiated by personal observations (November 2011) of cattle roaming well inside the Mudumu National Park, where both lion and hyena are found.

The mortality rate in the ZR was similar to other areas but in the MSA it was much higher and most likely linked to below average rainfall in 2008.

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[6] Caprivi Carnivore Project. http://www.caprivicarnivores.org/ Accessed May 2014.

Animal quality and improvement

In both areas most of the respondents were satisfied with the quality of their livestock (ZR in general and MSA with their bull quality in particular), but a substantial group felt that there would always be room for improvement. In the ZR the majority of cattle are indigenous Sanga, a breed that is genotyped and described to be its own ecotype, called Caprivi Sanga. Caprivi Sanga have developed special characteristics that enable them to better adapt to their local environment, such as high nitrogen retention in their bodies (Els, 2002). Nguni cattle, the indigenous breed dominant in the MSA, have also been found to have similar attributes, which makes the breed well suited to the semi-arid savanna of south-eastern Africa (Mapiye et al., 2009). The breed distribution and preferences in the MSA are typical of communal systems in South Africa, in that besides the local Nguni-type cattle, Brahman and Afrikaner-type cattle are favourites among local pastoralists (Scholtz et al., 2008). Both study areas reported the use of cross breeding, although in the MSA cross breeding was mainly limited to the 28% of farmers who said that they did use specific bulls for breeding.

Respondents from both study areas indicated the importance of grazing management, which was associated with animal improvement. The participation in or use of most of the technologies noted in the ZR and in the MSA for possible animal improvements were restricted by lack of knowledge, resources, and infrastructure for service delivery and distribution. This is a common challenge in such communal systems (Mapiye et al., 2009). Most farmers in the MSA also reported that grazing had to be better managed and that lack of knowledge or information was often a limiting factor for farmers who wished to adopt improved husbandry techniques.

Extension services and skill development

The overwhelming interest in improved extension services or any form of mentorship and skill development in both study areas indicated the level to which a lack of skill and knowledge marginalised the farmers. The positive aspect of these findings is the farmers' clear willingness to learn and develop skills related to cattle farming. The emphasis on the desire for an inclusive intervention in which all farmers can participate was particularly evident in the ZR and perhaps shows that not all farmers have been able to, or have not been allowed to, participate in skill development interventions. Knowledge transfer and training is a critical need in communal farming sectors (Smith et al., 2013) and further indicates the frequent shortfall in extentionists' skill levels and service delivery in the region (Koch and Terblanche, 2013).

Market participation and trade

Despite the option of formal trade with the Meatco abattoir, respondents from the selected study areas in the ZR reported the same level of market participation than in the MSA, which was ~46%. Low market participation and low off-take rates have been well documented in communal systems (Musemwa et al., 2008; Musemwa et al., 2010; Scholtz and Bester, 2010b). The lack of participation in the formal market in the ZR was mainly attributed to high transactional costs and to the fact that large herd sizes were required to justify the high transactions costs and risks. Local farmers were the biggest target market in both study areas in terms of the number of participants and number of cattle sold, and not local meat markets – formal or informal. It must be noted that if local farmers move (trade) cattle among themselves, it does not constitute off-take from the larger area in terms of a reduction in grazing pressure. In the MSA, income from selling heifers and from selling animals to local farmers was the highest per unit.

With many farmers in both areas not necessarily keeping cattle for predominantly trade purposes, it is perhaps not a surprise that most farmers in the MSA and as many as 44% in the ZR were satisfied with market prices. The majority in the MSA were also satisfied with market access in general and reflected the similar proportion of the respondents who did not trade any cattle in any case, and further re-emphasised the fact that cattle were mainly kept to serve as financial security as opposed to trade. The influence that the reason for keeping cattle has on market participation is well demonstrated in the MSA, in that there was a significant probability that farmers who said they kept cattle mainly to serve as a bank, were also satisfied with market access. Having traded cattle or not, did not, however, significantly influence perceptions of market access satisfaction in the MSA, further emphasising the smaller role that trade plays in terms of the considerations of farmers in the area. The data for sales and prices received in the MSA indicated that significant amounts of money do flow, unaccounted for within these systems, through the informal trade in cattle. Such trade is a substantial economic activity that is generally not recognised by policy makers, who typically do not regard it important for local economic development (Bushbuckridge Local Municipality, 2009). In the ZR, the important role the cattle industry played was better understood and acknowledged (Nyambe, 2013) and the presence of the local formal market, facilitated by means of the Meatco abattoir, and which could account for the value of the cattle trade, albeit only formal, was therefore important from a policy perspective. The low prices received for cattle in the MSA were similar to prices received elsewhere in areas not within disease control zones (Musemwa et al., 2010), which is an indication that constraints within market systems rather than disease control are important limitations to market access at the wildlife-livestock interface.

The off-take rates in the MSA and the ZR were typically low and similar to findings in similar farming systems elsewhere (Musemwa et al., 2010).

Herd size effect

Herd size varies considerably in communal farming systems, which was again shown in both study areas (Sutter, 1987; Dovie et al., 2006; Mendohlson, 2006; Scholtz et al., 2008). However, the broader link between herd sizes and the attributes, perceptions and aspirations of a population of farmers, has not been well demonstrated to the author's knowledge. The clear emphasis placed on herd size, especially by farmers in the ZR, in that larger herd sizes are a precursor for (formal) market access, indicates that the broader effects of herd size should be investigated. The statistical effect of herd sizes across variables included in this chapter was best tested in the MSA because of the quantitative data set gathered in this region, as opposed to the more qualitative data set obtained in the ZR. The significant difference in mean herd size between farmers in the ZR who did sell to Meatco, as opposed to those who did not, confirmed the information that was given during interviews. Previous reports in Namibia have also indicated the role herd size has played in herd viability as well as market participation (Mendohlson, 2006). Herd size also had a significant effect in the MSA, where the mean herd size of farmers who indicated that they kept cattle for commercial reasons was significantly larger than for farmers who indicated otherwise. The rest of the reasons mentioned by farmers, such as keeping cattle to serve as a bank or for household consumption, did not show a significant correlation to herd size. These reasons for keeping cattle were therefore not linked to herd size, unlike the motivation behind keeping cattle with the specific intention to sell. Similarly, most constraints to farming mentioned by farmers were shared across herd sizes, except for the four that indicated market access as a major constraint. The mean herd size in this regard was significantly larger than for the rest of the farmers, again demonstrating the link between herd size and market participation as shown in the ZR.

Herd size as a possible indicator of production orientation by communal farmers was demonstrated in husbandry practices as well. Farmers who are prone to wean calves and who take steps to improve their cattle through specific breeding practices have a significantly larger mean herd size than farmers not taking these steps.

From a food security perspective, and in terms of the indirect value cattle have at community level, there were strong links to herd size. The important role farmers with larger herds played in their communities was evident in that those in the MSA who said they use cattle for traditional ceremonies, including *lobola*, and as gifts to others, had a significant larger mean herd size than the rest. The same was true for farmers who sold milk to others and slaughtered cattle for household consumption. The likelihood that farmers with small herd sizes (below the population mean) used their cattle to contribute to household food security and to the food security of others, was significantly less than in the case of herds above the mean population herd size. Furthermore, farmers who said that they seek advice and consult others also had a significant larger mean herd size than those content with low levels of extension services.

These findings indicate the significant variation and diversity that exist within communal farming systems. There are groupings of farmers within farming systems that are clearly subsistence orientated and those who are significantly more commercially orientated in their cattle farming operations. Herd size can be a very valuable tool to distinguish between such groups in a farming community, and which can contribute to tailored interventions. The attribute profiles in this study indicate that farmers with herd sizes below 11 cattle are most likely subsistence orientated, that those between 11 and 22 are perhaps potential emerging farmers, and that those farmers with herd sizes above 22 animals are small-scale commercially orientated farmers in their own right.

3.5 Conclusions

The objective of this chapter was to analyse the cattle production systems and the constraints experienced within these systems by farmers operating in the regions under discussion. This was necessary in order to emphasise what the farmers themselves perceived to be the core production issues and challenges pertinent in their environments. In other words, the aim was not simply to compare the systems, but rather to be able to provide a synthesis of general similarities and differences in the production systems and of the respective needs in two entirely separate systems, both of which, however, have disease-control restrictions and wildlife-livestock interfaces in common. The data included in this study were vast and covered a wide range of aspects related to the cattle production systems in the respective study areas. The purpose was not to discuss each finding in detail, but rather to demonstrate the level to which these systems conforms to what is typically known of such farming systems, and also to identify clear differences between the study areas and to suggest what the reasons for such differences might be. If anything, the findings have re-emphasised the complexity of the role cattle play in poor households and the need to analyse the systems holistically, in line with the vision to develop pro-poor interventions.

An important finding, for the purposes of this study, was that the presence or absence of a formal market in the study areas did not seem to have a remarkable effect on the farming systems. This indicates that the barriers to accessing the available formal market in the ZR study area are substantial enough to negate the potential impact on poverty or as a pathway out of poverty. Also that not all farmers are trade-orientated which again highlights the multiple use and roles livestock play in rural communities. The findings highlighted the opportunities for further economic activity by means of taking full advantage of the value that could be added through cattle products currently not utilised at all in the MSA, such as cattle hides. Indigenous cattle hides are popular among tourists and can sell for several thousand rand per hide in adjacent conservation areas, in the form of curios.

A further very important finding of this study was the link between herd size and attributes of farmers and farmers' perceptions in terms of production, trade, and goods and services. Records of cattle demographics and movement are a requirement in FMD control zones, and the recording process is mostly conducted by state veterinary services. Records are kept by means of stock registers and individual stock cards, which are updated during cattle vaccinations and inspections at designated inspection points throughout a control/surveillance area. Herd size is therefore known and usually readily available: in the form of owner stock cards or stock registers kept at inspection points. In some areas, such as in the MSA, weekly inspections take place and the data on herd size and demographics are therefore kept up to date. The indication that herd size could be used to distinguish between the likely attributes of farmers in order to tailor interventions accordingly is valuable and should be further investigated. It strongly opposes the broad generalisation that communal farmers in the MSA, for instance, are subsistence orientated and hence do not justify investment in terms of local economic development. In fact, this study clearly demonstrates that informal trade in cattle is responsible for significant trade activity, which could be better harnessed for poverty alleviation, if the diversity of production aspirations within the farmer community were to be targeted with development interventions. It also shows that access to a formal market in the MSA will have significant support, albeit not from farmers of all herd sizes. The study further demonstrates the important role that farmers with larger herds fulfil in local food security, as well as in the provision of goods and services at village level. This role, more typical of large herd owners, has not been clearly demonstrated to date, and should be considered in future policies as well as market development interventions. It is also important to consider the potential unintended negative consequences that improved market access may have on the goods and services rendered by cattle at household and village levels.

The nature of the interface was reflected mainly in the constraints and risks farmers faced in the respective areas. Mortality rates were similar to (ZR) or substantially higher than (MSA) off-take rates, and demonstrated the impact vulnerability has on trade-related off-take. Decisions and practices related to cattle keeping in resource-poor environments are linked to risk mitigation strategies and behaviour that will minimise effort in order to maximise reward. These are typically called low input – low output systems. Risks and constraints should be well understood prior to planning and implementing interventions that would require substantial farmer participation.

In the MSA the constraints were generally linked to insufficient ecosystem services (grazing and water) and in the ZR it was the presence of wildlife that stood out over and above disease, which was an important factor in both study areas. These barriers need to be better understood, in order to account for them appropriately, should a commodity-based approach to market access be further contemplated. Overall, the findings will make a significant contribution to the development of appropriate prerequisite programmes aimed at the initiation of an integrated value chain approach, as proposed by Thomson et al. (2013b). The development of a Good Agricultural Practice (GAP) code, as part of a tailored prerequisite programme for an HACCP approach along the beef production chain, requires a thorough understanding of the constraints, risks, perceptions, and aspirations of farmers at the local level.

4 THE PERCEPTIONS OF COMMUNAL CATTLE FARMERS LIVING AT THE WILDLIFE-LIVESTOCK INTERFACE IN THE ZAMBEZI REGION OF NAMIBIA TOWARDS WILDLIFE CONTACT AND CONSERVATION

4.1 INTRODUCTION

The ZR of Namibia is known for its large amounts of wildlife, occurring in the wetlands and floodplains along the major rivers and wetland systems surrounding the ZR. Within the ZR, east of the Kwando River, there are two national parks, namely the Mudumu and Mamili National Parks. These also host vast quantities of wildlife, such as large herbivores (buffalo, elephant, and hippopotamus) and large predators (lion, hyena, leopard, and wild dog). In addition to the national parks in the ZR, communities have formed and officially registered several conservancies throughout the ZR, which enable them to benefit from community-driven efforts to protect wildlife and to use natural resources sustainably (Atkinson, 2011; Nuulimba, 2012; Cumming et al., 2013; NACSO, 2014). These community-driven conservation efforts have largely been successful. They emanated from innovative national legislation, which provided a legal framework as well as incentives for communities to take ownership of biodiversity conservation on land under communal tenure in their rangelands, in ways that could generate direct benefits for households in the form a range of ecotourism and sustainable utilisation models (Nuulimba, 2012; Cumming et al., 2013; NACSO, 2014). By the end of 2013, a total of 79 registered community conservancies in Namibia generated approximately N$ 72.2 million in annual returns for community members and facilitated 6 472 jobs (NACSO, 2014). In general, Namibia's wildlife numbers have also increased steadily in general, and in most conservancies since their establishment (NACSO, 2014). The same is true for game in the ZR (Chase, 2009) (see also Chapter 5).

Similar to the increase in wildlife numbers in the ZR, cattle numbers have also been on the increase (see Chapter 5). The majority of households in the ZR are dependent on livestock and the production of crops, such as maize, for food security and their daily livelihoods (Nyambe, 2013). However, the success of conservation efforts in the ZR potentially increases the interaction between wildlife and livestock. According to the IUCN (2005) human-wildlife conflict occurs when the needs and behaviour of wildlife impact negatively on the goals of humans, or when the goals of humans negatively impact on the needs of wildlife. The results are crop damage, livestock losses, and threats of injury or even death to residents, resulting in increasesd killing of protected and threatened species, such as wild dog, lion, and leopard. Human-wildlife conflict typically escalates when human activity intensifies in and around protected areas and where wildlife threatens the economic security and lives of people (IUCN, 2005; Mizutani et al., 2005). Human-wildlife conflict can occur in a range of forms. Generally, the main forms of human-wildlife conflict are categorised as human death or injury, attacks on domestic animals, crop damage, disease transmission to livestock or humans, and adverse interaction between wildlife and other threatened species (Lamarque et al., 2009; de Garine-Wichatitsky et al., 2013). In the context of pastoral systems, conflict between wildlife and livestock has been categorized by Muthiani (2001) according to four major limiting factors based on the perceptions of pastoralists in East Africa: grazing competition, water competition, disease, and predation.

Mizutani et al. (2005) surveyed four pastoralist communities in the Laikipia and Amboseli conservation areas of Kenya and found that disease, not predation, had the highest impact on net revenue from livestock in these areas. Furthermore, pastoralists in the Amboseli conservation area reported that the interventions they believed could mitigate the risk of predation of livestock were better and more secure kraaling at night (100% of respondents), keeping dogs (48%), use of fire at night (18%), improved herding during the day (13%), and having a night guard (7%) (Mizutani et al., 2005). Similarly, the successful use of herding and kraaling to avoid contact with wildebeest that carry the malignant catarrhal fever (MCF) virus, and to limit predation, have been reported as effective among pastoralists elsewhere in East Africa (Bedelian et al., 2007; Caprivi Carnivore Project, April 2013). Herding and kraaling are strategies applied by cattle farmers in many areas situated at the wildlife-livestock interface in southern and eastern Africa (Butt, 2011). It is considered part of the culture and tradition associated with cattle keeping of most indigenous peoples in these areas and is even applied by more and more commercial beef producers situated at the wildlife-livestock interface[7]. These practices are often applied differently but are, however, mostly associated with mitigating risk and improved livestock management (Mizutani et al., 2005; Bedelian et al., 2007; Butt, 2011). For this reason, the use of improved livestock husbandry practices, specifically herding, have been proposed as a potentially important tool to reduce human-wildlife conflict in general (Mizutani et al., 2005; Lamarque et al., 2009).

In the ZR, human-wildlife and livestock-wildlife conflict has been widely reported (Osofsky et al., 2005; Lamarque et al., 2009; Teweldmedhin and Conroy, 2009; Nyambe, 2013; Caprivi Carnivore Project, April 2013). In Chapter 3 of this thesis farmers interviewed in selected areas in the ZR confirmed that predation by wild carnivores was one of the major reasons for cattle losses incurred in 2011; and wildlife

[7] Namibia Rangeland Forum Meeting, October 2013, Rundu, Namibia

was also highlighted as an important perceived source of disease in cattle. The frequent FMD outbreaks reported in Chapter 6 of this thesis confirm the significant impact of FMD outbreaks, mainly caused by cattle-buffalo contact, on the livestock economy over a five-year period in the ZR. Similar occurences were reported elsewhere in southern Africa at the wildlife-livestock interface, where high-impact diseases, such as FMD, corridor disease, and bovine tuberculosis, have spilled over from wildlife to livestock with significant negative consequences (de Garine-Wichatitsky et al., 2013; Musoke et al., 2015). The cost of coexisting with wildlife can therefore outweigh the benefits and in the ZR it has been found that crop damage mainly by elephants has been a major contributing factor in terms of food insecurity (Nyambe, 2013). Communal livestock farmers at the wildlife-livestock interface continuously confronted by the negative consequences of living with wildlife can therefore become opposed to conservation efforts, because wildlife is seen as a threat rather than an opportunity (Bedelian et al., 2007; Cumming et al., 2013). Subsequently, finding feasible and sustainable ways for local communities at the conservation-production interface to meet the costs of coexisting with wildlife, and even to contribute to wildlife protection, is a major challenge for TFCA development in the region (Cumming et al., 2013; de Garine-Wichatitsky et al., 2013).

A potential strategy to improve the cost-benefit ratio for beef producers at the wildlife-livestock interface in and around FMD control zones in TFCAs, is the adoption of non-geographic trade standards for the trade in and potential exporting of beef (Thomson et al., 2004). With a mean number of approximately 145 000 cattle in the ZR, this is by far the most abundant herbivore species and is generally regarded as one of the most important livelihood assets in the area. However, due to the presence of buffalo in the ZR the entire area has been classified as an FMD-infected zone by the Department of Veterinary Services of Namibia. Animal movement, including trade in the products of cloven-hoofed animals in and from the ZR, is therefore strictly controlled in accordance with international trade standards set by the World Organization for Animal Health (OIE). Yet, an export-certified abattoir exists in the ZR and serves the entire region from its base in Katima Mulilo. It is argued that the so-called commodity-based approach to beef trade, and its recent inclusion in the Terrestrial Animal Health Code (TAHC) of the OIE by means of an article that provides a non-geographic based trade standard (Article 8.7.25, TAHC, OIE), could reduce the negative impacts that conventional FMD trade standards have on the mostly impoverished livestock producers at the wildlife-livestock interface in southern African TFCAs (Osofsky et al., 2012; Cassidy et al., 2013; Thomson et al., 2013a). A major benefit of a commodity-based trade approach and associated trade standards is that it does not require zoning and wildlife-livestock separation through financially unsustainable and ecological unsound measures, such as fencing (Gadd, 2012; Osofsky et al., 2012; Somers and Hayward, 2012; Cassidy et al., 2013). It has been proposed that a value chain approach to risk mitigation, in which food safety standards and disease risk management requirements are integrated along the beef value chain by means of a risk management system, such as HACCP[8], could provide a feasible alternative to current FMD control measures in FMD control areas (Thomson et al., 2013b). Through such an integrated value chain approach, prerequisite programmes dealing with risk mitigation are required at farm level, and may include practices such as herding and kraaling in order to reduce contact with wildlife, especially buffalo (Thomson et al., 2013b). However, the success of interventions such as a commodity-based trade approach and the associated prerequisite programmes in which farmers should participate depends largely on the level to which livestock producers in the first instance want to coexist with wildlife, and secondly, the way they perceive risk (Fowler and Brand, 2011). Risks posed to livestock farmers in the ZR in the form of predation, crop damage, and disease have been described and documented. But if livestock owners do not perceive wildlife, specifically buffalo, to be linked to their inability to trade their beef due to disease control measures imposed during an FMD outbreak, an alternative approach can potentially have a lower initial impact or level of support from farmers. Understanding the perceptions of livestock producers towards cattle-buffalo contact and general conservation efforts in the area will aid the way marketing and trade of beef using a commodity-based approach could be strategised. It could also influence the level to which proposed risk mitigation strategies, and farmer producer codes associated with a value-chain approach to disease control, are adopted. Perhaps more important is that the overall attitude of livestock farmers in the ZR towards conservation efforts, and potential strategies aimed at integrating conservation and livestock production, is crucial to the KAZA-TFCA's effort to succeed in generating higher socioeconomic benefits from diversified land use systems.

Our objectives with the research presented in this chapter were therefore to focus on farmers' perceptions towards risks associated with buffalo-cattle contact, as well as the dynamics and intensity of buffalo-cattle contact, since contact with buffalo is regarded a major risk for the transmission of FMD to cattle (Thomson and Bastos, 2004). The strategies farmers use to mitigate risk at the wildlife-livestock interface together with their perception of risk within the selected areas of the ZR were therefore investigated, and will be reported in this section. Here, attention was given specifically to the potential role traditional risk mitigation strategies, such as herding and kraaling, could play in avoiding contact between buffalo (as well as other wildlife species) and cattle. Lastly, this research explores consequences of wildlife-livestock conflict on the perceptions and attitudes of pastoralists (in selected areas in the ZR) towards wildlife conservation initiatives and their coexistence with wildlife in general.

[8] HACCP stands for Hazard Analyses and Critical Control Points

Perceptions of pastoralists in the Mnisi Study Area (MSA) of South Africa were included in some instances in order to compare perceptions from different interface areas.

4.2 Methodology

The selected study areas in the ZR and in the MSA were described in Chapter 2. The survey methods used to collect the data presented in this chapter were also explained for both study areas in Chapter 2 as well as Chapter 3. Importantly, the areas selected for farmer interviews in the ZR, as presented in this chapter and others, were largely based on the distribution of buffalo and a relatively higher potential for contact between cattle and buffalo within the selected areas. The results are therefore not representative of the entire ZR cattle farming community, but rather of farmers in selected areas with a higher probability of making contact with buffalo.

Survey methods in the ZR were a combination of qualitative and quantitative methods in order to explain the general perceptions and nuances of buffalo-cattle contact, contact-mitigating strategies, and conservation efforts. However, the number of interviews per area, not per village, could be considered representative of the farmers in the area, because more than 20% of the farmers in each area were randomly selected and interviewed (see Chapter 2). Villages were selected from three areas in which semi-structured interviews provided the necessary structure yet flexibility with which to explore these perceptions, to our knowledge in many instances not yet documented before, for the ZR and elsewhere.

In some instances descriptive statistics were used to compare response categories, mainly expressed as a percentage or response frequency. The non-parametric chi-square test was used to test significant differences between response categories at a 95% confidence interval.

4.3 Results and Discussion

4.3.1 Perceptions regarding buffalo-cattle contact and risk

Kraaling and herding

Respondents in the ZR were asked if they kraal their cattle every night. Respondents indicated that they did kraal their cattle every night, except for one respondent from Lizauli (Interview 35). This respondent indicated that in the late dry season when grazing is scarce, they leave their cattle to graze through the night. When asked why they kraal their animals, most respondents (87%) indicated that they kraal to protect their cattle. Kraaling for improved husbandry and management purposes was mentioned by 14% and 7% of the respondents respectively. The practices associated with kraaling included activities such as milking, separation of calves from mothers overnight for milking in the morning, and counting and inspecting cattle on a daily basis. Only 2% of the respondents mentioned the tradition of kraaling and better control of cattle movement as reasons for kraaling cattle.

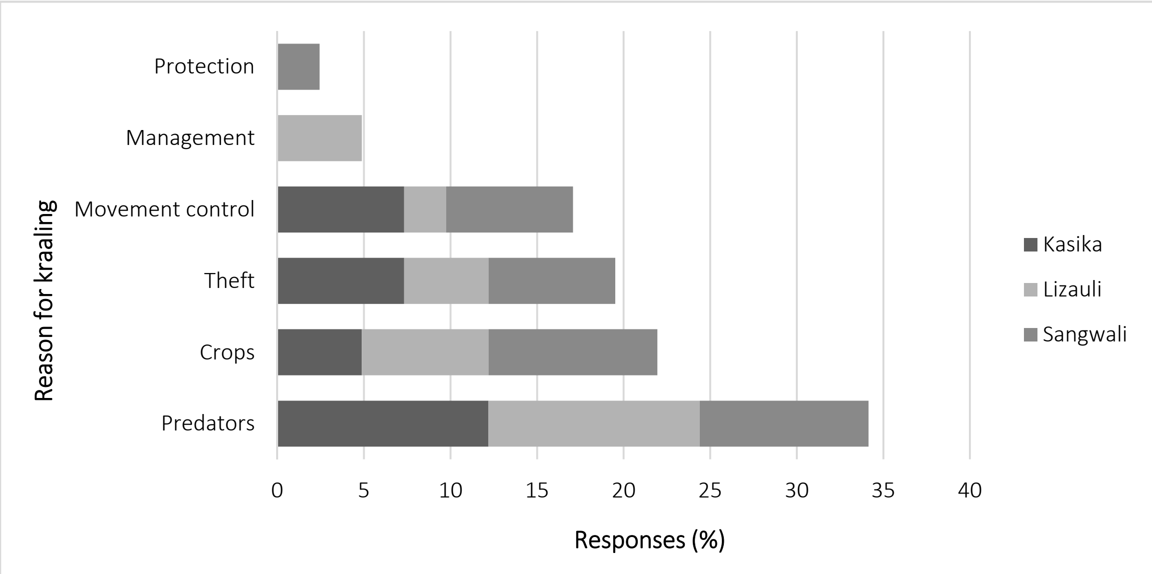

Figure 4-1: Percentage of respondents in selected areas in the ZR (n=41) that kraaled for a specific reason

Protection was clearly the biggest reason for kraaling in the ZR, hence we enquired what respondents were protecting their animals against, as this would indicate what they perceived to be the highest risk at night. Consequently, 68% of the respondents said that predation was the reason they kraal cattle whereas 14% also mentioned both protection against theft and to keep cattle from raiding their crops (Figure 4-1). Protection against crops was mainly mentioned by people in the Kasika area, as well as the Lizauli village in the west. Protection against theft was a concern for people from the Kasika and the Sangwali areas.

Respondents were asked whether their cattle were being herded or allowed to walk freely. Responses were categorised in order to provide better insight into the way herding was practised, or not practised (Table 4-1). In total, 46% of the respondents (n=20) said that they do herd their cattle. Of these, 10 were from the Kasika area and the rest were from villages in the west around Mudumu NP. Only 9% (n=4) of the respondents specifically stated that they always herd their cattle. Therefore, if these responses were combined, 55% of the respondents indicated that they do herd their cattle. A further 32% indicated that they only herd their cattle in the crop season, to keep the cattle away from crops. Of these respondents the most were from Lizauli (n=5) and Lianshulu (n=2). At least 75% of the respondents therefore indicated that they do herd their cattle at least during some parts of the year. Only 11% (n=5) of the respondents, represented by one respondent from each of five different villages, indicated that they do not herd their cattle at all. Only one farmer from Lizauli indicated that he always herds his cattle.

Table 4-1: The level to which respondents in the ZR participate in cattle herding (n=43). Figures in brackets are sub-categories of aforementioned totals

Response		No. of respondents	Percentage
Yes		38	88.4%
	- Always	(4)	(9.3%)
	- Only in the cropping season	(14)	(32.5%)
No		5	11.6%
Total		43	100

When asked why they herd their cattle, the majority indicated that it was in order to protect their cattle from predators (34%) and to prevent their cattle from raiding their crops (22%) (Table 4-2). However, 20% of the respondents indicated that they herd their cattle to prevent stock theft whilst 17% just wanted to control their movements. Movement control was mostly associated with preventing cattle from wandering too close to the boundary of Mudumu NP, in order to avoid predation. Two respondents (5%) also implied that herding assisted them with managing their cattle better, such as in terms of injuries (Interview 28).

Table 4-2: The reasons why farmers in the selected areas in the ZR herd their cattle. Results presented as a percentage of respondents for each category (reason) and per study area in the ZR (n=41)

Response	Frequency	Total (%)	Kasika area	Lizauli area	Sangwali area
Predators	14	34.1%	12.2%	12.2%	9.8%
Crop protection	9	22%	4.9%	7.3%	9.8%
Theft	8	19.5%	7.3%	4.9%	7.3%
Movement control	7	17%	7.3%	2.4%	7.3%
Management	2	4.9%		4.9%	
Protection	1	2.4%			2.4%
Total	41	100%			

Spatial-temporal movement of buffalo

During the interviews in the ZR, respondents were questioned regarding the extent of contact and interaction between cattle and buffalo, and between cattle and wildlife in general. It is important to understand the way in which livestock and wildlife interact, how closely they interact, and what livestock keepers' perceptions are regarding such interaction. Such knowledge could assist in understanding the risks associated with disease transmission between livestock and wildlife, the level to which people perceive wildlife and livestock to be compatible land users, and in order to develop appropriate risk mitigation strategies upstream in the production chain that would be both practical and acceptable to livestock owners. The study areas were selected to a large extent based on potential overlap with the range and movement patterns of GPS-collared buffalo in the ZR (Du Preez and Naidoo, 2008; Atkinson, 2011). It was therefore important to find out to what extent farmers actually encounter buffalo in their rangelands, what the dynamics of such encounters are, and how they perceive such encounters.

Respondents were asked whether they or their herdsmen ever encounter wildlife such as buffalo and elephant when in the rangelands with their cattle. Elephant are mostly regarded the biggest concern to people living and farming in conservation areas in Africa (Lamarque et al., 2009) and although they are not necessarily linked to the spread of disease, it was important to get a sense of the level of interaction farmers experienced. A total 91% of the respondents indicated that they do encounter elephant in the rangelands, whilst 88% of the respondents encountered buffalo (Figure 4-2).

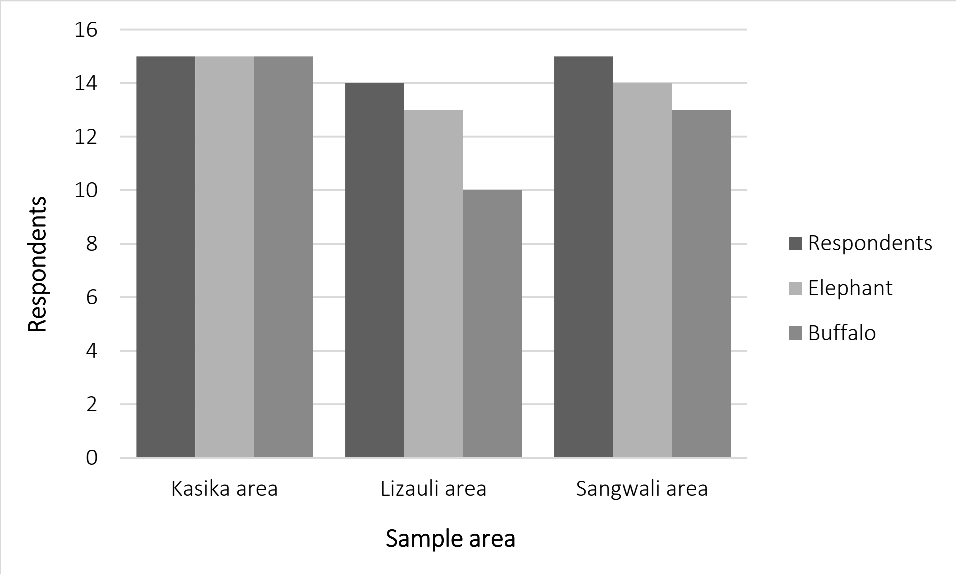

Figure 4-2: The number of farmers interviewed per sample area in the ZR and the number that indicated the presence of elephant and buffalo (n=44)

Only one respondent each from the Sangwali area and the Lizauli area indicated that they have not come across elephant in their rangelands. All respondents from the Kasika area reported seeing both elephant and buffalo in their rangelands. A total of six respondents (two from the Sangwali area and four from the Lizuali area) reported not seeing buffalo in their rangelands before. Three of the respondents in the Lizauli area that have not seen buffalo were from the Sachona and Lubuta villages and one was from Lizauli. One each from the Malindi-West and Mbambazi villages in the Sangwali area had not seen buffalo before.

The frequency of encounters with buffalo were important in the context of this study and respondents were therefore asked how often they encountered buffalo, and what time of the year they saw them most often. Ideally, a range of participatory methods could be used to determine the overall consensus at village level regarding the generally perceived frequency of buffalo contacts at a particular time of year. However, the objective of the interviews was to get a sense of the level to which encounters with buffalo in the rangelands surrounding each village varied between interviewees and between areas. Questions in this regard were open ended in order to allow for farmers to explain the frequency in their own words. Responses were then categorised into units of time for comparison.

Answers varied considerably in space and time (Figure 4-3). Daily and weekly encounters with buffalo were reported by 18.8% (n=6) of the respondents in each instance. Four respondents (12.5%) reported seeing buffalo at least once a month. Eight respondents (25%) saw buffalo rather frequently, but only during a specific time of the year (‘periodic’), with a further seven respondents (22%) reporting sporadic

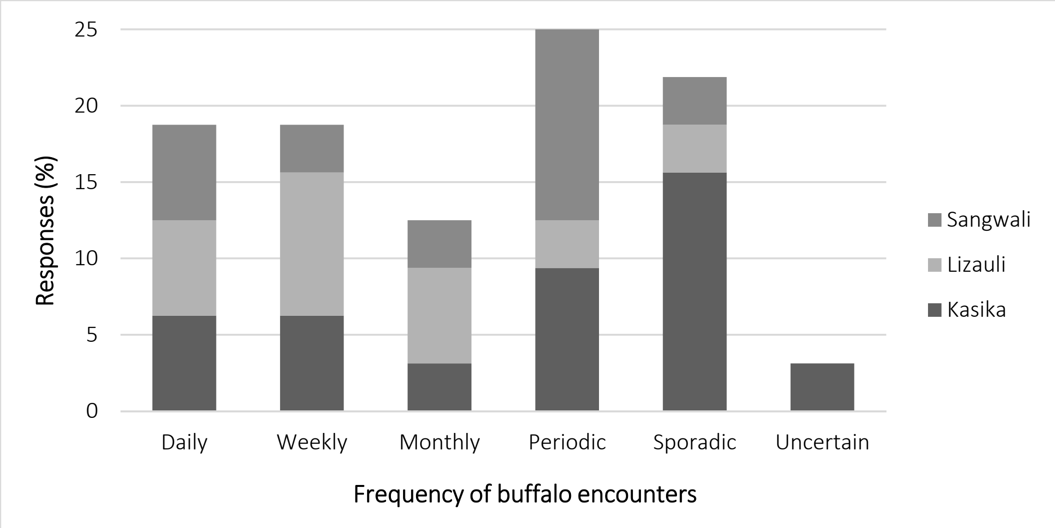

Figure 4-3: The frequency of buffalo encountered by respondents (n=44). 'Periodic' meant that for a certain time of the year buffalo were seen more frequently than the rest of the year. 'Sporadic' meant seen every now and then (sometimes) without an indication of season or time

encounters with buffalo (seen 'sometimes', or 'every now and then'). One other respondent was uncertain about the frequency of his herdsman's encounters with buffalo.

Two people each from Kabulabula, Lizauli, and Malengalenga reported daily encounters with buffalo. A further two from Kabulabula reported weekly encounters, together with another one respondent from Lianshulu and three from Lizauli. Monthly encounters with buffalo were reported by one respondent each from Kabulabula and Lianshulu, whilst two respondents from Lizauli reported monthly encounters. Frequent encounters with buffalo during certain periods of the year were reported by two respondents each from Kasika, Lianshulu, and Malengalenga and by a further one respondent each from Kabulabula and Lizauli. Three respondents from Kabulabula reported sporadic encounters with buffalo whilst one each from Ivirivinzi, Kasika, Lizauli, and Mbambazi reported sporadic encounters. One person from Kasika was uncertain. Although frequent encounters were reported by herdsmen in the Malindi-West area, cattle owners from this area refrained from elaborating on the frequency of encounters with buffalo.

The fact that periodic encounters with buffalo were reported most by respondents (25%) implies that there might have been seasonal trends in the presence of buffalo in some areas. Respondents were therefore asked to indicate if there was a time of the year they saw buffalo the most often. Respondents in the Kasika area felt that buffalo were seen mostly during summer, and to a large extent right through the year (Figure 4-4). Here, buffalo were seen to a lesser extent in winter. However, in the Sangwali area respondents reported seeing buffalo mostly in the winter months, and to a lesser extent right through the year or in summer. Two respondents from Kasika indicated that buffalo were encountered more frequently during flooding (February – March) than during the dry season. One respondent reported: "*They [buffalo] come and go. During floods buffalo stay and elephant leave for Botswana*" (Interview 1). Another respondent said: "*Now [November] they [buffalo] are more north but they come February to March a lot*" (Interview 3). On the other hand, two other respondents also from Kasika specifically indicated an increase in buffalo from July until the first rains in December.

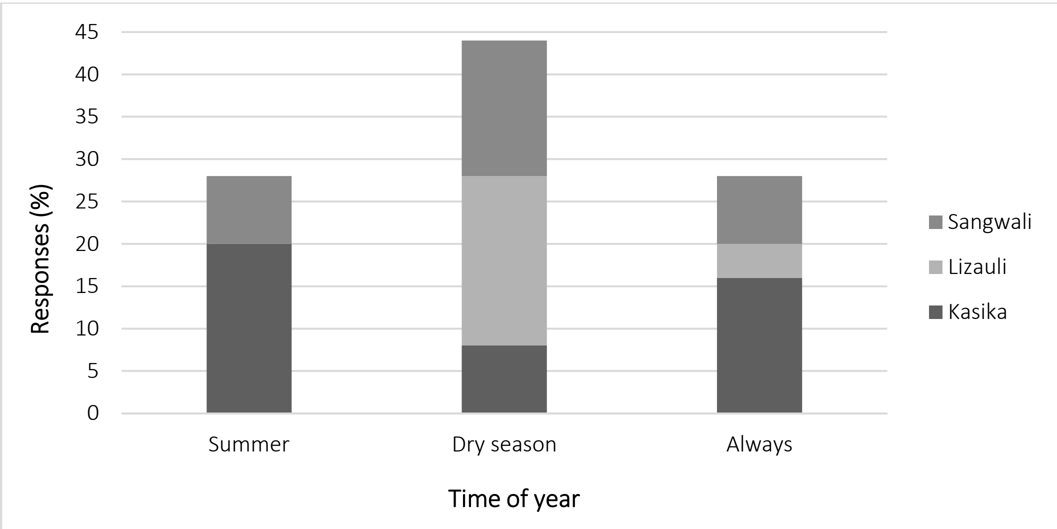

Figure 4-4: The time of the year respondents (n=25) in each area reported seeing buffalo most often

Respondents from Kabulabula on the floodplains were more in agreement. Most indicated that the presence of buffalo increased during the dry season (August – November) until the floods came in February. Several, however, indicated that buffalo are encountered right throughout the year, mostly, according to them, because of the conservancy in which they live. One respondent indicated that in the late dry season (November) buffalo come across the Chobe River from Botswana at night and return at day break (Interview 13). Two respondents, however, did indicate that buffalo were found during flooding on islands and areas not flooded. One interviewee in Ivirivinzi also indicated that buffalo frequented the area in the dry season and the wet season, up until the onset of the floods.

The villages on the western side of the ZR along the Kwando River and in proximity to Mudumu and Mamili National Parks all said that buffalo were most common during the dry and late dry season. The respondents from Lizauli, Lianshulu, and Malengalenga explained that during the rainy season there is enough grazing and water in the parks and most of the buffalo therefore remain there most of the time. During the dry season they move out of the park in search of grazing and water – mostly along the river.

Intensity of buffalo-cattle interaction

The risk of the transmission of disease such as FMD from wildlife to livestock is, unlike vector-borne diseases, dependent on a degree of contact or closeness between species. Based on the frequent encounters between livestock owners or their herdsmen and buffalo in the selected study areas, the intensity or level of interaction/contact between cattle and buffalo was explored. Respondents were asked whether cattle and buffalo mixed completely into one herd when they made contact in the rangelands, or if they remained separate. Responses were categorised into three categories of interaction, namely: cattle and buffalo mix completely into one herd, cattle and buffalo graze closely together but do not necessarily mix into a combined herd, and cattle and buffalo remain in separate herds away from one another.

In total, 56% (n=19) of the responses indicated that cattle and buffalo tend to mix completely when they meet in the rangelands (Figure 4-5). This was significantly more than the responses that indicated cattle and buffalo either grazed close together or remained entirely separate ($\chi^2 = 7.824, P=0.02$). Some respondents reported: *"They mix completely. I once fetched my cattle and only afterwards saw there were two buffalo cows in the herd. I ran away and called villagers to help me chase them away"* (Interview 17 - Kabulabula); and*:* "*They just mix and graze together. Sometimes they [buffalo] want to mount the cows"* (Interview 29 – Lizauli); and: *"They mix. They are friends. Even elephant – they are friends"* (Interview 33 – Lizauli). Only 21% of the respondents indicated that buffalo grazed closely together with cattle without mixing, and a further 24% of respondents indicated that buffalo remained entirely separate from cattle and never really mixed or grazed close together. Some respondents reported: *"Sometimes there is a little space around them"* (Interview 3 – Kasika); and: "*Close together but not mixing. Buffalo push cattle from grazing"* (Interview 10 – Sangwali); as well as: *"Close, but separate*" (Interview 20 – Ivirivinzi). Some of these responses concluded: "*Cattle run away from buffalo*" (Interview 23 – Lianshulu); and: "*They don't mix. Buffalo smell people on the cattle"* (Interview 30 – Lizauli); and: "*Just separate – cattle smell of humans*" (Interview 40 – Malengalenga).

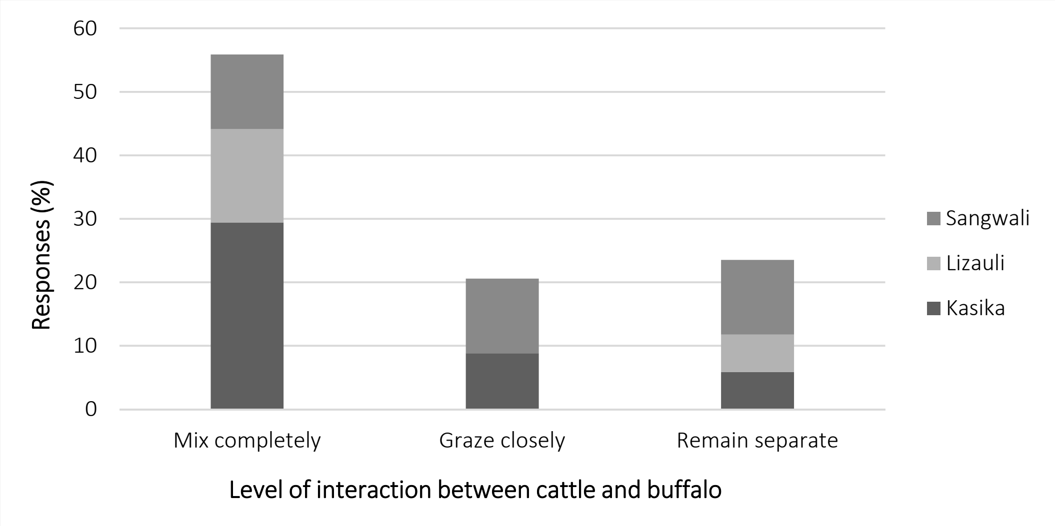

Figure 4-5: The extent to which cattle and buffalo interact in the selected study areas in the ZR, as perceived by respondents (n=34).

Most of the respondents indicated a significant level of close interaction between cattle and buffalo. This interaction was reported from most of the areas – especially in the Kasika area on the eastern floodplains, but also the Lizauli village and Sangwali areas in the western woodlands areas (Figure 4-5). Lizauli, Kasika, Kabulabula, and to an extent Lianshulu, reported the highest level of cattle-buffalo interaction. However, the frequency of occurrence of the reported high levels of mixing between cattle and buffalo was not specifically investigated.

Consequences of cattle-buffalo contact and risk mitigation

It was important to establish how the respondents felt about such close interaction between cattle and buffalo in the rangelands. Their perceptions in this regard are important because they will be associated with their perception of risk, which influences their behaviour and their willingness to engage in possible strategies to mitigate risk. The respondents were therefore asked whether they mind their cattle grazing close to or with buffalo: 82% of the respondents (n=38) indicated they did mind such close interaction. Five respondents (13%) did not mind cattle grazing with buffalo, whereas two respondents (5%) felt that it depended on the circumstances, such as when they need to fetch the cattle but the cattle have already mixed with the buffalo (Interview 5 – Kasika). One of the respondents from Lianshulu, who did not have a problem with the buffalo mixing with cattle, said that the buffalo just came out of the park at night and returned early in the morning and therefore posed no problem (Interview 25). Examples of other responses in interviews where respondents did mind the interaction were: *"Yes [we do mind it] – that is why we herd them. To keep them away from the park and buffalo"*

(Interview 8 – Malindi-West); and: *"These animals bring disease like FMD and runny stomach"* (Interview 38 – Lubuta).

The respondents that had a problem with cattle mixing with buffalo made it obvious that they had specific reasons for saying so, and were subsequently asked to give the most important reason for problems caused by such interaction. A significant majority of the respondents (43%) indicated that the risk of disease spreading from buffalo to cattle was the single biggest reason why for concern regarding cattle-buffalo interaction (χ^2 = *19.686, P=0.001*) (Figure 4-6). Because it was important to see whether or not respondents would spontaneously link buffalo-cattle contact with FMD risk specifically, those that did mention FMD in response to the question were listed separately from the 'diseases' category. When combined, a total of 60% of the respondents were concerned with disease transmission in general, but of the 60% of respondents, 17% specifically indicated the risk of FMD transmission (Figure 4-6). Two respondents were concerned with buffalo being responsible for tsetse flies and another two specifically mentioned buffalo passing on ticks to cattle. Some of the remarks were: *"Saliva of buffalo cause diseases"* (Interview 30 – Lizauli); and: "*We've heard that cattle can get FMD if grazing where buffalo graze*" (Interview 40 – Malengalenga). Disease in general was a concern shared by farmers in all three study areas in the ZR; however, FMD specifically was mainly mentioned by farmers in the Sangwali area.

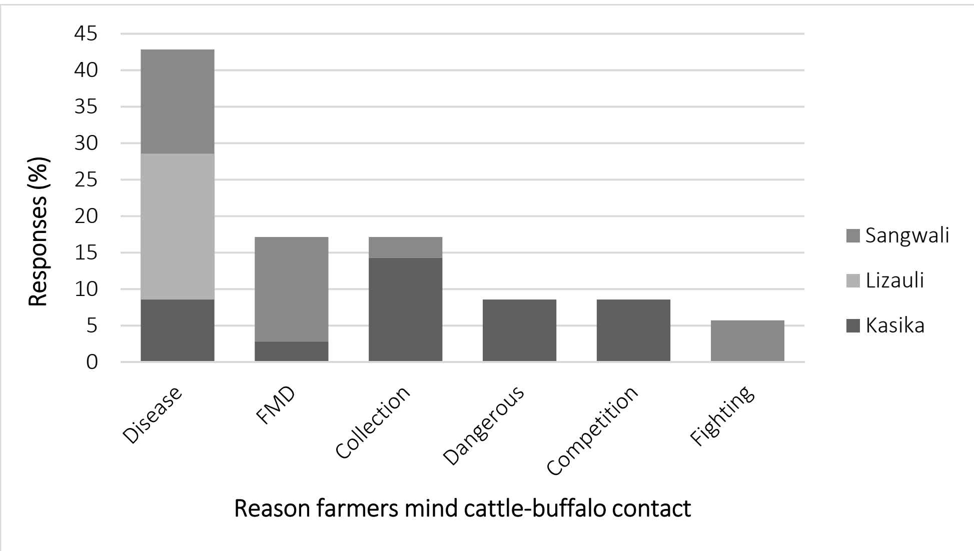

Figure 4-6: The reasons why respondents (n=35) considered buffalo-cattle interaction problematic in the Sangwali, Lizauli, and Kasika areas of the ZR

Only one of the 11 respondents from the Kasika area that were concerned with cattle-buffalo contact considered FMD transmission to be a major risk. Of these respondents, six had traded with Meatco before and five had not (see Chapter 3). However, all the farmers from the Sangwali area that were concerned with FMD transmission in relation to buffalo-cattle contact indicated that they did trade with Meatco, whereas all the farmers that only had a problem with disease in general, and not FMD specifically, did not trade with Meatco (see Chapter 3).

A further 17% of the respondents remarked that the main reason they considered cattle-buffalo interaction to be problematic was because they could not collect cattle from among buffalo once they had mixed (Figure 4-6); and 9% of the respondents mentioned the fact that buffalo were considered dangerous and herdsmen were therefore afraid to approach cattle that mixed with buffalo. When this happens, it can mean that cattle will not return to the kraal at night and thus are at risk for predation or theft. As one respondent from Kasika explained: *"They [buffalo] mix with cattle and then [we] can't collect them. Leave them and then lions catch them"* (Interview 4). When combined, 25.7% of respondents were therefore mainly concerned with problems associated with the difficulty and danger of collecting cattle from among buffalo. All these respondents, with the exception of one, were from the Kasika area. Three respondents (9%) – all from Kabulabula (Kasika area) – mentioned that competition for grazing between cattle and buffalo was a major concern to them. Two respondents (5.7%) from the Sangwali area regarded the fact that cattle and buffalo fought with one another to be a major concern, because cattle were often injured as a result.

In some areas, few farmers thought of the risk of cattle-buffalo contact in terms of FMD transmission. Farmers' perceptions regarding the link between cattle-buffalo contact and market access were subsequently explored further because of the importance in terms of risk mitigation strategies at primary production. Farmers were therefore asked during the interviews if they thought that cattle-buffalo contact in their rangelands had any influence on market access and market prices: 59% of the respondents (n=23) felt that the presence of buffalo in their rangelands had a negative influence on market prices and/or market access. Of these, most respondents felt that the diseases caused by buffalo or other wildlife forced them to quarantine their animals, to accept lower prices for their animals, or for the Meatco abattoir to close. Other reasons were not linked to disease directly, but rather grazing competition with buffalo, that indirectly reduces the value of their animals (reduced carcass yield). Furthermore, 33% of the respondents felt that the presence of buffalo in their rangelands did not have any influence on the prices they received for their cattle. Two respondents said that such an influence depended on whether there was an active disease outbreak at the time.

Since the majority of respondents considered buffalo-cattle interaction to be problematic for various reasons, respondents were asked to explain what they or their herdsmen did when they encountered buffalo in the rangelands, in order to ascertain what measures or tactics herdsman and/or cattle owners might have been employing to mitigate the risk of cattle-buffalo contact. The majority (n=17) indicated that herdsmen tried to herd the cattle away to avoid cattle-buffalo contact because, once they mix, there is seemingly not much anyone can do (Figure 4-7). As one respondent explained: *"They [herdsmen] try to keep them [cattle and buffalo] apart because once they mix you can't do anything"* (Interview 15 – Kabulabula); and another said: *"Try to separate them [cattle and buffalo] but it doesn't always work"* (Interview 5 – Kasika). Another respondent explained: *"Try to herd them away but sometimes the buffalo come to the cattle*" (Interview 9 – Malindi-West); and finally: *"Try to separate [cattle and buffalo] – mostly it works"* (Interview 14 – Kabulabula).

Ten respondents tried to keep cattle from making contact with buffalo by scaring the buffalo away. Various methods were mentioned, which ranged from shouting, clapping hands, to hitting sticks against one another. As one respondent indicated: *"Just clap your hands. If you shoot it [buffalo] you will be arrested. They [herdsmen] will try and keep cattle away from buffalo"* (Interview 42 – Malengalenga). A couple of respondents indicated that the mere smell of humans was enough to scare the buffalo away.

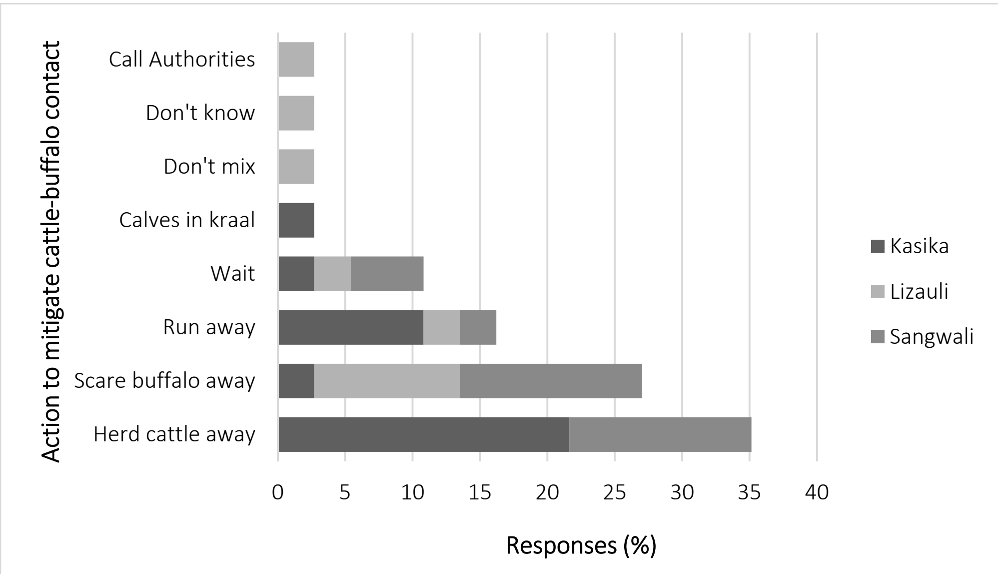

Figure 4-7: Tactics used by respondents (n=37) in the various areas of the ZR to mitigate cattle-buffalo contact

However, 16% of the responses (n=6) indicated that the herdsmen just fled at the first sight of buffalo. One respondent mentioned an incident five years prior to the interview where a boy was killed by buffalo while herding cattle. Incidents such as these cause fear among the herdsmen. They flee from buffalo and simply wait then for the cattle to return. Many of those that had run away explained that, if the buffalo were still some distance away, they would first try to herd the cattle away rather than run straight away. The five responses that indicated that waiting was the only option, referred to instances where buffalo and cattle had already mixed. According to the explanations, once cattle and buffalo have mixed there is not much you can do other than wait. Three respondents, however, indicated that they specifically kept calves at the kraal when the cattle go out to graze during the day to make sure that the cows will return at night. This tactic seems to work for some, as explained by one respondent: *"Run away. If far, try to keep them [buffalo and cattle] separate. We keep the calves here [at the kraal] so in the evening the cattle will come back"* (Interview 18 – Kabulabula).

4.3.2 Wildlife-livestock integration and community conservancies

The threat posed by wildlife

Respondents were asked whether they thought wildlife numbers had increased over the last few years: 91% of the respondents (n=42) felt that wildlife numbers in general had increased in recent years. Only two respondents felt wildlife numbers had remained constant. One of these two respondents stated that numbers remained constant because professional hunters kept the numbers in their area in control (Interview 8 – Mailindi-West).

Respondents were subsequently asked whether they thought cattle numbers had increased over the same period: 77% of the respondents (n=35) felt that cattle numbers had also increased in recent years. Of the eight respondents (23%) who felt that cattle numbers were not increasing, disease was thought to be the biggest reason. Lack of sufficient grazing was also mentioned as an important reason.

Respondents were asked whether they generally regarded wildlife as a threat to their cattle. This was a more general, open-ended question than a previous question that enquired specifically about problems regarding cattle-buffalo contact. Of the 42 respondents who replied, 88% felt that wildlife in general was a threat to their cattle. Five respondents (12%) indicated that they did not think wildlife was a threat to their cattle in any way. One respondent specifically mentioned that the threat posed by wildlife had declined since they had established a conservancy (Interview 25 – Lianshulu).

It was clear that those that did see wildlife as a threat had specific reasons for thinking so. Respondents were therefore encouraged to explain why they felt wildlife posed a threat to their cattle. One of the five respondents that did not think wildlife posed a threat to their cattle in a previous question changed his mind when asked why he did not see wildlife as a threat.

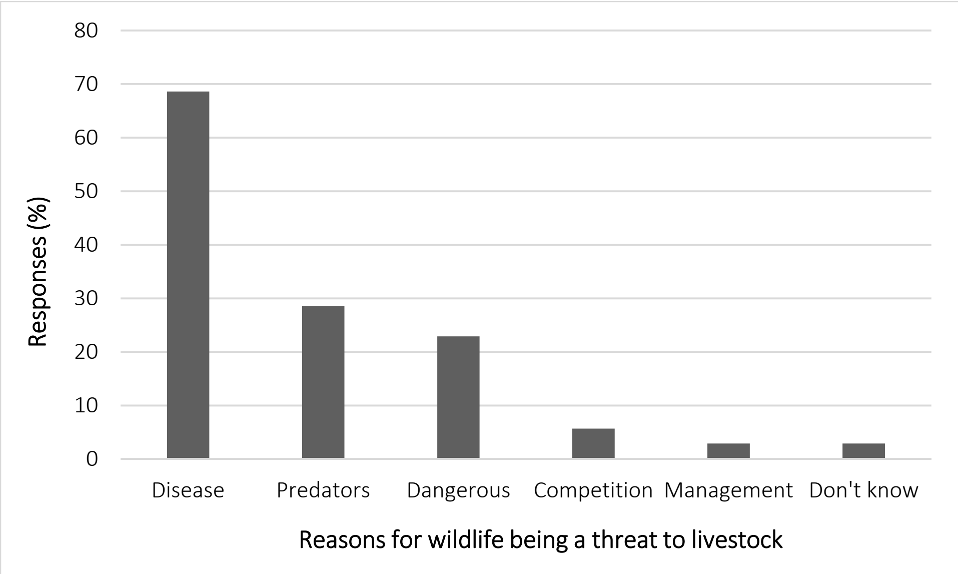

Figure 4-8: The reasons why respondents (n=35) considered wildlife to be a threat to their livestock

Of all the reasons given, the threat of disease was the most important and was mentioned by 69% of the respondents (n=24) across all three areas samples in the ZR (Figure 4-8). Predators (29%) and the dangers wildlife pose to livestock and humans (23%) were the reasons mentioned second and third most frequently, whilst a few remarked on the threat of competition with livestock (n=2) and the difficulty of collecting animals from among wildlife (management). A few remarks made during interviews with respondents captured the range of disease-related issues:

- *"They [wildlife and cattle] graze and drink together [which] gives infections to cattle."* (Interview 2 – Kasika)
- *"They [wildlife and cattle] graze the same area. The saliva left over night and infect the cattle."* (Interview 27 – Lizauli)
- *"Cattle eat the zebra's faeces. Zebra are not vaccinated and graze with cattle."* (Interview 39 – Malengalenga)
- *"Big threat – where buffalo have grazed cattle will also graze and get diseases."* (Interview 42 – Malengalenga)

During the discussions on the general threat posed by wildlife, buffalo was again the species mentioned most (n=6), mainly in relation to disease but also because they can injure livestock and herdsmen (Interview 20 – Ivirivinzi). One respondent, however, felt that predators and elephant were the only concern and that buffalo posed no threat (Interview 6 – Malindi-West). Elephant was mentioned specifically by four respondents because they were considered to be the biggest problem in terms of livelihoods, but not livestock specifically. One respondent from Lizauli (Interview 31) felt that elephant was the only problem they had regarding wildlife. At least three other respondents also indicated that elephant do injure cattle and kill people and are therefore considered to be a major threat (Interviews 6, 21, and 29).

Proposed solutions to the threat posed by wildlife

Since the majority of the respondents felt threatened by wildlife in some way, respondents were asked to explain what they believed to be potential solutions to the problems caused by wildlife. The majority of the respondents (26%) either felt that there was nothing they could do about the problem, or that wildlife should be separated from their livestock/crops (Figure 4-9). The majority of the respondents who felt that there was no solution to the problem were from the eastern floodplains (Kasika area). Almost all of the respondents that felt separation was the only solution were from the western woodland areas around Mudumu National Park (Sangwali and Lizauli areas). Some of the responses regarding either separation or acceptance due to the lack of a feasible alternative, were as follows:

No solution:

- *“Nothing. Accept it even though they don’t like it.”* (Interview 2 – Kasika)
- *“No, they agreed they must be together. Can’t do anything. Only if they take them all away.”* (Interview 3 – Kasika)
- *“No solution - can't avoid one another. Provide access to drugs for when there is an infection.”* (Interview 1 – Kasika)
- *“No solution - don't have the right to kill them if attack their livestock.”* (Interview 22 – Mbambazi)
- *“Nothing we can do. Our area is different. There are no fences here. Animals go freely.”* (Interview 34 – Lizauli)

Separation:

- *“If a possibility of separating them completely it will be fine.”* (Interview 12 – Kabulabula)

- *"No, they are not good to us. They damage crops. They should put an electric fence around the Park [Mudumu NP]."* (Interview 23 – Lianshulu)
- *"Cordon fence if I had a choice without considering others."* (Interview 35 – Lubuta)
- *"Must put a fence at the park [Mudumu NP]."* (interview 44 – Sachona)

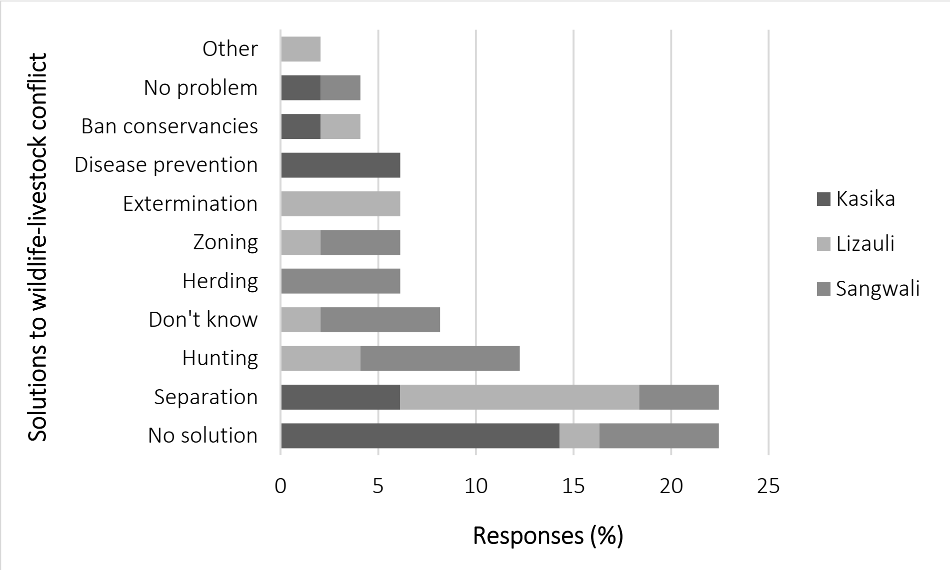

Figure 4-9: Solutions proposed by respondents to resolve wildlife-livestock conflict in the three sample areas in the ZR. Results given as a percentage of the total number of responses (n=52) given by respondents (n=43)

The zoning of certain areas for specific land use is another form of separation that was proposed by three respondents. One respondent (Interview 24 – Lianshulu) commented that farmers should start adapting by using other areas than the conservancies in order to prevent conflict. Others proposed that specific grazing areas should be zoned exclusively for use by cattle. Respondents in the vicinity of Mudumu National Park that proposed separation or zoning mostly asked for fences to be erected around the Park.

Six respondents proposed hunting or shooting the wild animals as a solution to the problems caused by wildlife. These respondents proposed that the numbers should be controlled by proper culling techniques, or that the wildlife should be shot at to drive them away or back into the park. One said that professional hunters should shoot the predators, but conceded that this would not be easy.

Four respondents did not know what the solution would be. They seemed uncertain as to whether or not they should think of wildlife as a threat in the first place. As one respondent said: *"At the moment,* *we don't know if the mixing is good or bad. Veterinarians can't tell us. At the moment we don't mind"* (Interview 25 – Lianshulu). Another admitted that he did not have enough knowledge to really know whether wildlife poses a threat or not. He explained: *"I need education. Three elephant died in the area – even in the river. Is it a problem? Don't know!"* (Interview 26 – Lianshulu). Three respondents proposed better disease prevention strategies. These respondents felt that government should see to it that their cattle are better protected. One respondent suggested that both wildlife and cattle should be vaccinated (Interview 16 – Kabulabula).

Three suggestions, all from the Lizauli area, were more drastic and proposed that wildlife should be exterminated in the area. Two other respondents, one from Lizauli and one from the Kasika area, felt that conservancies should be banned in order to get rid of wildlife. One respondent, the Induna (head) of his village, suggested that: *"They (wildlife) must all be shot!"* (Interview 27 – Lizauli). Another said that if it was down to him only, he would chase away all conservancies (Interview 29 – Lizauli). Yet another respondent, also from Lizauli, said that if he could do so he would shoot all the elephant because of the damage they cause to the crops (Interview 31 – Lizauli). A number of respondents indicated that the solutions they proposed did not necessarily consider other peoples' views. They felt that there most probably people from their village who would disagree with their suggestions; or at the very least, that it was not down to them to decide what the best solution would be in an area where everybody has a say on what happens on the land. Respondents in the Sangwali and Kasika areas were less drastic and proposed alternative interventions in the form of herding to avoid wildlife-livestock conflict (n=3, Sangwali area) and improved disease preventive measures (n=3, Kasika area).

Advantages of wildlife

The results from the previous section seem to indicate a strong negative sentiment towards wildlife in livestock owners from sample areas. The respondents were therefore specifically asked if they did not perhaps see any advantages or benefits from having wildlife in their areas, in order to clarify whether in fact these farmers were completely against wildlife and conservation efforts in every respect. It was an open-ended question in order to allow respondents the freedom to answer in the ways they thought best.

A total of 46% of the respondents (n=19) felt that wildlife did have advantages, whereas 39% (n=16) felt wildlife was of no benefit to them (Figure 4-10). The majority of farmers interviewed on the eastern floodplains (Kasika area) felt that wildlife was of no benefit, whereas the majority of the farmers interviewed in the Sangwali area felt that wildlife had some benefits. Two respondents (Lizauli area) felt that wildlife would have advantages on the condition that they were separated from the cattle. Two other respondents felt that the advantage depended on the species, because some species cause harm and destruction, whereas others bring benefits (Interview 31 – Lizauli). One other respondent felt divided between the fact that wildlife is their rich heritage, and the fact that buffalo bring diseases, and therefore concluded that it depended on the species (Interview 42 – Malengalenga). One respondent did not really feel there were many advantages but did see the need for wildlife presence (due to the conservancy) and that he therefore had to accept it (Interview 5 – Kasika). In general, the farmers that did not feel wildlife presented any advantages again blamed mainly diseases, which influence the value of their cattle and their market access. These farmers depend on their cattle, despite possible advantages wildlife may create (Interview 29 – Lizauli).

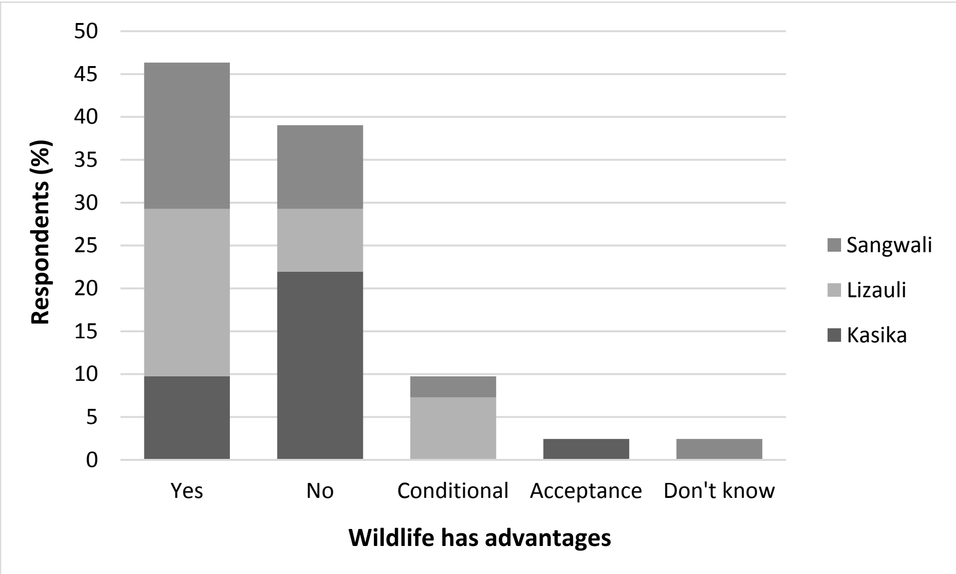

Figure 4-10: The opinion of respondents interviewed in the sample areas in the ZR on whether they thought there were any advantages to having wildlife in the area (n=41)

The respondents that felt wildlife did have advantages mainly linked the benefits to either income (36.8%), or to the contribution to preserving their natural heritage (36.8%) (Figure 4-11). One respondent mentioned benefits from tourism (5%) and four others mentioned advantages linked to hunting (21%). The advantages of both tourism and hunting were linked to income, but hunting had the added advantage of the distribution of meat. There was a strong sense of ownership and pride linked to wildlife, which many felt was part of their natural heritage. Respondents explained how they wanted their children to grow up knowing what wildlife is and with the ability to distinguish between species. A few respondents explained as follows:

- *"Natural heritage because our children will know them. We are proud of them. Won't like to see them disappear."* (Interview 10 – Sangwali)
- *"The kids can learn about them. In the old days, the people didn't know them. Now if you tell them that is impala, kudu, oribi they know it. Even impala they graze here near the kraal - so people can learn."* (Interview 25 – Lianshulu)
- *"Yes, they [wildlife] are the wealth of the nation."* (Interview 30 – Lizauli)

Most respondents from the Kasika area were more interested in the income wildlife offers as a form of beneficiation, whereas the majority of the farmers in the Sangwali and Lizauli areas linked the advantages of having wildlife to a contribution to their natural heritage. Hunting and tourism were mentioned by farmers in the Lizauli and Sangwali areas, but not in the Kasika area.

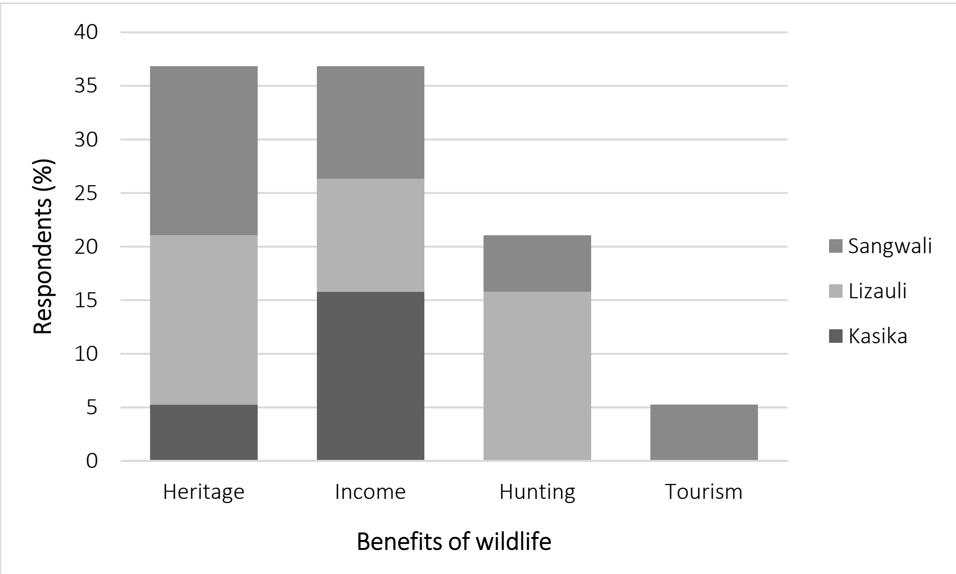

Figure 4-11: The benefits of wildlife according to respondents in the different sample areas in the ZR which felt there were advantages to having wildlife in their areas (n=19)

Community conservancies

All the respondents interviewed stayed within registered community conservancies. A total of six conservancies were represented in the interviews (Table 4-3; Figure 4-12). The respondents were asked how they viewed the conservancies in which they lived. It was an open-ended question so that respondents could express their opinions freely. Responses were categorised either as positive, negative, or neutral. Most of the respondents (39%) saw the conservancies in a positive light (Figure 4-

10); 14 respondents (32%) were negative about conservancies, whilst a further 14% had mixed feelings and 11% were reluctant to comment.

The Kabulabula Conservancy has only been officially registered and gazetted since November 2011, the same month in which the interviews were conducted. The perceptions of respondents within the Kabulabula conservancy could therefore not be linked to their actual experience of the effect, impact, and functioning of a conservancy and were therefore treated accordingly.

Table 4-3: The number of respondents per registered conservancy interviewed in the three sample areas of the ZR

Conservancy	Study area	Frequency	Percent
Kasika	Kasika area	5	11.4
Kabulabula	Kasika area	10	22.7
Dzoti	Sangwali area	8	18.2
Wuparo	Sangwali area	1	2.3
Balyerwa	Sangwali area	6	13.6
Mashi	Lizauli area	14	31.8
Total		44	100.0

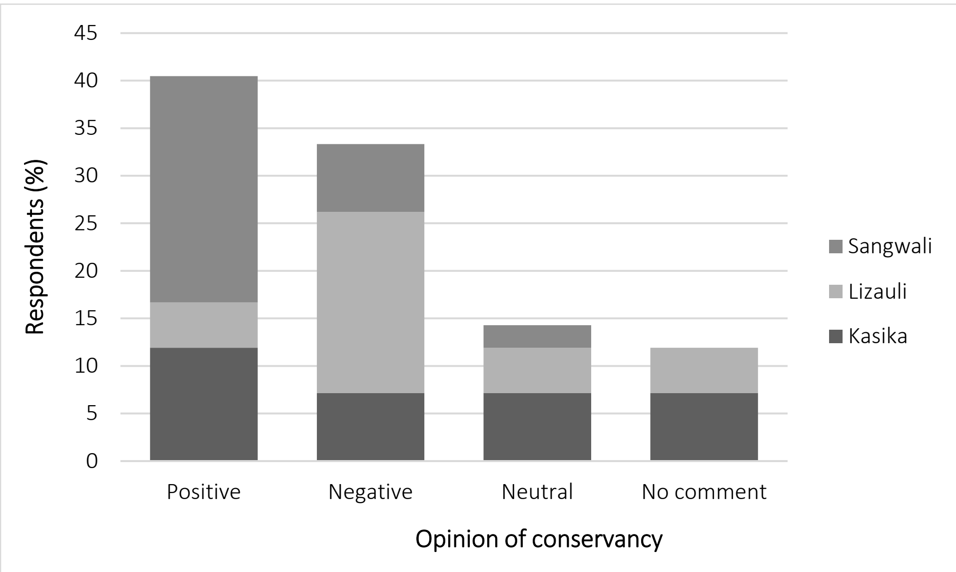

Figure 4-12: The general feeling of respondents (n=42) towards their specific conservancies

The strongest negative sentiments towards conservancies were from the Lizauli area, in which all the sample sites fell within the Mashi Conservancy (Figure 4-12 and Figure 4-13). The majority of the respondents from the Mashi Conservancy (63.6%) had a negative opinion about their conservancy, whereas in the Sangwali area on the other side of the Mdumu National Park, 71.4% of the respondents were positive about their conservancies (Dzoti and Balyerwa), with the exception of one respondent in the Wuparo conservancy. The fact that the Kabulabula conservancy was not yet fully functional was evident in the mixture of opinions received from respondents living there. Three were negative about its prospects and three others were positive about what they felt it will contribute to them. One specifically mentioned that he was unsure whether the benefits accrued from their new conservancy would outweigh the potential risks they anticipated, mainly in the form of increased human-wildlife conflict.

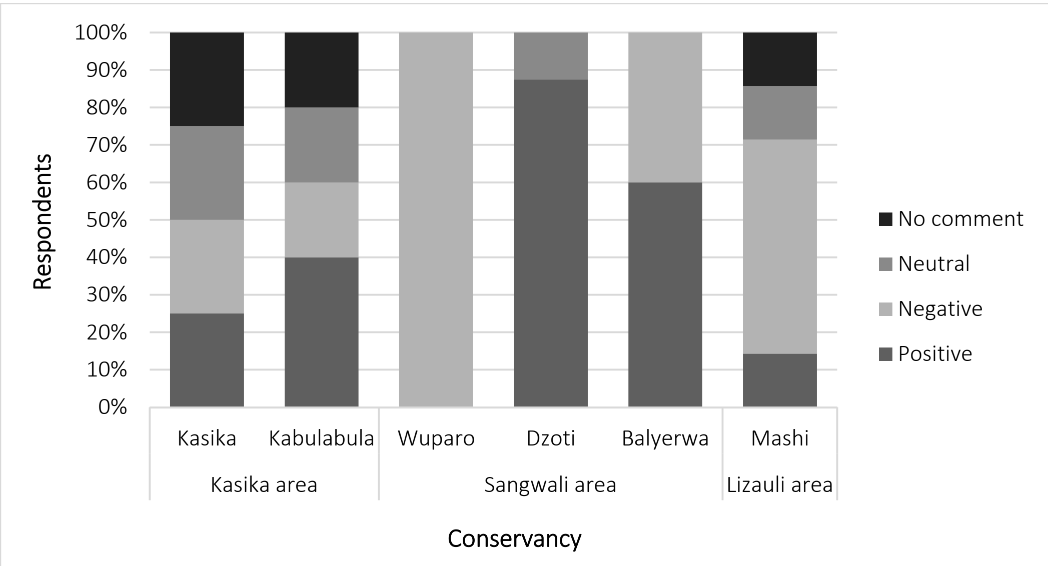

Figure 4-13: The sentiment of respondents within each conservancy towards the conservancy (n=42)

The positive sentiments towards conservancies mainly stemmed from the benefits respondents experienced (53.3%), and a strong sense of ownership of the natural heritage they represented (26.7%) (Figure 4-14). One respondent was positive about the compensation he received for wildlife-associated damage, whilst another two felt positive about the jobs that were provided. The mixed feelings of some respondents mainly resulted from the appreciation of some of the benefits conservancies offered weighed against the problems they brought, such as increased crop damage and loss of livestock.

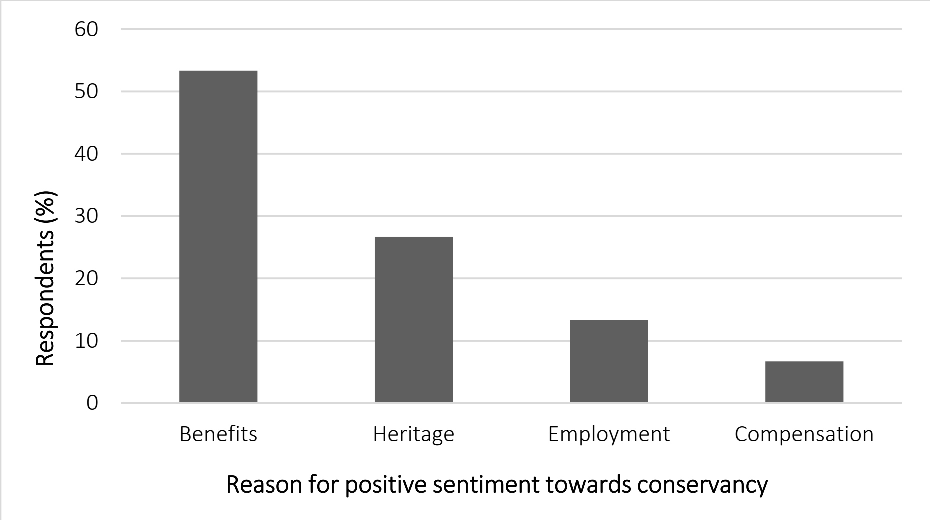

Figure 4-14: *The main reasons why some respondents (n=15) were positive about their conservancies*

The conflicts experienced by the respondents were evident in several comments, as indicated below:

- *"Everything has advantages and disadvantages. Advantage: there are benefits [from conservancies] but not sufficient. Disadvantage: elephants destroy all our trees!"* (Interview 4 – Kasika)
- *"Wildlife must be there as well. They [conservancies] can be there but they must understand farmers' problems. Compensation! Because they say it is your wildlife too."* (Interview 6 – Malindi-West)
- *"It [conservancy] is good but we also have problems with wild animals. Elephants! They are the biggest problem!"* (Interview 36 – Lubuta)
- *"On the one hand it is good because of jobs for young generation. On the other hand, wild animals have diseases. Therefore we need zoning in the area."* (Interview 40 – Malengalenga)

Of the respondents that expressed negative sentiments towards conservancies, the majority (59%) gave conflict with wildlife as the main reason, whilst 21% felt that the benefits from either compensation or conservancies in general were insufficient (Figure 4-15).

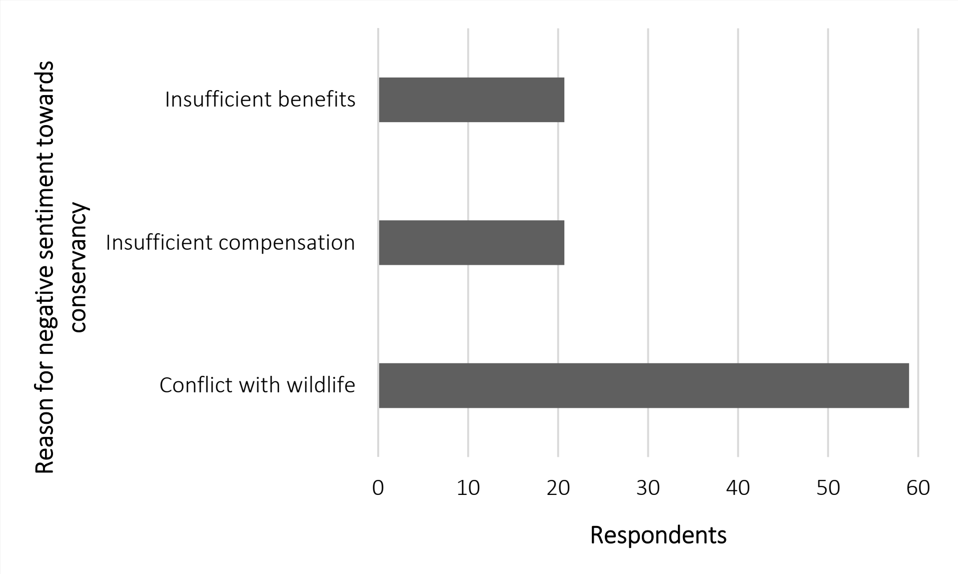

Figure 4-15: The main reasons why some respondents (n=14) were negative towards their conservancies

Some of the responses from respondents who were negative towards conservancies were as follows:

- *"Less hunters come and when they shoot something they don't bring it to the villages anymore. [We] Must go fetch it ourselves."* (Interview 1 – Kasika)
- *"We are hungry. The people don't plough [as a result of sustained crop damage]. Animals get diseases."* (Interview 19 – Kabulabula)
- *"I have 10 cattle that can be caught by lions. I get $90 from them [conservancy] a year. It doesn't replace a cow. The Ministry of Tourism compensated last year for two [cattle] caught by hyena. This year [2011] they stopped. You have to have a herdsboy otherwise they don't pay!"* (Interview 23 – Lianshulu)
- *"I can lose animals. They [wildlife] destroy crops. Only compensate $500 or $400 for a whole maize field. It's nothing!"* (Interview 33 – Lizauli)

The opinions of respondents varied considerably between positive and being negative in terms of conservancies and wildlife in general. Most of the discussions related to personal opinions based on personal experiences. It was therefore important to reach a better understanding of how they saw the overall benefits of conservancies towards their communities in general: 60% of the respondents conceded that the conservancies did benefit their communities, although they did not necessarily feel that the compensation was sufficient. A further 20% saw no benefit. Perceptions of people in Kabulabula were excluded in the analysis.

Negative sentiments were expressed by individuals that felt that the consequences of allowing wildlife into their rangelands through the conservancies outweighed the benefits of having wildlife in the area. Compensation and income generated through the wildlife economy associated with each conservancy, many felt, were so diluted due to the number of beneficiaries, that little tangible benefits were seen at household level. One respondent also explained that, in terms of employment directly associated with conservation activities, only a few benefited. Respondents felt the compensation offered was not sufficient given the impact that wildlife-related damages or losses had at household level. Compensation offered, although welcomed by most, was generally considered insufficient.

It is not only the damage caused by wildlife through predation, crop raids, or disease that concerned respondents: there is also the impact on their living conditions. The Induna of Kasika explained that in his specific village, on a sand embankment on the eastern floodplain, so many large trees have been destroyed by elephants in recent years that most of the village dwellings are now exposed to the sun. They do not have shade anymore and some people have moved out of the village because of this.

4.3.3 Mnisi Study Area

Herding

Only the practice of herding was tested in the Mnisi area by means of a structured questionnaire survey (see Chapter 2): 62% of the respondents (n=140) said that they herded their cattle, whereas 30.7% said that their cattle walked freely without being herded. Some (5%) mentioned using both herding and the available camps, whereas 4.3% used the camps specifically. The farmers that did use the camps (n=10) were asked if they would leave their cattle out in the camps at night, and all responded that they would not because of the threat of stock theft. Two also indicated that they were worried about predation and would therefore not leave their cattle out in the rangeland at night. Improved husbandry in the form of seeing the cattle in the morning and milking them was mentioned by three others as further reasons for not leaving their cattle out in the rangeland at night.

When the farmers who indicated they did herd their cattle were asked who herded their cattle, 46% replied that they herded their cattle themselves, 42.7% said that they used a paid herdsman, and 11% said that their children herded their cattle. Three respondents said that either they themselves or their children herded their cattle and another said that either he himself or a paid herdsman herded his cattle.

Perceptions of adjacent conservation areas

The Mnisi study area borders several conservation areas for approximately 75% of its boundary. The respondents in this area were therefore asked to state whether they regarded the adjacent conservation areas as beneficial to their communities: 48% of the respondents (n=140) said that the surrounding conservation areas were assisting their communities, whereas 46.4% disagreed (Figure 4-16). However, the majority of the respondents (57%) said that they did have problems with the adjacent reserves, whereas 39.3% did not have any issues with the conservation areas (Figure 4-16).

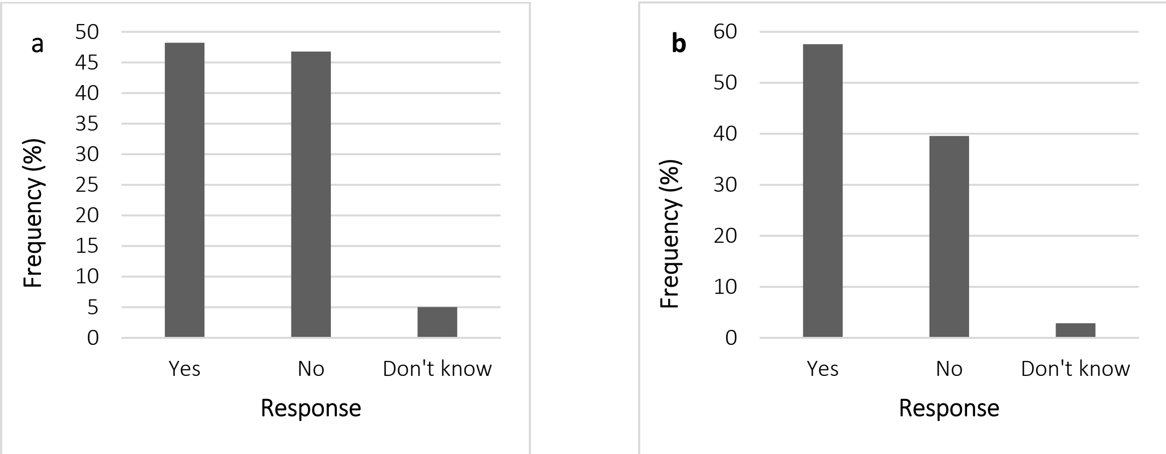

Figure 4-16: The percentage of respondents in the Mnisi study area that a) felt the adjacent reserves were helping their communities, and b) had a problem with the adjacent conservation areas (n=140)

Respondents in the Mnisi study area were asked in what ways they felt the adjacent conservation areas could assist their communities. The question was open-ended and responses were not limited to preconceived categories. They were also allowed to give multiple responses. A total of 166 responses were received from the 140 respondents. All answers were categorised and an overall response frequency (5) is provided in Figure 4-17. Assistance in the form of employment opportunities was the category with the most responses (41.6%) followed by many (n=28) who were not sure how the adjacent reserves could assist them (17%). A further 8% of the respondents felt that benefits from tourism operations in the area would help, whilst 7.7% of the responses indicated that grazing access in the conservation areas would be welcomed. Three of these respondents did not necessarily want to graze in the reserve, but indicated that they would like to harvest grass in the adjacent reserves to bring out and feed their cattle.

Support in the form of training and skills development was indicated by 4.7% of the respondents, while 3.6% of the responses indicated that supporting local schools would make a big difference. Assistance with infrastructure development in general was referred to by 1.2% of the respondents, whilst assistance with water provision to villages was mentioned by 2.4%. In terms of wildlife specifically, 3% referred to compensation for wildlife damage, improvement of the fences between the villages and the reserves, and assistance in terms of keeping wildlife away from the villages in general. Three respondents said that they would appreciate the provision of venison. Two respondents said that it would be best if the reserves were sold and they were given the money for them. Two other respondents respectively stated that they wanted to plant crops in the reserve, and that assistance with retrieving the cattle that stray into reserve would be welcomed.

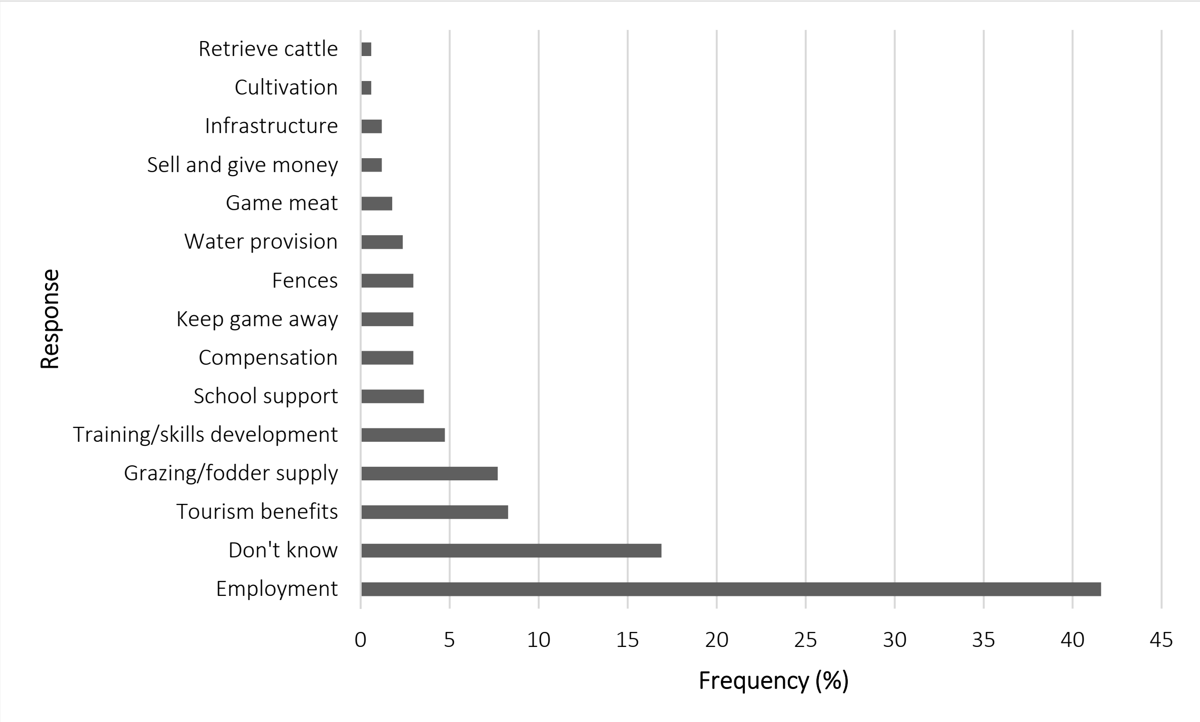

Figure 4-17: The ways in which the respondents in the Mnisi study area felt the surrounding conservation areas could assist the communities (n=140)

4.4 Discussion

4.4.1 Perceptions regarding buffalo-cattle contact and risk

Zambezi study area

Respondents in all three sample areas in the ZR confirmed that kraaling and herding were used by most farmers as a measure to reduce risk through controlling the movement of their cattle. The main risks farmers mitigated through kraaling and herding correlated with the most important challenges they face in farming cattle in their respective areas (see Chapter 3): predation, crop protection, stock theft, and wildlife contact. However, disease prevention was not mentioned specifically by farmers in relation to kraaling and herding despite it being one of the biggest challenges faced by farmers in the area. Herding was not thought of as a tool to mitigate grazing competition or as a means to manage grazing in general. These perceptions were in contrast to findings elsewhere: for example, Maasai pastoralists in Kenya have reported using herding specifically to avoid contact with wildebeest as a means to prevent the transmission of disease (Muthiani, 2001). The ways in which herding was applied varied between farmers and no standard approach seems to exist in any one of the three sample areas in the ZR. Few, however, seemed to herd their cattle permanently during the day, and many seemed to view herding as simply fetching animals in the afternoon to return them to the kraal, or a measure taken to prevent animals from entering crop fields in the rainy season.

The most important inference from the data regarding kraaling and herding was perhaps that no respondent linked either kraaling or herding to avoiding contact with buffalo, in other words, as a strategy to reduce the risk of disease. Herding was also not referred to as a strategy to reduce grazing competition with wild herbivores. Farmers clearly felt that disease was one of the biggest concerns in both the MSA as well as the ZR, as well as competition with wild herbivores in the ZR (see Chapter 3). Respondents in the ZR often made the link between wildlife, such as buffalo, and potential threats to cattle health. However, neither of the two major mechanisms traditionally employed to control cattle movement and to protect cattle from various risks, namely herding and kraaling, were explicitly linked to disease prevention. Instead, the fear of other risks, such as predation, crop raiding, and theft, motivated better control of animal movement. Although disease risk was not explicitly mentioned as a reason for herding and kraaling cattle, the reasons provided might still indirectly play an important role in mitigating the risk of contact with buffalo.

Respondents confirmed that buffalo and elephant were a familiar occurrence in most of the sample areas of the ZR. The exception was the Sachona and Lubuta villages in the Lizauli area, which are both situated rather far away from rivers, to the north of Mudumu National Park. It was clear that farmers here did not encounter buffalo because buffalo are water dependent and generally do not frequent areas far from water. Data from collared buffalo showed very little buffalo activity in the Sachona and Lubuta areas (Atkinson, 2011). The level of contact respondents from Sachona and Lubuta reported coincided with the distribution of buffalo. Respondents from all the other areas on the eastern floodplains (Kasika area) and along the Linyanti River (Sangwali area including Lizauli village) did come across both buffalo and elephant in their rangelands, again consistent with previous reports of wildlife distribution (Chase, 2007; Chase, 2009; Atkinson, 2011).

Farmers living near major rivers, such as the Kwando River (Sangwali area including Lizauli) and the Chobe River (Kasika area) had the most frequent encounters with buffalo. This was especially true for areas in close proximity to national parks, such as Mudumu National Park. Lizauli and Lianshulu are villages along the Linyanti River and the Mudumu National Park's northern and southern boundaries. Malengalenga is situated near the Mamili National Park together with Malindi-West, where herdsmen indicated frequent encounters with buffalo as well. Mamili National Park contains large swamps that provide a good habitat for buffalo, especially in the dry season.

Despite farmers in all three areas in the ZR reporting frequent interaction with buffalo, there was considerable spatial variation in the time of year buffalo were seen most frequently. In the Kasika area on the eastern floodplain buffalo were encountered most frequently during the dry season after the floods – especially the late dry season when the river was the lowest and buffalo were able to cross over from the Chobe National Park in Botswana. The farmers in the Kasika area that reported seeing buffalo during flood periods (late summer/autumn months) were most probably thinking of individual cases where buffalo remained in high-lying areas or on islands during the floods. These occurrences could increase interaction with cattle if cattle were to remain behind on the same islands – especially since some farmers in the Kasika area reported staying behind during flooding out of fear that their cattle would succumb to tick-related diseases should they move to the upland areas near Kabbe (see Chapter 3). Contrary to the majority of the farmers in the Kasika area, famers in the Lizauli area and Sangwali areas were generally in agreement that buffalo are more frequently seen during the dry winter months when both buffalo and cattle are concentrated along the rivers. Farmers from both areas indicated that apart from the time of year when buffalo are seen, buffalo also preferred coming into the grazing areas at night when cattle are kraaled instead of during the day. This phenomenon has been reported by tourists in the Kasika area, canoeing down the Chobe River, as well (Von Wielligh, 2012). However, the author has seen buffalo crossing the Chobe River in the late dry season from Botswana to the ZR to graze on the large green floodplains in the Kasika area during the day[9] and it is possible that no clear trend in this regard exists, at least in the Kasika area's open floodplains.

The fact that a significant majority of the respondents felt that buffalo and cattle mixed readily, often forming one integrated herd, emphasises the true level of risk that exists for diseases such as FMD to be transferred from buffalo to cattle. Buffalo carry a range of diseases that can be transmitted to cattle (Michel and Bengis, 2011) most of which require close interaction or contact with buffalo. Farmers in the ZR were able to describe intimate interactions between cattle and buffalo, and importantly, approximately 40% of the respondents reported coming across buffalo on a daily or weekly basis. These observations were once again independently reported in an account by tourists on a canoe safari on the Chobe River, from Kasane to Ngoma in November 2011 (Von Wielligh, 2012). Their report described how they canoed past an island in one of the river channels where a herd of cattle grazed among a herd of buffalo in the middle of the day, most probably in the vicinity of Kasika/Kabulabula[10]. The tourists reported that a herdsman canoed to the side of the island and started to call his cattle. When the tourists passed the island a while later, only the buffalo remained and they assumed the cattle swam back with their herdsman to the mainland.

It is well known that the seasonal movement of wild herbivores is largely associated with resource availability, mainly in the form of forage and water. The low-input livestock farming system described in the ZR in Chapter 3 implies that farmers are generally as dependent on natural resource availability in the rangelands as the wildlife, because farmers lack the ability to supplement food and water when it is naturally scarce or absent. Thus, the common resource needs of wildlife and livestock bring them into contact, especially during the dry season when water is limited to perennial rivers.

The author has observed exceptionally large numbers of wild herbivores moving from the dry, sandy, woodlands of the Chobe National Park onto the more fertile alluvial soils of the eastern floodplains that still retain green grass in the dry season (August – November) (see also Chase, M. 2007). Game move across the Chobe River to graze on *Cynodon dactylon* grass (Mendohlson, 1997) and thus compete for grazing with the cattle from villages along the Chobe River. The floodplains of the ZR have the highest cattle density of all the areas in the ZR (see Chapter 5) and this is probably why competition for grazing in association with buffalo-cattle interaction was reported by three respondents from Kabulabula only.

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[9] Personal observation, October 2013: a herd of several hundred buffalo crossed the Chobe River near Kasane, Botswana, to graze on the floodplains in the Kasika area during the day.

[10] Based on the description of the area and their point of departure on the day. Personal communication, Ricolette von Wielligh, April 2014, Pretoria, South Africa.

Von Wielligh (2012) reported seeing large numbers of wildlife that moved from Botswana across the river onto the grass plains of the ZR eastern floodplains. She also reported large numbers of impala on the eastern floodplain in the late dry season, which has also been observed by the author. Impala have been found to play an important role in increasing FMD virus levels in areas where FMD-infected buffalo occur, and should be regarded as a major risk factor at the wildlife-livestock interface, especially where high impala densities occur (Vosloo et al.,2009).

The fact that the majority of the respondents do consider buffalo-cattle interaction to be a risk, and specifically a disease risk, indicates that there is a significant level of awareness of the disease risk posed by buffalo to cattle farmers. The one disease mentioned specifically by farmers in relation to buffalo-cattle contact is FMD. Yet, there was an interesting spatial variation in terms of what farmers considered to be the main problem caused by buffalo-cattle interaction. Farmers in the Kasika area were concerned with the problem of collecting cattle from among buffalo rather than with FMD. Only three respondents from the eastern floodplains mentioned disease as a concern and only one mentioned FMD specifically. In contrast, most respondents from the areas where frequent cattle-buffalo interaction took place along the Kwando River near the Mudumu National Park were concerned with buffalo as a carrier of disease. Only one respondent from this area (Malindi-West), however, was concerned with collecting cattle from among buffalo. Possible explanations for these disparities are:

- Buffalo on the floodplains generally move in much larger herds than those in or near Mudumu National Park, where most respondents mentioned that breeding herds avoided grazing areas during the day. Mostly older bulls remained behind in the grazing areas along the Linyanti River during the day. On the eastern floodplains, however, herds of several hundred to over a thousand buffalo cross the Chobe River from Botswana to the eastern floodplain of the ZR to graze. Once a herd of cattle mingles with such a big buffalo herd on the open plains, chances of retrieving them will be slim; unlike in the savannah-type woodlands along the Linyanti/Kwando Rivers where buffalo herds might be smaller, and shelter for herdsmen moving cattle away from a buffalo herd is more readily available due to the vegetation structure.
- The farmers from the eastern floodplains, especially remote areas such as Kabulabula and Kasika, generally do not trade with Meatco, and movement control because of FMD outbreaks is therefore less of a concern. It is probable that frequency of disease outbreaks due to cattle-buffalo interaction in this area is low, as indicated by the minimal perception of disease risk. The possible availability of cattle markets across the Zambezi River in Zambia, which is much closer than the nearest quarantine station at Katima Mulilo, could be an added reason for cattle

owners from this area being unconcerned by the consequences of disease control measures on trade during an FMD outbreak. Trade of this nature is illegal and uncontrolled, with no consideration for the potential risks of disease transmission. This will be discussed further in Chapter 6. The western areas of the ZR (Sangwali area) might be more dependent on either informal, local markets or the abattoir in Katima Mulilo; hence, the consequences of an FMD outbreak will be of higher importance to them, as reflected in the results.

- The eastern floodplains are basically tick-free, as opposed to the woodland areas in the west where ticks are a major constraint to livestock health. If buffalo are considered as carriers of ticks that can transmit disease, such concerns would naturally be expressed by livestock owners in the west, but not the eastern floodplains, as is also evident from reports in this study (see Chapter 3) as well as others (Mashebe et al., 2014).

The awareness of the disease risk posed by wildlife for pastoralists living at the wildlife-livestock interface has been reported in other areas as well. In Zimbabwe's Malipati area, farmers were reported as having accurate perceptions of the most significant diseases affecting their cattle, such as FMD, and the role wildlife plays regarding such risks (de Garine-Wichatitsky et al., 2013). In East Africa, the Maasai people specifically herd cattle away from grazing areas frequented by wildebeest during high-risk periods of the year, as a measure to prevent malignant catarrhal fever (MCF) infection (Mizutani et al., 2005; Bedelian et al., 2007). However, avoiding contact with buffalo to reduce the risk of disease transmission was not the main reason for using kraaling and herding strategies, according to the farmers sampled in this study. Rather, these techniques were used to mitigate the risks of predation, to protect crops in summer, and to prevent stock theft. These measures coincided with the main challenges farmers experienced when farming in the ZR (see Chapter 3), except for that of disease. Disease was one of the most important challenges cattle farmers faced, yet kraaling and herding was not spontaneously linked to mitigating the risk of diseases transmitted by wildlife. However, when specifically asked, the majority of farmers conceded that they used herding to avoid contact between cattle and buffalo. Interestingly, the majority of respondents from the eastern floodplains were willing to herd their cattle away from buffalo if they saw them in time; and if not, to run away rather than to try and scare the buffalo away. These actions were in contrast to the actions reported from the western areas along the Linyanti River near the Mudumu National Park. Here, herdsmen were more prone to try and scare the buffalo away. This variation in tactics is most probably due to the difference in the environment and the way the animals subsequently interact. On the eastern floodplains the visibility is very good and herdsmen can usually see for several hundred metres, if not for kilometres. Spotting buffalo in time and then herding the cattle away might therefore be a viable option. However, if it does happen that cattle and buffalo interact closely, such as on a small island or sand bank along the river, the herdsmen prefer to wait for the cattle to separate of their own volition. There are relatively few trees on much of the floodplain, and therefore no escape route should a buffalo charge a herdsman. In the western woodland areas visibility is much lower due to the vegetation structure, and the chances of suddenly stumbling upon a herd of buffalo are thus far higher. If herdsmen make enough noise whilst herding cattle through the bush, nearby buffalo will most probably be persuaded to steer clear of contact with herdsmen and their cattle. Furthermore, the swamps north-west of Mamili create a mosaic of wet and dry patches, pools, reeds and wooded areas. Cattle enter these areas to graze the lush green vegetation and it is difficult to control their movement in such an environment.

Furthermore, in the hot, dry season (September – November) the day temperature on the floodplains can easily exceed 40°C. This area is characterised by large, flat, open grass plains, and thus there is little shade to be found. During interviews with livestock owners grazing the floodplains in 2013 (see Chapter 7), the owners explained that their herdsmen remained in the shade during the hottest period of the day, and only searched for their cattle later in the afternoon. Should the cattle have mixed with a herd of buffalo the chances of retrieving them before sunset would therefore be slim. Furthermore, many smaller farmers cannot afford full-time herdsmen, and if the cattle are not herded by the owner himself, they are fetched in the afternoon by young boys, who are likely to run away if they encounter buffalo. Still, the report of Von Wielligh (2012) confirmed that at least some farmers on the eastern floodplain have found ways to separate their cattle from buffalo – probably because it is such a regular occurrence for them.

The fact that 60% of the respondents associated buffalo specifically with disease risk and that 59% felt that the presence of buffalo had a negative impact on market access and prices received for their cattle implies that strategies to mitigate buffalo-cattle contact, in relation to initiatives for improved market access, will likely be supported by most farmers; if it can be proved that the risk of disease associated with buffalo does have a negative influence on market access and trade income, albeit indirectly. This is regardless of the fact that only seven of the respondents actually traded with Meatco in the year of the survey. However, many more indicated that they had traded with the abattoir before in the past (see Chapter 3).

Mnisi Study Area

In the MSA, fenced camps (normal cattle fences, not game-proof fences) were provided for each village as designated grazing areas, and most farmers saw herding as merely taking the animals to the specific camp on the outskirts of the village and fetching them again in the evening. The majority of farmers used these camps and because they are fenced, many let their cattle graze freely within. An important difference between the MSA and the ZR is the fact that a game-proof fence separates conservation areas from communities in the MSA, whereas in the ZR sample areas this was not usually the case. The game-proof fence in the MSA has reduced the level and frequency of wildlife-livestock interaction significantly, especially in terms of larger mammals, such as elephant, buffalo and large predators. This was also evident when only two farmers (out of the 10 that were asked in the MSA) indicated that predation was the reason they did not want to leave their cattle in the grazing camps at night. Instead, fear of stock theft was the biggest concern and probably the main reason that farmers still kraal their cattle despite fenced grazing camps that could keep animals out of crop fields at night. All farmers in the MSA kraal their cattle at night (Lagendijk and Gusset, 2008).

4.4.2 Farmers and conservation

The observations of the majority of the farmers in the various sample areas, that wildlife numbers are generally on the increase, are in line with scientific reports that indicate similar trends in wildlife numbers (Chase, 2009). In the medium term, cattle numbers have been fluctuating, and in the sample year (2011) cattle numbers in the ZR were at their mid-term lowest (see Chapter 5), despite most farmers' perception that cattle numbers are also on the increase. Another study also reported a slight decrease in cattle numbers in recent years in the ZR (Nyambe, 2013).

Wildlife is perceived as a risk by the majority of farmers, and once again, the spread of disease is their biggest concern. Disease risk was associated with species other than buffalo, such as zebra and elephant. Importantly, many associated the risk of disease transmission with cattle grazing the same rangelands as other cattle, and not necessarily contact with a particular wildlife species. This indicates that possible misconceptions around disease epidemiology exist and will influence farmers' perceptions of risk and possible mitigation tactics. The respondents' perceptions of threats posed by wildlife are in line with perceptions of pastoralists in other areas (Mizutani et al., 2005; Lamarque et al., 2009).

The wide variety of possible solutions proposed by farmers to mitigate the multiple threats posed by wildlife, to their cattle and their livelihoods, can be seen as an opportunity to suggest feasible solutions within the complexity and diversity of the landscape. However, the risk exists that helpless farmers in the face of growing human-wildlife conflict could resort to damaging solutions: already evident in the fact that many farmers suggested the separation of livestock from wildlife, mainly through fences but also through the zoning of grazing areas. Others suggested worrisome solutions such as banning conservancies or exterminating wildlife. The idea that increased hunting could help was a positive suggestion, because the controlled culling of wildlife offers many advantages for nearby communities

(Cumming et al., 2013). The fact that some respondents, although the minority (6%), thought herding strategies could help mitigate the threats posed by wildlife was positive. Improved husbandry practices such as herding and kraaling were proposed by many as a potentially feasible community-driven strategy to mitigate human-wildlife conflict (Mizutani et al., 2005; Lagendijk and Gusset, 2008; Lamarque et al., 2009; Butt, 2011). Again, spatial variations in terms of the proposed solutions were apparent.

It is important to note that several farmers demonstrated an open and spontaneous respect for possible alternative views in their villages regarding how to deal with the threat posed by wildlife. This implies farmers are aware that the issues could not be resolved selfishly and that decisions need to be made at village level, since both wildlife and the land are shared resources. However, the tension created by the need to protect their precious assets versus keeping the interests of the community in mind was evident. This was further illustrated when farmers weighed the costs of living with and conserving wildlife through conservancies against the benefits conservancies provided. Although the majority still felt wildlife and conservancies in general were more beneficial than otherwise, it was clearly a close call for most, and quite a large percentage felt that the balance was tipped against conservancies. Again, the sense that wildlife had a place in their communities as part of their natural heritage was emphasised by the majority of the farmers who were positive about wildlife and conservancies –despite concerns about the negative impact wildlife could have on their livelihoods.

A similar observation has been made by Lagendijk and Gusset (2008) who found that farmers in the Mnisi study area were positive regarding the presence of large predators in the conservation areas near to them, despite many having lost cattle to predation. The sense that this was part of their natural heritage was mentioned yet again. This finding was confirmed in our more recent survey, specifically of cattle farmers in the MSA, of whom the majority felt that the adjacent conservancies contributed positively to their communities. However, as in the ZR, the farmers in the MSA still had many problems with the conservation areas and felt that they should help communities more than is currently the case, in the form of job creation and skills development as well as through a range of other means. Here too, the costs of living near conservation areas versus the tangible benefits received through conservation were closely matched. In the MSA the overwhelming expectation of employment from the adjacent conservation areas poses a further risk of continued disappointment with conservation efforts, because the number of direct employment opportunities provided by tourism enterprises to local communities is generally low (Cumming et al., 2013).

Benefits from hunting were cited as one of the biggest advantages to having wildlife in the area, and should hunting outfits reduce their activities, further strain could be placed on the cost-benefit ratio of conserving wildlife in and among communities in the ZR. A recent report indicated that trophy exports from Namibia to the USA were the lowest in ten years in 2011 – the year of the survey, and that these declined rapidly from a 10-year high in 2009 (The Humane Society, 2016). Similarly, NACSO in Namibia (NACSO, 2014) highlighted the threat posed by anti-hunting lobbies to conservancies, in terms of their ability to generate tangible benefits for nearby villagers by means of hunting.

Finally, farmers were concerned about unreliable government compensation schemes and the annual pay-outs from conservancies to people living within, which often did not match the costs they incurred. Perhaps of more significance was the fact that the majority of the farmers in the then newly-proclaimed Kabulabula conservancy were sceptical regarding the supposed benefits of living in the conservancy. Their opinions were as a result of observations they had made themselves, and talking to farmers in the adjacent Kasika conservancy, who perceived more problems than benefits from coexisting with wildlife. These perceptions could stand in the way of forming more conservancies in the ZR and could lead to more tension within communities if those for and those against such an endeavour are closely matched in terms of numbers.

4.5 Conclusions

The occurrence of buffalo in the sample areas confirmed that our selection of areas based on the possibility of buffalo-cattle contact was sufficient and coincided with other reports of buffalo distribution in the area. However, previous reports on cattle-buffalo contact was not able to provide insight on the intimacy and dynamics of buffalo-cattle interaction as observed and explained by the farmers themselves. We conclude that buffalo-cattle contact in areas near perennial rivers and national parks in the ZR is frequent and intimate. The reports by farmers indicate that, should cattle in the ZR not be adequately protected against diseases such as FMD, the high level of contact between cattle and buffalo could result in more FMD outbreaks in the ZR in years to come – especially in light of both species' growing numbers. The potential role played by other wild herbivores, such as impala, which occur in high densities in some areas of the ZR, must be investigated (Vosloo et al., 2009).

The integrated value-chain approach to disease risk mitigation and food safety control, proposed by Thomson et al. (2013b) depends on the successful implementation of prerequisite programmes to reduce the risk of disease and to ensure food safety and quality. FMD risk is associated with buffalo-cattle contact and the successful mitigation of the risk of cattle-buffalo contact will therefore contribute to achieving the desired disease control and food safety requirements. Results from this study confirm that the majority of the farmers in the high-risk cattle-buffalo contact areas sampled in the ZR do associate buffalo with disease risk. They also associate contact with buffalo with reduced market access, increased trade transaction costs, as well as lower returns when trading their cattle with the Meatco abattoir in Katima Mulilo.

Findings from this study suggest that farmers in the ZR implement both herding and kraaling as measures to reduce risk – most notably the risk of predation. The fact that most farmers regard cattle-buffalo contact as problematic, albeit not necessarily due to their perception or understanding of the FMD risk posed by buffalo, is an advantage. More importantly, the willingness of farmers to prevent contact between their cattle and buffalo implies that the introduction of specific strategies to actively mitigate the risk of cattle-wildlife contact could be considered and should therefore be explored further in the context of the ZR (Mizutani et al., 2005). Most of the reasons mentioned by farmers in the ZR for herding and kraaling cattle were linked to mitigating the most important challenges they faced in farming cattle in the ZR, and if awareness could be created around the potential benefits for reducing disease in this way as well, further incentives will become apparent for such good practices. Importantly, Thomson et al. (2013b) have proposed that in order to participate in a value chain approach to disease control and SPS management on the basis of commodity-based trade, a farmer will have to actively reduce risks of disease transmission on site. Here strategic herding and kraaling could play an important role, and our results suggest that farmers in the ZR have sufficient local knowledge of buffalo movement patterns, as well as a willingness to reduce potential contact with buffalo, for these strategies to be considered further. However, the strategies used by farmers varied considerably and indicated that much more awareness and perhaps even training in this regard will have to be considered if such strategies are to be successfully implemented. It is further suggested that more research will have to be conducted to indicate the risk of disease transmission through sharing rangelands with wildlife such as buffalo, especially in terms of the threat posed by indirect contact, such as with the saliva and faeces of buffalo. Furthermore, the potential impact of active and strategic herding, based on the spatial and temporal movement of buffalo in high-risk buffalo-cattle contact areas, on reducing the risk of disease transmission, especially in conjunction with proper FMD vaccination, should be investigated.

It has been confirmed that the livelihoods of farmers living at the wildlife-livestock interface in the ZR face a growing and often overwhelming threat from wildlife. Our results add to the findings of others in the ZR, who have indicated that wildlife threatens livelihood sustainability and household food security, and the ability to cope with climate change (Cumming et al., 2013; Nyambe, 2013).

Despite the negative consequences of living with wildlife that farmers expressed, the majority are still positive towards conservation and wildlife in general. The fact that many farmers view wildlife as their natural heritage, which should retain its existence in their areas, is encouraging. Additionally, the fact that several farmers admitted that solutions to wildlife and conservation issues are not up to them alone, and are rather the responsibility of the larger communities, is noteworthy. It implies that solutions and strategies to mitigate wildlife-human/livestock conflict could be addressed at the village level, where overall buy-in could be achieved and collective action promoted. Perhaps the conservancy governance model (Nuulimba, 2012) already at work in all the areas surveyed could facilitate such processes in future, especially in terms of its importance in relation to disease control and market access.

However, it is clear that farmers are finding it increasingly difficult to accept the costs of living with wildlife, and actively protecting it by means of conservancies, when the benefits are being eroded. There is already evidence that this feeling of hopelessness could transpire in less constructive ways of dealing with the threat of wildlife.

Lastly, it can be accepted that the added burdens of FMD outbreaks and general FMD control measures on farmers in the ZR contribute to the tension between farming and conservation of wildlife in general. It is therefore of utmost importance that policies aimed at the facilitation of more favourable trade regulations, despite the high FMD risk posed by residential buffalo in the ZR, be explored as an additional strategy to make wildlife and livestock more compatible (Thomson et al., 2013a). Strategies that could enhance the cost-benefit ratio, not necessarily in monetary terms alone but through an integrated approach towards mitigating risks such as disease, predation and grazing competition in conjunction with an increase in benefits from conservation, are likely to be supported by livestock farmers within the ZR and elsewhere in similar areas.

5 THE SPATIAL DISTRIBUTION OF GRAZERS AND GRAZING IN THE ZAMBEZI REGION AND ITS IMPACT ON ANIMAL PRODUCTION

5.1 INTRODUCTION

Sub-Saharan Africa, notably eastern and southern Africa, still boasts the most extensive natural rangelands in the world, encompassing semi-arid grassland, savanna, and shrubland (Wrobel and Redford, 2010). The characteristic low and variable productivity of semi-arid rangelands results in a constant state of change or transition, with only brief periods of stability (Scogings et al., 1999; Du Toit et al., 2010; Walker, 2010). This characteristic leads to the need for larger, interconnected areas in which wild and domestic herbivores have the space to adjust to the temporal and spatial dynamics of available forage and other natural resources. One of the major reasons for the development of TFCAs in southern Africa has been to make the creation of vast protected areas across multiple land types, which are not limited by the artificial boundaries of countries, an international priority. Such vast, interconnected wildlands are considered vital for the conservation and survival of large and mega-herbivores, whose survival depends on their ability to move over very large spaces. Their migration is dictated by climate, weather patterns, and changes in resource availability (Osofsky et al., 2012). However, rangelands themselves (and not just the wildlife in them) are threatened by a range of factors, including agricultural intensification, urbanisation, biofuel production, food prices, food demand, poverty, climate change, land degradation and even poor land use policies (Scogings et al., 1999; Wrobel and Redford, 2010). This competition for land in terms of various land uses and land users is evident in most wildlife-livestock interface environments in and around TFCAs – including the two study areas (Chaminuka et al., 2010; Coetzer et al., 2013; Nyambe, 2013).

Findings discussed in the previous chapters of this thesis confirmed that a lack of grazing for herds, or grazing competition with wildlife, was considered one of the most important constraints to livestock production by livestock owners in both study areas. Similarly, several farmers indicated that improved grazing conditions would be something that could improve their livestock productivity. Animal performance in areas stocked at ecological carrying capacity (the potential of a rangeland to sustain grazing and animal performance over a prolonged period without a negative impact on the ecosystem) is expected to fluctuate with resource availability, because little surplus forage exists with which to maintain production at a constant level (Tainton, 1999; Campbell et al., 2006). Stocking rates for livestock in communal areas is generally regarded as very high, with animal density mostly exceeding that of commercial production areas (Vetter, 2013).

Recently, the thinking around rangeland use and the conventional methods for measuring grazing capacity and stocking rates for livestock in rural, communal rangelands have been criticised for being too simplistic and thus inappropriate, given the complex, multifunctional context of these social-ecological systems (Campbell et al., 2006; Dovie et al., 2006; McGranahan and Kirkman, 2013; Vetter, 2013). It is argued that the mosaic of multiple land uses, the disequilibrium and dynamic nature of rangeland productivity as influenced by multiple drivers in the form of fire, herbivory (both wild and domestic such as in the ZR) and especially climate change, as well as the complexity around livestock valuation in these systems, are all factors that are incompatible with traditional approaches to policy and development that stem largely from commercial agriculture. Models for measuring rangeland sustainability must not merely aim to match the available grazing to annual forage production, but should attempt to account for high levels of environmental variability, as influenced by increasingly erratic climate and precipitation patterns as well as different vegetation types at the local landscape level. The two broad philosophies in livestock management that deal with environmental variability are the constant conservative model, and the opportunistic tracking model (Campbell et al., 2006; McGranahan and Kirkman, 2013). Each comes with its own challenges and trade-offs, but ultimately requires that livestock are either stocked conservatively enough below carrying capacity to ensure net forage availability across seasons and climate cycles, or that stocking rates should adapt to the ebb and flow of resource availability between rainfall cycles and even seasons.

Rich and Perry (2011) have identified three possible limiting factors to the successful implementation of commodity-based trade approaches in southern Africa, namely: (1) the *low quality* of the product in many production systems; (2) the need to invest in *risk-management systems along the entire supply-chain*; and (3) the need for *improved efficiency and productivity* for most of the African livestock sector. Most beef in southern Africa is produced in extensive grazing systems (Casey, 1993) and the quality and quantity of the grazing will therefore influence carcass quality and yield – especially in communal farming systems where carcass finishing through feedlots is uncommon. Appropriate carcass quality is mostly dependent on the target market. Targeted markets will require beef to be of a specific quality, and not just free from disease and safe for human consumption. Carcass and meat quality, as well as what is considered edible and what not, is difficult to define, because these factors are dictated by cultural and socio-economic norms (Casey, 1993). Affluent consumers are used to having a range of options and generally prefer lean, tender meat, whereas less affluent societies are less discerning with regard to quality and may even prefer tougher meat from older animals (Casey, 1993; Ransom, 2011).

The development and implementation of risk management systems along the supply chain can come at a cost. One of the ways through which added costs of managing risk along a value chain can be counterbalanced is by increasing the income generated by beef, by means of access to high-value beef markets and/or by increasing productivity. However, this will require beef quality to be appropriate – something which could arguably can be a major limiting factor to communal beef producers and the associated access to better markets, despite alternative disease management approaches (Rich and Perry, 2011; Thomson et al., 2013).

This chapter will 1) investigate the perceptions of communal producers in the ZR about meat quality, 2) describe the carcass quality and yield, as well as temporal fluctuation in quality, as recorded by the Meatco abattoir; and 3) it will assess whether the current density and distribution of both herbivores and available forage in the ZR is influenced by vegetation type, and whether this can be regarded as a limiting factor for improved beef production.

5.2 METHODOLOGY

5.2.1 Study area

The target area for this study was the eastern ZR, specifically all data applicable to the area to the east of the Kwando river (i.e. all areas and crush-pen data within the ‘pan handle’, or Bwabwata National Park, were not considered in this study). More information on this study area is provided in Chapters 1 and 2.

5.2.2 Data analysis

Perceptions regarding carcass quality

This information was collected during semi-structured interviews, conducted in selected areas in the ZR during November 2011. The methodology and specific study areas were described in Chapter 2 of this thesis.

Carcass yield and quality

Information regarding carcass yield and quality was obtained from the procurement office of the Meatco abattoir in Katima Mulilo for the years 2007 to 2011.

Vegetation types

Mendohlson (1997) conducted a land type classification for the entire ZR. The spatial data from his analysis was obtained from the Environmental Information Service, Namibia (http://www.the-eis.com/ – accessed 06/12/2015).

Cattle density

The density and distribution of cattle was calculated as a first step to determine the estimated cattle density per vegetation type. To avoid the over-simplification of cattle density based on the point location and relative number of cattle per crush-pen within a vegetation type, kernel cattle density was calculated. Kernel animal density accounts for variable degrees of cattle density around a crush-pen at a set radius (normal distribution), and is spatially influenced by cattle numbers (densities) of proximate crush-pens (data points). Kernel density will provide a better estimate of the actual distribution of cattle numbers in the landscape than a point density estimate in this instance, where a single crush-pen point represents a total cattle sub-population. The point density calculates the density of a population within a specified neighbourhood around the point location, whereas kernel density spreads the known quantity of the population for each point from the point location at a specified gradient. The surface area around each point location is calculated by means of a quadratic formula, with the highest value at the centre of the surface (point location), from where it tapers to zero based on the specified search radius (see https://pro.arcgis.com – accessed November 2015). Kernel density is therefore the most popular and widely used spatial formula to calculate home range or animal distribution (Kie et al., 2010; Walter et al., 2011). Most of the estimate error that might be associated with kernel density is based on multiple data points generated by GPS devices on animals (i.e. animal tracking) in which case either over- or under-smoothing of data may occur. These limitations were regarded not applicable for the purposes of this study, given the type of data used.

Kernel density is a density estimate that was used in this study to compare probable cattle densities between vegetation types. For the purposes of this study, the search radius was set at 10km, which was considered appropriate given the maximum estimated grazing range around villages in the absence of measured distances. The mean walking distance of cattle in extensive livestock production systems in Africa has been found to be approximately 14km per day (de Leeuw, 1985). However, it was found that this distance can increase to 20 – 30km in the late dry season in northern Nigeria (van Raay and de Leeuw, 1974). In the ZR, some farmers reported grazing their cattle near the rivers in the dry season, such as a farmer in Linayanti which is approximately 10km from the nearest perennial river. Others reported putting up temporary kraals near rivers in the late dry season in order to prevent them from being herded back and forth. In the absence of measured distance and range use in the ZR, rangelands beyond a 10km radius around a crush-pen was therefore regarded as animal (livestock) absent areas in this study. Kernel density will account for the probability that a proportion of an animal population linked to a specific crush-pen will utilise several vegetation types within a set 10km radius of the crush-pen. This is important, since many crush-pens in the ZR are situated, for instance, in the Mopane woodland vegetation regions, but in very close vicinity to the Caprivi floodplains, or vice versa. An estimate of cattle density within vegetation types can therefore not be linked to the specific location of a crush-pen and its associated cattle population size alone, as cattle in communal areas roam around freely to utilise the available habitat optimally. It is assumed that the kernel density produced around a crush-pen will provide a sufficiently probable distribution of cattle, albeit that distribution density will vary temporally. Unfortunately, temporal changes in the distribution of cattle within the estimated home ranges as influenced by vegetation types cannot be accounted for when crush-pen data (point data) only is used in the absence of animal tracking data. Some farmers in the ZR study areas have explained that they practise a form of transhumance by alternating their grazing areas between floodplains in the dry season and woodland areas in the summer periods. The data also cannot account for the temporary movement of some cattle out of the eastern floodplains, during seasonal flooding, to adjacent woodland areas. This usually happens in the Kabbe area; cattle return to the floodplains as the flood waters retract.

Cattle density across the ZR was calculated by means of Spatial Analyses Tools in GIS software (ArcMap 9.3). Cattle census data for the year 2011 was used to derive kernel density estimates at various gradients around each crush-pen within a search radius of 10km. In order to calculate cattle density relative to vegetation type, cattle density gradient polygons (after being converted from raster graphics to feature data) at increments of 1 km^2 were combined with the spatial information of the vegetation types. Data was exported to Microsoft Excel (2010) for further analysis or for importation into IBM SPSS (version 23). All non-grazing areas were excluded from the analysis (Hanselka and McGinty, 2006), namely Mamili and Muduma National Parks, Kopano and Katima quarantine stations, as well as open surface water.

Vegetative biomass production

Measuring forage production in an attempt to assess the forage supply and demand of the area was not part of the initial planning of this research. However, given the similar timing of the work conducted by Mulonda (2011) in his measurement of the forage production in the ZR in 2011, it was decided that his results should be used, but only after refining their application significantly. Mulonda (2011) measured forage production in each vegetation type in the ZR and used it to calculate overall grazing capacity without consideration of animal distribution and animal type.

Two recent studies measured herbaceous biomass production in the ZR in order to estimate appropriate stocking rates for cattle. Both Mulonda (2011) and Rothauge (2014) estimated herbaceous biomass production in the ZR by clipping and weighing dried herbaceous matter classified within ecological functional groups. Mulonda (2011) selected three random sites within each of the three main vegetation types of the ZR (i.e. floodplains, Mopane woodland, and Kalahari woodland) where he conducted his vegetation surveys, including herbaceous biomass estimation. His surveys were conducted in the peak growing season (March and April) and it can therefore be assumed that his estimations reflected the maximum annually available biomass. On the other hand, Rothauge (2014) conducted surveys in both the KM and Kopano quarantine stations (QS), in the late dry and peak wet seasons of 2013/2014. The quarantine stations are exposed to a different grazing regime when compared to the communal rangelands in the rest of the ZR. The quarantine stations are subdivided into camps of different sizes, which are grazed by cattle during the 21-day quarantine period prior to being taken to the abattoir in Katima Mulilo. The biomass estimates of Rothauge (2014) in the distant transects (furthest away from water and infrastructure within a particular camp in each QS) in both the dry and wet seasons can therefore be seen as a potential benchmark for biomass production within the particular vegetation types. Rothauge (2014) reported up to a 54% decline in available biomass on the same sites between late summer and late winter.

Conducting biomass estimates in the ZR was beyond the scope of this study and it was therefore decided that the biomass estimates of Mulonda (2011) were sufficient, given that his surveys were conducted in 2011, during which data from all three main vegetation types targeted in this study was randomly collected. Biomass estimates per vegetation type calculated by Mulonda (2011) were used.

The herbaceous biomass in the QS as measured by Rothauge (2014) was much higher than that which was calculated by Mulonda (2011) and it was assumed that the latter, measured within the communal cattle rangeland areas at randomly selected plots, mostly in relative proximity to villages where the cattle density is usually higher, would be a better reflection of the actual available biomass in the rangelands of the ZR. Measured biomass was reduced by 50% to account for losses associated with animal impact and the effect of defoliation on the grass sward (Lubbe, 2005; Thorne and Stevenson, 2007). In order to account for landscape variation in biomass within each vegetation type, three biomass categories were applied to each model, namely the mean estimated biomass within each vegetation type as well as both the maximum and minimum biomass levels (range) estimates (kg/ha) within each vegetation type, as determined by Mulonda (2011).

In most cattle grazing systems the available surface area (total grazing area) is known, because cattle are grazed in fenced or demarcated ranches or camps. Calculating the total surface area to be used in the calculation of total biomass availability is therefore not problematic. However, the communal grazing areas are not demarcated and cattle can roam freely, making accurate estimates of total available biomass difficult. The kernel density estimates and associated density gradients around cattle crush-pens were used to calculate the total surface area per density gradient within each main vegetation type of the ZR. This provided both total cattle per density gradient within each vegetation type as well as total surface area per density gradient within each vegetation type. Total cattle DM (dry matter) intake requirements per density gradient can therefore be calculated in order to determine a shortage or over supply of dry matter per surface area for cattle production.

Available forage biomass can be used to calculate the grazing capacity of a specific rangeland if the dry matter intake of the grazer species, such as cattle, is known (Hanselka and McGinty, 2006; Thorne and Stevenson, 2007; Mulonda, 2011). Biomass production is influenced by many factors and will vary between vegetation types (Thorne and Stevenson, 2007; Mulonda, 2011). Biomass consumption by a bovine in the ZR was not assumed equal to that of a typical Large Stock Unit[11] (LSU) because indigenous Sanga and Nguni-type cattle exhibit small to medium frames and therefore do not have the same nutrient requirements or daily DM intake as a typical LSU. Instead, four animal models were used:

A1) An animal unit (AU) in the ZR was defined as 80% of a typical LSU based on the estimated live body mass[12] of 360kg for mature Sanga-type bovines in the ZR (Rothauge, 2014). Daily DM intake was calculated at 3% of live body mass per day, as is required by a growing LSU.

A2) An AU similar to A_1 but daily feed intake was reduced to 2.3% of body mass because it has been found (Meissner, 1995; Hanselka and McGinty, 2006; Thorne and Stevenson, 2007) that mature bovines do not necessarily consume DM per day equal to 3% of live body mass. These authors indicated that adult cattle would rather consume between 2.0kg and 2.6kg per day and not the 3% a growing steer of an improved breed would, growing at a rate of 500g per day.

A3) An AU live body mass estimate of 300kg. The median live body mass of an entire cattle population (n~15 000), measured across type and age categories of mainly Nguni-type cattle in a communal system in South Africa, was used[13], at a mean feed intake of 2.3% of live body mass.

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[11] 1 LSU is defined as a steer weighing 450kg with an average daily gain of 500g (growth) at 3% body mass/day.

[12] Average general carcass mass, across all grades and types (Meatco KM slaughter data) = 163kg. With an estimated dressing percentage of 45% given that most cattle that are slaughtered are old, this equates to 360kg live mass.

[13] HDSS-Live. (2014). Unpublished data. Mnisi Community Programme, University of Pretoria, South Africa.

A4) A2 at maintenance, which is generally regarded as a daily DM intake of 1.5% of live body mass (Tainton, 1999; Thorne and Stevenson, 2007).

The DM requirements for each cattle model were calculated according to the method used by Hanselka and McGinty (2006), Thorne and Stevenson (2007), Mulonda (2011) and Rothauge (2014). Instead of using a grazing period of 365 days as Mulonda (2011) and Rothauge (2014) did, a period of 8 months (243 days) was used, although some estimates at 365 days were included for comparative purposes. The grazing period of 8 months was mainly used because the biomass survey of Mulonda (2011) was conducted in March/April, which is generally considered to be the peak period of biomass production before the rainy season ends and forage production ceases over winter. This is considered the appropriate time to estimate available forage for the dry season, but it is preferred that follow-up estimates be conducted towards the end of the dry season to adapt stocking rates for the late dry season (Hanselka and McGinty, 2006). May to December are 8 months (243 days) of reduced biomass production before full production levels are recovered in the peak rainy season. In the absence of dry season, fodder estimates for a period of 8 months were therefore considered sufficient, over which the fodder available in April should last.

Equation 1: Total available forage (DM) (kg) for surface area Y:

$$F = f(0.5)*Y, \text{ where:}$$

F_Y = total available forage (kg) for area Y

f = available forage (kg/ha)

0.5 = 50% utilisation efficiency of forage produced

Y = surface area (ha)

Equation 2: Forage requirement of cattle on surface area Y using animal model A:

$$R_{YA} = A(248)*T_Y, \text{ where:}$$

R_{YA} = forage required (kg) over 248 days for all cattle on surface area Y using animal model A

A = animal model used (kg)

248 = total number of grazing days

T_Y = total number of cattle on surface area Y

Equation 3: Balance between forage supply and forage required for surface area Y:

$$B_{YA} = C_{YA} – R_{YA}, \text{ where:}$$

B_{YA} = balance (kg) between forage supply and requirement for surface area Y using animal model A

F_{Y} = total available forage (kg) for area Y

R_{YA} = forage required (kg) over 248 days for all cattle on surface area Y using animal model A

This model accounted specifically for landscape heterogeneity by estimating biomass availability within each of the main vegetation types of the ZR. Vegetation types occur in the context of their own landscape, and ecological properties are responsible for much variation in rangeland productivity. Estimated biomass availability and fluctuation will be accounted for by allowing animal forage requirements to change according to kernel density (animal density) increments in each vegetation type. In the absence of sufficient, quantitative data regarding fluctuation in herbaceous productivity across seasons, possible variation in animal performance was used to account for variation in potential stocking rates across the landscape (animal models A1-4).

Spatial analyses were conducted to determine the available surface area per cattle density gradient (increments of 1 animal/km^2) per vegetation type. Total cattle numbers were then calculated for each gradient increment within each vegetation type. Because kernel density analyses are estimates of the probability of a certain number of animals present in a specific area, the estimated total population size for each vegetation type was calculated based on the size of each density increment within a vegetation type, multiplied by its estimated density. The total population estimate obtained from the density estimates was lower than the actual medium-term (2005-2012) median population of the ZR (~143,000 animals) because census data from the 2011 cattle census was used, which was much lower than the medium-term median and also lower than the 2012 census. Furthermore, coordinates could not be found for all the crush-pens included in the cattle census, effectively reducing the total number of cattle included in the density estimates. In order to use the medium-term cattle population size as a reference point in order to compare model outputs, the kernel density estimated population size was proportionally increased with a constant factor across all vegetation types, to resemble the mean estimated stocking rate per vegetation type that could be used in the model. Biomass estimates by vegetation type, relative to estimated stocking rates and the distribution of cattle, were then used to map areas where the probability exists for cattle forage requirements to either exceed or fall short of the estimated forage supply per vegetation type. Mean forage supply was used across all areas to account for spatial variation in forage supply. Maps were calculated based on total available surface area and the associated cattle densities per vegetation type. Due to substantial amounts of land in the Kalahari woodlands (and to some extent also in the Mopane woodlands) that were indicated during the spatial density analyses to have a high probability for absence of cattle, these areas were also excluded in part of the model (*'z'* – zero animal areas included; '*p*' – animal present areas only); i.e. only those areas with a high probability of having >0 animals/ha were considered. This was done so as to reflect the biomass availability in rangeland areas to which cattle are most likely restricted. The model outputs had to reflect actual biomass availability per AU within a particular vegetation type. The large areas most probably inaccessible to cattle due to their distance from kraals and water, if included, would cause an overestimation of the amount of biomass available (Mulonda, 2011) which in turn would provide a false estimate of the ecological carrying capacity. Crop fields were not excluded from calculations because spatial data for crop fields were not available and it was beyond the scope of this project to calculate cropping areas for the entire ZR. Although some estimates were provided by Mendohlson and Roberts (1997) these were regarded as too outdated to be of use. Additionally, post-harvest crop stubble generally contributes substantially to forage supplementation in beef production systems.

5.3 Results

5.3.1 Perceptions and preferences: carcass quality

Respondents (n=44) were asked by means of open-ended questions to explain which cattle, in terms of type and age, they generally preferred to sell. The question was not linked to any specific market and responses therefore included people that only sell to local markets or local farmers. Responses were grouped into similar categories and indicated the strong preference of farmers to sell old (46%) oxen (68%) (Figure 5-1). Only 7% of the responses indicated a preference for selling young animals, because there was a market for young animals, especially heifers, bought as replacement animals.

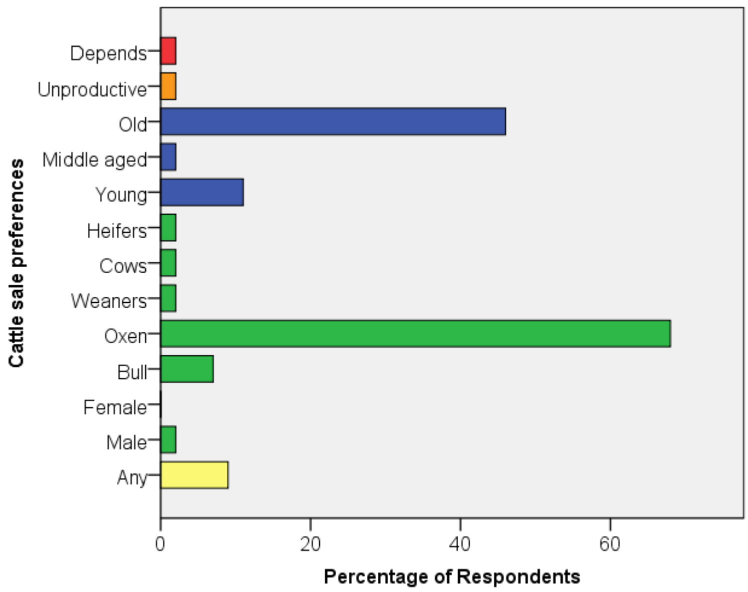


Figure 5-1: Percentage of respondents that indicated a specific type and age category of cattle they preferred to sell

Respondents were then specifically asked what type and age of animal they thought provided the tastiest meat. The majority of respondents indicated young animals (73%), either male (36%) or female (39%) (Figure 5-2). Oxen and 'middle-aged' animals were preferred by 25% and 18% of the respondents, respectively. The respondents' definition of 'young' animals was mostly animals between 3 and 5 years old.

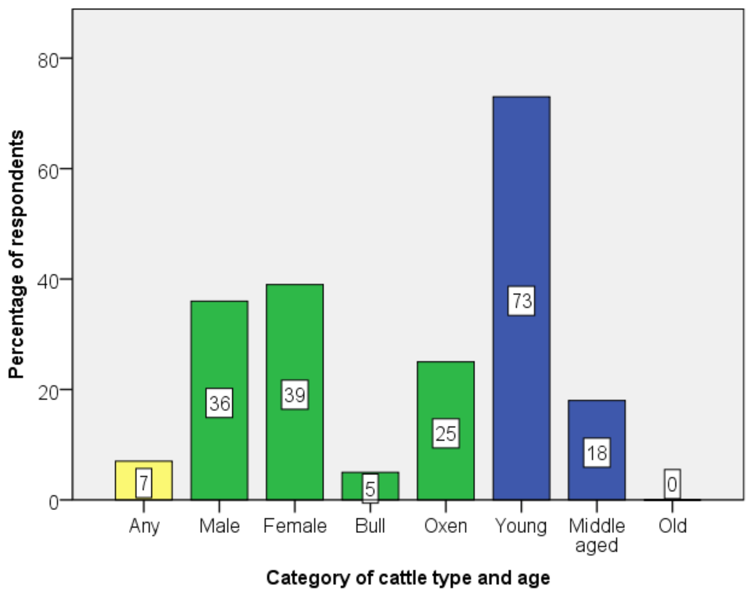


Figure 5-2: Percentage of respondents that indicated a preference for a specific cattle type or age category in relation to meat taste preferences

5.3.2 Carcass yield and quality

The average carcass weight per month analysed over the period from 2007 to 2011 and the average value of carcasses over the same period showed significant correlation (R=0.556; P=0.001) (Figure 5-3). April was on average the month with the highest beef carcass prices paid per kg (N$18,54) after which the price gradually declined towards December (N$15,30). May was the month in which on average the highest carcass weights were recorded (173kg). From May to August, the onset of the late (hot) dry season, which usually lasts until October (before the first rains in November), the average weight declined rapidly by approximately 12% (19kg) to 154kg. The average carcass weight rose slowly from August to December (158kg) after which it increased rapidly over the wet season through to May. There was a gradual increase of approximately 8% (12kg) in the annual average carcass weights from 2007 to 2011. The average price/kg increased from 2007 to 2011 by approximately 33% (N$4,50).

Oxen were the cattle type marketed significantly more than other types and comprised between 65% and 72% of monthly sales from 2007 to 2011 (Figure 5-4). Cows were sold the second most often, with monthly sales comprising between 17% and 26% of total sales. The number of bulls sold per month ranged between 5% and 11% and heifers between 0.3% and 1.5%. Both bulls and oxen had peak sales in November. Cows and heifers had peak sales around August/September and cows again in January/February.

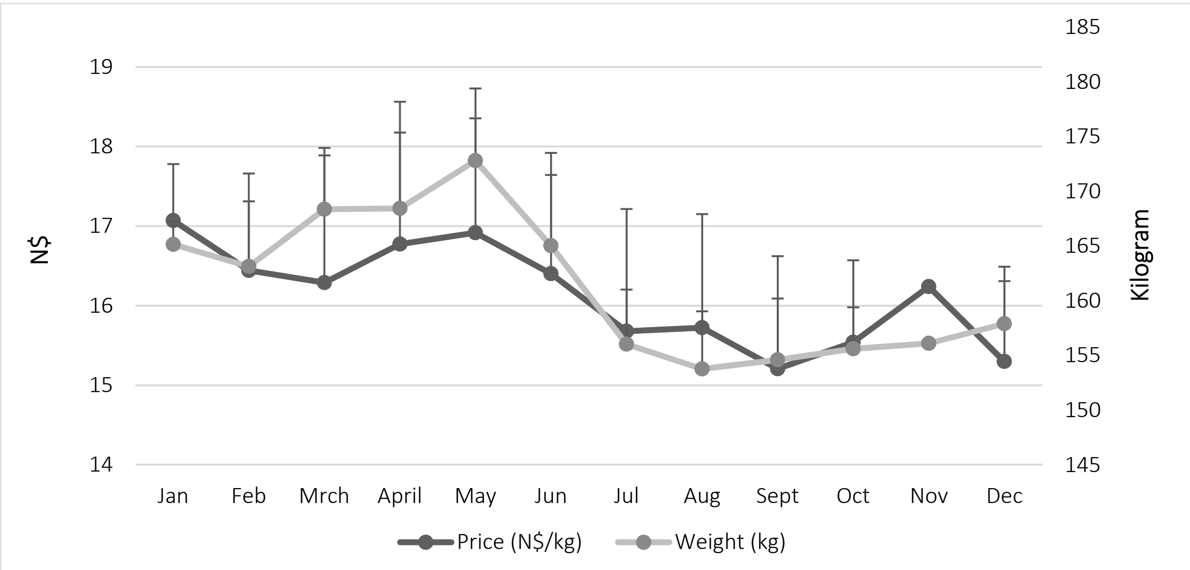
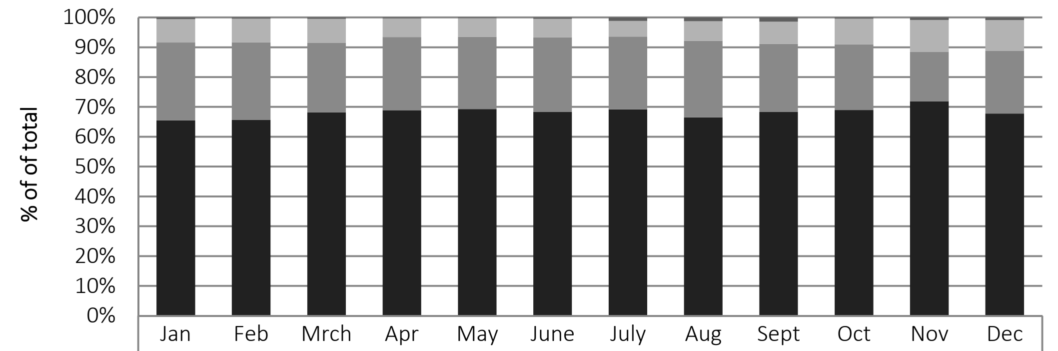
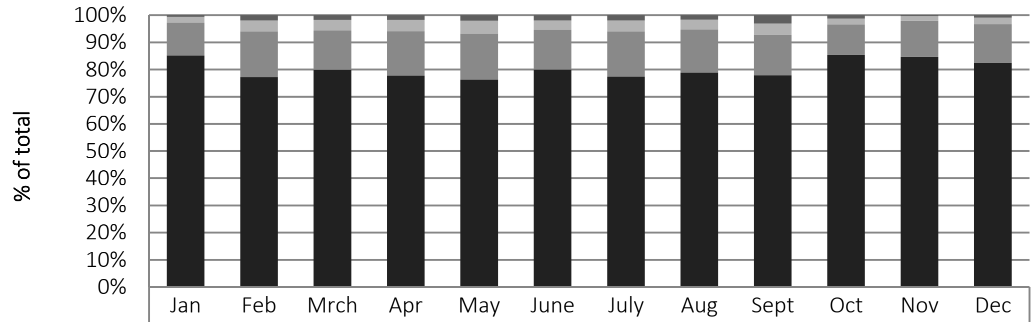


Figure 5-3: Average price/kg (N$) and average monthly carcass weights (kg) between 2007-2013, as recorded by the Meatco abattoir in Katima Mulilo. Error bars – Standard Error of the Mean



	Jan	Feb	Mrch	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
Heifers	0.6	0.4	0.5	0.3	0.3	0.5	1.2	1.3	1.5	0.4	0.8	0.9
Bulls	8	8	8	6	6	6	5	7	7	9	11	10
Cows	26	26	23	24	24	25	24	26	23	22	17	21
Oxen	65	66	68	69	69	68	69	66	68	69	72	68

Figure 5-4: Proportions of different cattle gender categories sold per month (2007-2011)



	Jan	Feb	Mrch	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
A Grade	0.6	2.0	1.7	1.7	2.1	1.9	1.9	1.6	3.1	1.2	0.3	0.9
AB Grade	2.1	4.0	3.9	4.2	4.8	3.4	4.0	3.6	4.2	2.2	1.8	2.4
B Grade	12	17	14	16	17	15	17	16	15	11	13	14
C Grade	85	77	80	78	76	80	77	79	78	85	85	82

Figure 5-5: Monthly proportions of different carcass grades slaughtered from 2007-2011

Grade C carcasses constituted the bulk of the cattle slaughtered monthly at the KM abattoir, ranging between 77% and 85% of total monthly sales (Figure 5-5). Second most (12% to 17%) of cattle slaughtered yielded carcasses of the B-grade. A & AB grades only made up between 0.3% and 3.1% and 1.8% and 4.8% of carcasses slaughtered respectively.

Monthly changes in carcass fat thickness for grades B and C dropped from 49.2% (grade C) and 35.9% (grade B) in May to a low of 10% in September (grade C) and 3.6% in October (grade B) (Figure 5-6).

The number of carcasses with a fat class of 0-1 for grades B and C increased proportionally as the number of carcasses in fat classes 2-4 decreased.

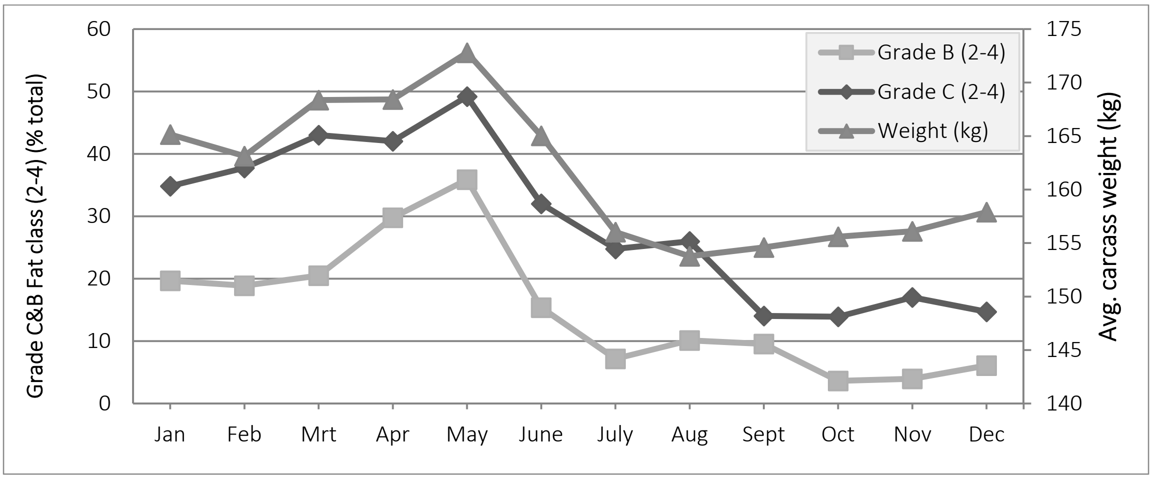


Figure 5-6: Monthly trends in the mean number of Grades C & B carcasses with fat classes 2-4 recorded at the Meatco Abattoir, Katima Mulilo, between 2007-2011

There was a significant correlation between the monthly change of grade B carcasses within fat classes 2-4 and grade C carcasses within fat classes 2-4 ($R=0.901$; $P<0.001$). There was, however, no significant correlation between mean monthly change in the number of carcasses per fat class in grades C and B carcasses and mean carcass weight ($P=>0.05$) despite this seeming to follow a similar monthly trend (Figure 5-6).

5.3.3 Cattle population dynamics

The total number of cattle recorded during the November 2011 census by the Department of Veterinary Services, Katima Mulilo, was 128 905 animals. This figure was 15% less than the 2010 census and 11% less than the 8-year mean of 144 740 animals (Figure 5-7). The median population size was very similar to the mean, at 146 309 animals. In 2012 the cattle population in the ZR recovered again to ~140 000 animals which was near (3% below) its medium-term mean size. A similar apparent drop in the cattle population in 2011 occurred in 2007, with gradual recovery taking place over 2008 and 2009.

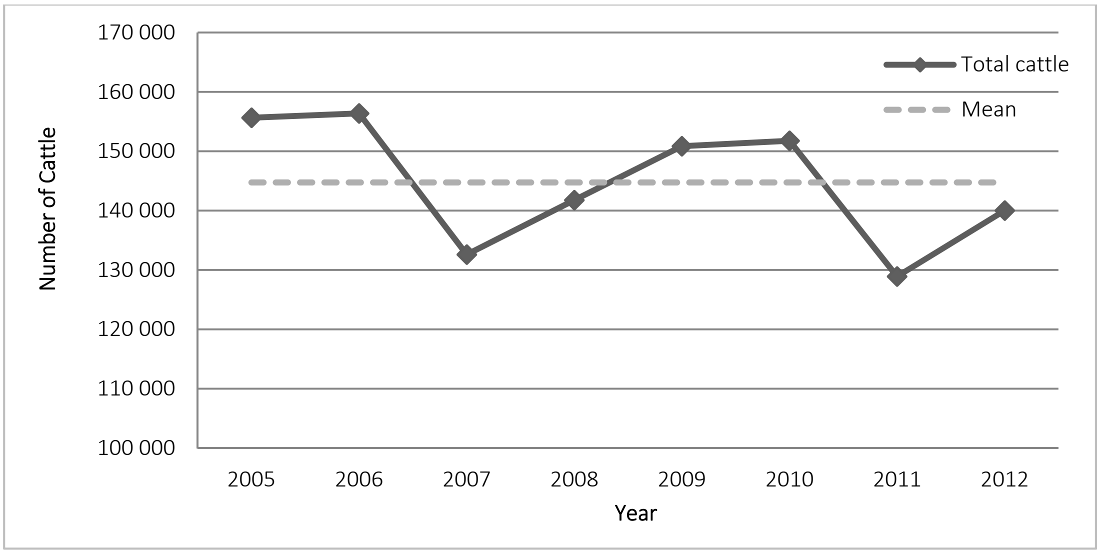


Figure 5-7: Cattle population change in the ZR from 2005 to 2012 (Source: Department of Veterinary Services, 2005-2011; Katima Mulilo, 2012: http://www.mcanamibia.org/files/files/MCABulletinSep2013.pdf – accessed 06/12/2015)

5.3.4 Vegetation types of the ZR

The Mopane woodland (MW) vegetation type of the ZR is the largest in the ZR east of the Bwabwata National Park (Kwando River) and comprises 40% of the total surface area. The Floodplain (FP) (33%) and Kalahari woodland (KW) (26%) vegetation types are second and third largest vegetation areas (Table 5-1). The Riverine woodland and islands vegetation types constitute a mere 1% of total surface area of the ZR, and the calculated total surface area of the ZR east of the Kwando River was 11 415 km^2.

A map of the vegetation types of the ZR is provided in the Appendix 5.

Table 5-1: Total surface area of each vegetation type of the ZR

Vegetation type [a]	Size (km^2)	Percentage of total area [b]
Caprivi floodplain (FP)	3 712 km^2	33%
Caprivi Mopane woodland (MW)	4 622 km^2	40%
North-eastern Kalahari woodlands (KW)	2 922 km^2	26%
Riverine woodlands and islands (RW)	159 km^2	1%
TOTAL	11 415 km^2	100%

[a] *Open surface water (0.8% of total surface area) was not considered in this chapter and the Impalila Island vegetation type was included in the Riverine woodland type due to its small size*
[b] *Total of 100% due to rounded figures*

5.3.5 Cattle density and distribution

Table 5-2: The summed surface areas and cattle numbers per vegetation type in the ZR calculated from kernel density estimates across vegetation types. Animal density with and without consideration of cattle absent areas as derived from the spatial analyses

Vegetation Type	Animals present areas (ha)	Animals absent areas (ha)	Total area (ha)	Total cattle (Animals)	[a] Corrected for 2011 (Animals)	[b] Corrected for mean (Animals)	Density (animals/ha) *P-areas
FP	305 721	29 589	335 310	48 291	65 952	74 368	0.29
MP	296 180	94 287	390 467	33 323	45 509	51 317	0.17
KW	148 746	131 563	280 309	11 374	15 534	17 516	0.17
RW	14 484	663	15 148	1 399	1 910	2 154	0.15
	765 131	256 102	1 021 233	94 387	128 905	145 355	0.17

[a] Estimated total cattle population (cattle numbers) per vegetation type proportionally corrected to reflect total population size of the year 2011

[b] Estimated total cattle population (cattle numbers) per vegetation type proportionally corrected to reflect mean cattle population size (2005-2012)

*P-areas: calculated using animal present areas only. Cattle density calculated with corrected cattle numbers for reference population (medium-term mean)

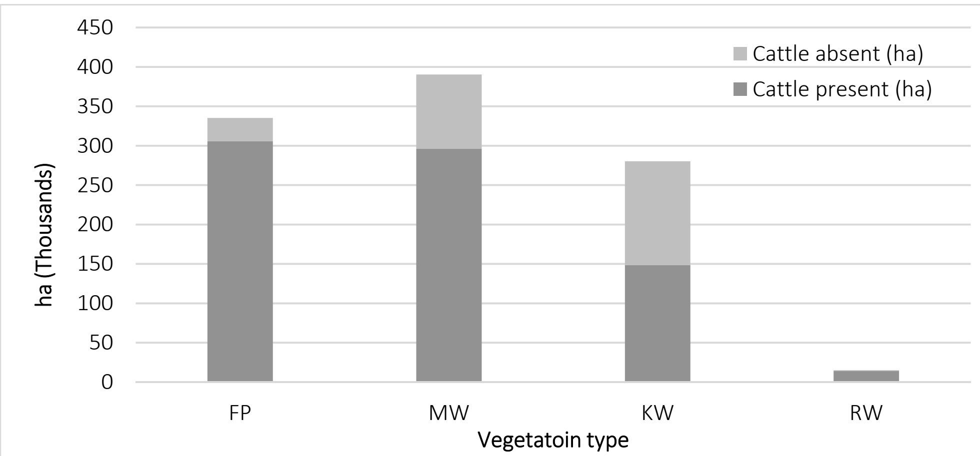


Figure 5-8: The total surface area (ha) in each vegetation type of the ZR with or without cattle as calculated from kernel density estimates. Cattle absent areas were outside the search radius of 10 km around crush-pens

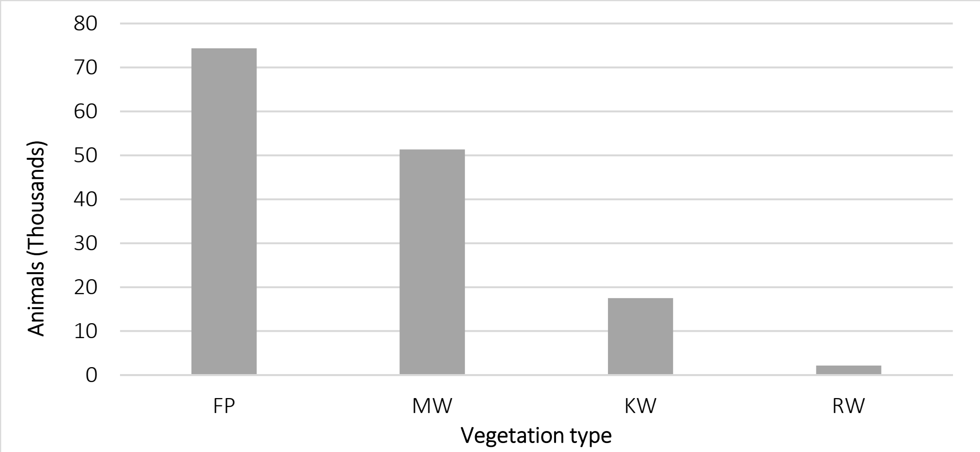


Figure 5-9: Total number of cattle in each vegetation type of the ZR based on kernel density distribution. Adapted with constant factor to reflect medium-term mean cattle population size

In order to test for significant differences between vegetation types and the estimated number of cattle per vegetation type, non-parametric tests for independent samples were used because the distribution of the variables was not normal (Kolmogorov-Smirnov; P<0.001). Cattle density distribution was normal and ANOVA was therefore used to compare mean density between vegetation types. The sizes between the vegetation types differed significantly (Independent-samples Kruskal-Wallis Test: χ^2=60.3; P<0.001). The Mopane woodlands provide the largest available rangeland (38%) in the ZR, followed by floodplains, which provide 33% of the available rangeland, then Kalahari woodland (27%) and riverine woodland and islands (only 2% of the available rangeland). However, the floodplains in the ZR have the largest surface area utilised by cattle (40%) followed by Mopane woodlands (39%), Kalahari woodlands (19%) and riverine woodlands (2%) (Table 5-2; Figure 5-8).The density distribution estimates indicate that 46% of the grazing areas in the Kalahari woodlands is not occupied by cattle, 24% of the Mopane woodland is not occupied, followed by 9% of the floodplains and only 4% of the riverine woodlands and islands. The number of cattle in each vegetation type differ significantly (Independent-samples Kruskal-Wallis Test*:* χ^2=80.0; P<0.001; 95% CI). It was estimated that 51% of the cattle population of the ZR occurred on the floodplains, followed by the Mopane woodlands with 35% of the cattle, the Kalahari woodlands with 12% of the cattle, and the riverine woodlands and islands with 2% of the cattle population (Table 5-2; Figure 5-9). Mean cattle density differed significantly between vegetation types (ANOVA F=10.34; P<0.001; 95% CI) (

Appendix 6).

The estimated cattle density in cattle occupied areas in the ZR overall was the highest on the floodplains, with a mean density of 0.29 animals/ha (Table 5-2). The lowest mean cattle density was in the Kalahari woodlands and the Mopane woodlands, with an estimated cattle density of 0.17 animals/ha (Table 5-2). The number of cattle per density polygon was significantly correlated with the size (ha) of each density polygon in the floodplains, Kalahari woodlands and the riverine woodlands (Spearman's Rho*:* R=0.442, .818, .596 respectively; P<0.005), but not in the Mopane woodlands (R=0.235; P=0.195).

5.3.6 Biomass production and distribution

The mean overall vegetative biomass production differed significantly between the vegetation types in each biomass category (BM_L/M/H) (Independent-samples Kruskal-Wallis Test: χ^2=55.0/56.6/58.3; P<0.001; 99% CI) (Table 5-3). However, the biomass produced in the floodplains and the Mopane woodlands did not differ significantly, nor did it differ significantly between the Mopane woodlands and the Kalahari woodlands at a mean biomass level (P>0.05).

Table 5-3: Descriptive statistics of the total vegetative biomass production in the ZR as estimated model outputs for the highest, mean and lowest measured biomass levels in each vegetation type (Mulonda, 2011). All figures x 100 000, except N

Biomass Level	Vegetation Type	N	Mean	Median	SEM	SD	Sum
BM_L	FP	38	35	38	3	19	1 341
	MW	33	37	31	9	49	1 210
	KW	35	42	16	20	116	1 472
	RW	31	2	1	0	2	61
BM_M	FP	38	45	48	4	25	1 707
	MW	33	59	50	14	79	1 945
	KW	35	50	19	23	139	1 758
	RW	31	2	1	0	2	77
BM_H	FP	38	57	62	5	32	2 180
	MW	33	83	71	19	110	2 733
	KW	35	60	22	28	166	2 102
	RW	31	3	2	0	3	98

There was a significant difference between the estimated biomass produced in the animal absent and animal present areas of each vegetation type within each biomass level used (Mann-Whitney: U=104; P=0.04 two tailed) (Table 5-4).

Table 5-4: The descriptive statistics of the estimated vegetative biomass production in animal present and animal absent areas using the highest, mean and lowest biomass production levels measured by Mulonda (2011). All figures x 100 000, except N

Biomass level	Cattle presence	N	Mean	Median	SEM	SD	Sum
BM_L	Absent	4	276^{A}	205	151	301	1104
	Present	133	22^{a}	16	2	21	2980
BM_M	Absent	4	362^{B}	310	182	365	1449
	Present	133	30^{b}	20	2	29	4039
BM_H	Absent	4	461^{C}	426	223	446	1843
	Present	133	40^{c}	27	3	38	5270

$^{X/x}$ significant difference at 95% CI

5.3.7 Grazing capacity and stocking rate

The model outputs used to calculate the stocking rate and grazing capacity for the ZR are summarised in Appendix 7 and Appendix 8, together with a summary of the main model inputs. The non-parametric test for related samples (Wilcoxon Signed Rank Test) was used to test for significant differences between the reference population size and output population sizes at a 5% significance level. The mean cattle population size as calculated in the medium term (2005-2012) was used as a reference population for the assumed medium-term ecological carrying capacity of the area, with which modelled stocking rate estimates were compared. Results indicated that the difference between the mean reference population size and the population sizes representing the estimated carrying capacity for the different model combinations were most significant in the high biomass levels. In terms of total population sizes, all the model combinations in the high and medium biomass levels of both the *p*- and *z*- models were significantly larger than the reference population (Wilcoxon Signed Rank Test: P<0.05). In none of the model combinations did the *z*-models effect a significance change between cattle population estimates if compared with the *p*-model outputs. The mean reference population only exceeded the mean population at carrying capacity in model $LA1_p$. All other population sizes at carrying capacity exceeded the reference population. In the case of models LA2/3 and MA1 for both *p*- and *z*-

models, the reference population was not significantly smaller than the estimated population at carrying capacity (P>0.05). The differences in the weighted population size estimates (%) (Appendix 7) indicated that the population at carrying capacity exceeded the reference population in LA1/2_p but only in $LA1_z$ of the *z*-models. All the other estimates of carrying capacity in terms of population size exceeded the reference population by as much as 214% ($HA4_z$).

In as far as vegetation type had an effect on estimates, the reference population only exceeded the population size at the estimated carrying capacity with a significant number of animals in the floodplains of model $LA1_{p/z}$ (Related Sample Wilcoxon Signed Rank Test*:* P<0.05). The *z*-model outcomes had an insignificant result as opposed to the significant result of the *p*-models, based on the difference between mean reference population and the population at carrying capacity in models LA2 and MA1 of the floodplains alone. The converse was also true for model LA2 in the Kalahari woodlands, where the differences in mean population sizes of the z-models were significant, but not in the *p*-models with the same inputs. In all other model outputs in all vegetation types, the levels of significance between the *p*- and *z*-models were similar. The level and frequency of significant differences between the reference populations and the population estimates increased from the low biomass level to the high biomass level models in both *p*- and *z*-models. The frequency of significant differences between the population estimate at carrying capacity and the reference population was the lowest in the Mopane woodlands, where a significant difference occurred in 7/ 12 model outputs (*p*- & *z*-models).

The estimated population size at ecological capacity in the floodplains was 37.4% lower than the reference population ($LA1_p$) and 32% lower than the reference population in the Mopane woodlands. The ecological carrying capacity exceeded the reference population size by 70% in the Kalahari woodlands and by 2.4% in the riverine woodlands, although the mean differences in the population sizes of the estimated and reference populations in each of these vegetation types were not significant *(*P>0.05). This excess of 23.6% in the stocking rate of the reference population ($LA1_p$) was reduced to 6% above the capacity of the ZR if forage produced in animal absent areas was included in the model ($LA1_z$). The estimated population size at carrying capacity of model $LA1_p$ was 12% lower than the actual cattle population in November 2011. The reference population size exceeded the estimated carrying capacity in the floodplains in animal models A1-3 when low biomass availability in animal present only areas (*p*-areas) (Figure 5-10) were considered, and models LA1-2 in all available rangeland areas (*z*-models) (Appendix 7). The floodplain's carrying capacity was also exceeded in $MA1_{p/z}$ (Figure 5-11) but in no subsequent models with higher carrying capacity estimates (Appendix 7). The carrying capacity in the Mopane woodlands was exceeded in models $LA1_{p/z}$ and $LA2_p$ (Figure 5-10) but in no further outputs

(Appendix 7). The estimated carrying capacities of the Kalahari woodlands and the riverine woodlands were never exceeded by the reference population in any one of the models.

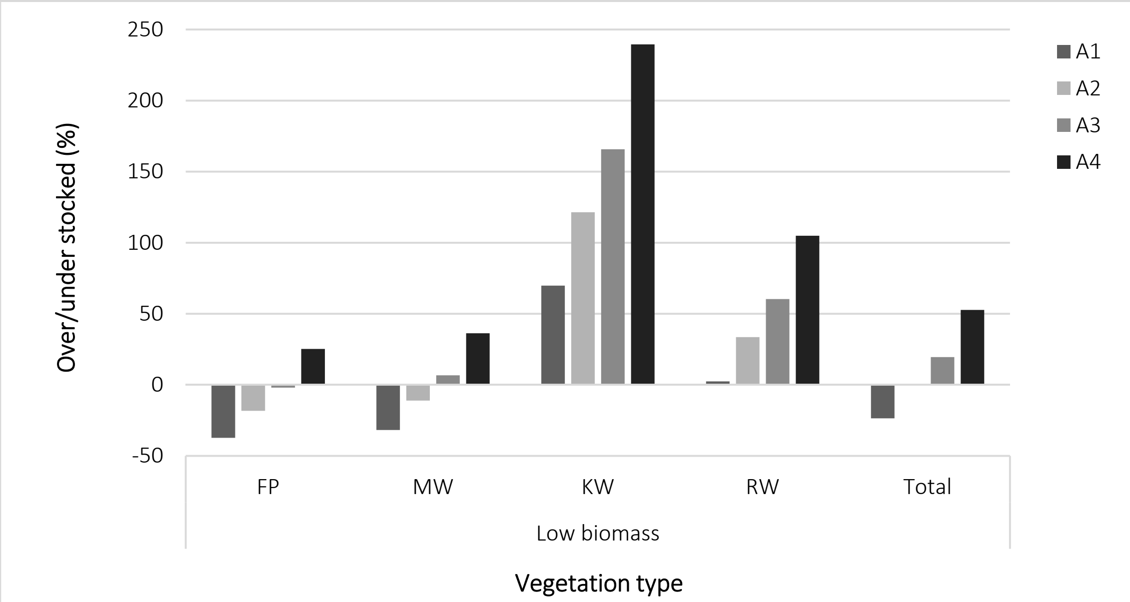


Figure 5-10: The percentage of the total cattle population with which each vegetation type in the ZR is estimated to be either over (-) or understocked (+) given the biomass requirements of animal models A1-4 using the lowest measured biomass production in each vegetation type (Mulonda, 2011). RW biomass production assumed equal to FP. Production requirements based on 8 months (243 days), animal present areas only

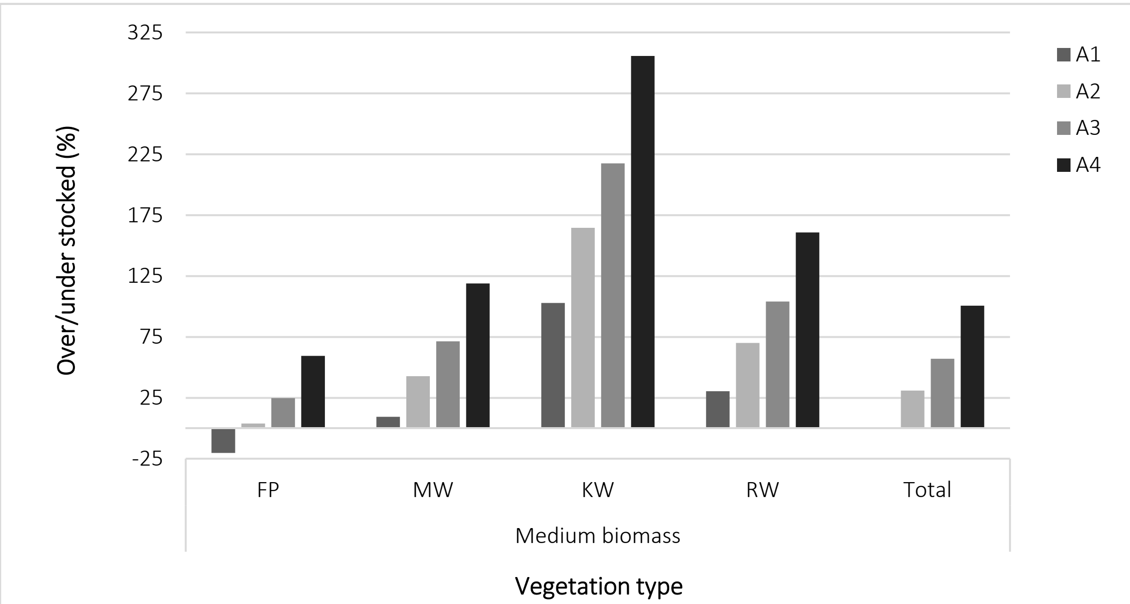


Figure 5-11: The percentage of the total cattle population with which each vegetation type in the ZR is estimated to be either over (-) or understocked (+) given the biomass requirements of animal models

A1-4 using the mean measured biomass production in each vegetation type (Mulonda, 2011). RW biomass production assumed equal to FP. Production requirements based on 8 months (243 days), animal present areas only

If the mean reference population is assumed a reasonable indication of the medium-term carrying capacity of the ZR, as is generally the case in wildlife populations, it can be used in the spatial model to indicate areas where estimated cattle numbers of each animal model output(A) either exceeded the mean reference population (R) or vice versa. If the natural biomass fluctuation range (low (L), mean (M), high (H)) is considered, as measured by Mulonda (2011) in each vegetation type, the cattle density increment at which LA>R is considered overstocked; HA>R is considered understocked; (HA>R)<MA>(LA>R) is considered the optimal or sustainable stocking rate in the medium term. Each density increment represents a total cattle number and specific surface area as generated by the spatial analyses, and by using these equations for each model output for animal model A1, over 40% of the rangelands in the floodplains were overstocked, whereas only ~30% of the Mopane rangelands, 10% of the Kalahari woodlands and ~20% of the riverine woodlands were overstocked (Figure 5-12). The percentage of the surface area of the floodplains that was overstocked declined to only ~5% in A4. The land surface area that was overstocked in the floodplains in A1 was ~180,000 ha (Figure 5-13). Similarly, over 80% of the cattle population on the floodplains were under pressure due to overstocking using A1, which constituted ~60 000 animals, or approximately 45% of the mean (reference) population. Similarly, 50% of the estimated cattle population in the Mopane woodlands was overstocked if model A1 was used, 30% of the cattle in the Kalahari woodlands, and ~45% of the cattle in riverine woodlands (Figure 5-13). The areas that are overstocked or underutilised according to animal model A2 was mapped (Appendix 9).

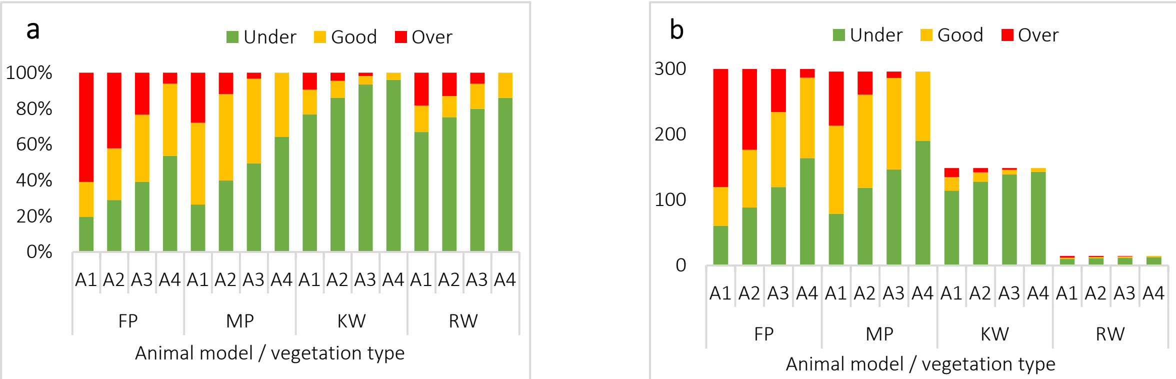


Figure 5-12: a) The proportion (%) of the size (ha) of each vegetation type, and b) the total area (ha in thousands) that is estimated to be either over or understocked with cattle, or at a sustainable stocking rate (good) based on the biomass requirements of each Animal Model (A1-4). Lower and upper limits of what is considered to be a sustainable stocking rate were set using the lowest and highest biomass production levels of each vegetation type (Mulonda, 2011) to calculate carrying capacity (number of cattle) but returned a negative value if the estimated mean cattle numbers for each density category was subtracted. Production requirements based on 8 months (243 days), animal present areas only

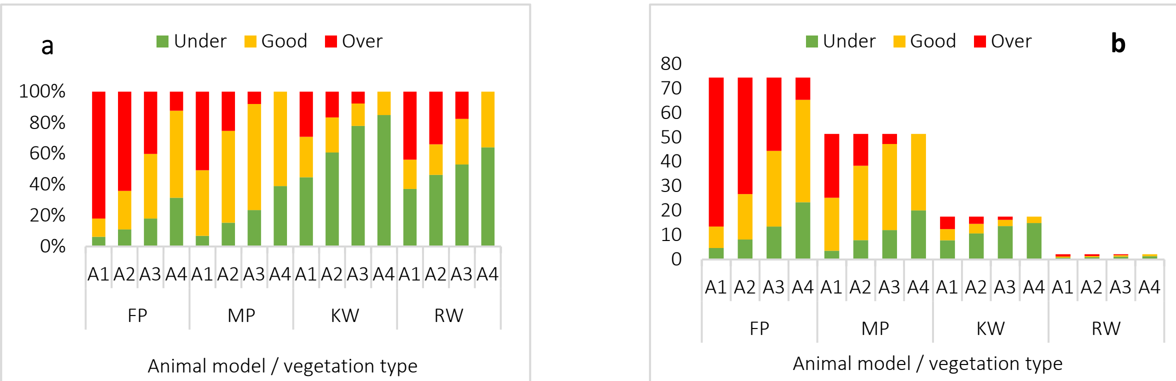


Figure 5-13: a) The proportion (%) of the total cattle population in each vegetation type, and b) the total number of cattle (thousands) that is estimated to be either over or understocked, or at a sustainable stocking rate (good) based on the biomass requirements of each Animal Model (A1-4). Lower and upper limits of what is considered to be a sustainable stocking rate were set using the lowest and highest biomass production levels of each vegetation type (Mulonda, 2011) to calculate carrying capacity (number of cattle) but returned a negative value if actual cattle numbers in each density category was subtracted. Production requirements based on 8 months (243 days), animal present areas only

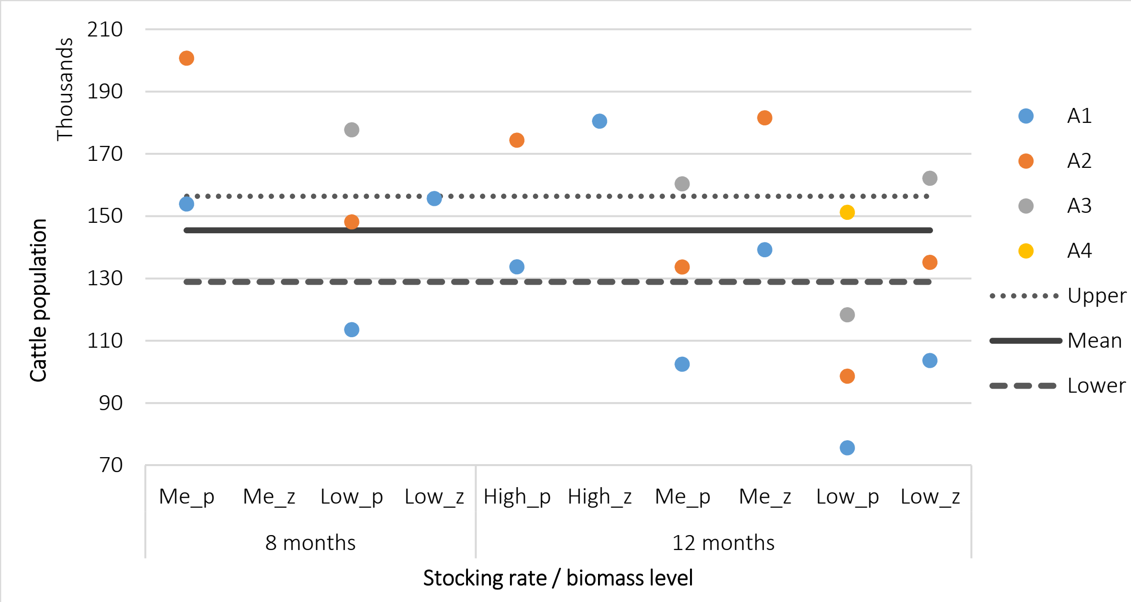


Figure 5-14: The variation in total cattle population size estimates for ZR of selected model outputs in relation to the reference population size (mean, upper and lower limits between 2005-2012). Variables included total biomass estimates (low, mean, high) (Mulonda, 2011) for the ZR as calculated per vegetation type, excluding animal absent areas (*p*-model), Animal models (A1-4), and the stocking rate period (8 and 12 months). Model outputs returning cattle numbers higher than 200k were omitted from the graph to focus on outputs in range of the reference cattle population

The distribution of the estimated population sizes at carrying capacity for a selection of model outputs relative to the range and mean of the reference population of the ZR is provided in Figure 5-14. Population estimates beyond 200 000 animals were not included because the objective was to determine which models estimated a carrying capacity within the range of the measured cattle population over the medium term (2005-2012). The visualisations suggest that a population with the requirements of A1 during mean level of forage production over a period of 8 months will be at carrying capacity within the medium-term population range if cattle are restricted to animal present areas only ($MA1_p$–8 months). The population with the same forage intake requirements will have to drop to just above 110 000 animals if stocked at carrying capacity over an 8-month period of low levels of forage production ($LA1_p$–8 months). That is, unless under such low biomass conditions the same population gains access to grazing areas usually outside the assumed normal range of cattle ($LA1_z$–8 months). If the period for which forage needs to be available is extended to 12 months under similarly low biomass production levels, the same population will have to be halved to remain at carrying capacity ($LA1_p$–12 months). This will entail that the reference population will experience nutritional stress and the vegetation will be overstocked as well. If the forage availability remains below what the population requires, cattle will be forced to accept intake levels for smaller animal sizes with lower metabolic rates in order to survive, unless they are able to access surplus forage in areas of the Zambezi outside the normal grazing range. The lowest range of the medium-term cattle population was ~129 000 animals (2011). During the below average rainfall period between 2010 and 2011 the cattle population in the ZR dropped from ~151 000 animals to a low of ~129 000 animals at the end of 2011. This implied that forage availability for large parts of the cattle population was insufficient, and if the cattle production and intake were similar to that of A1 at mean forage production levels, the population started switching towards the intake levels (performance levels) of A2-type animals in order to survive, with the population size of ~129 000 animals between $LA2_p$–8 months and $LA1_p$–8 months. If the period of mean to low forage levels extends to 12 months more cattle will have to switch to production requirements of A2 in order to survive or maintain production. Larger types of cattle, such as oxen, exposed to periods where low forage production levels persist over 12 months, will have to switch to maintenance levels to survive ($LA4_p$–12 months).

5.3.8 Competition with wildlife

The total estimated wildlife population that occurs on the floodplains of the ZR in areas that are normally also grazed by cattle, hence representing potential competition for grazing (Table 5-5), is proportionally distributed across all density gradients of the floodplain areas that do support cattle.

Table 5-5: The estimated number of wildlife in the floodplains of the ZR in 2011 and their animal unit equivalents

Type of animal	Large-animal units per animal	Browse-animal units per animal	Estimated Numbers	Total LAU's	Total AU's	% of Total
Low selectivity grazers						
Buffalo	1.25	0.13	1 579	1 976	2 372	37.0
Burchell's zebra	0.66	0.00	213	141	170	2.6
Hippopotamus	2.05	0.00	289	593	711	11.1
High selectivity grazers						
Reedbuck	0.20	0.04	10	2	2	0.0
Red lechwe	0.26	0.04	78	20	24	0.4
Mixed feeders						
Common impala	0.10	0.25	105	11	13	0.2
Elephant	2.57	5.56	1 011	2 602	3 123	48.7
TOTAL			3 285	5 346	6 415	100

Notes: Replacement values obtained from Bothma (2002).

- Animal numbers estimated as follows: Total wildlife populations counted in entire floodplains area in 2004, 2007, 2009. Inherent population growth rate (Bothma, 2002) (2004-2009) per species calculated forward from 2009 – 2011. Proportion of population of each species counted in conservancies and communal land in 2009 times total population size of each species in 2011.
- AU (Animal Unit) equal to 80% of LSU (Large Stock Unit) as calculated by Rothauge (2014).
- Only LSU equivalents were used in calculations, not browse animal equivalents as well.

The total number of wildlife species, as a proportion of the total number of cattle on the floodplains using the A1 animal model in each of the three biomass production levels, was used to increase the cattle population estimate proportionally, with the number of cattle equivalents of the wild herbivores. The number of cattle did not increase significantly on the floodplains if the cattle equivalent of the number of wild herbivores was added to the number of cattle in each density gradient for any one of the $A1_p$ models for low, mean, or high biomass production levels (Wilcoxon Signed Rank Test*:* P=0.087 (L); P=0.255 (M); P=0.411 (H); 95% CI).

5.4 Discussion

The cattle type that farmers in the ZR preferred to sell in general confirmed the carcass type mostly received by the Katima Mulilo abattoir: old oxen. Old oxen do provide the highest carcass weights but also the poorest quality based on the lower carcass grades. Overall, the selling of cows, heifers, and weaners was not preferred by local farmers. Old cattle were defined as either cows past their breeding age or oxen too old to be used for draught purposes but still fit enough to be marketed (i.e. trekked to the QC). From the farmers' explanations of when an ox becomes too old to be used for draught power, these animals may easily exceed 10 years in age. Similarly, cows that become too old to reproduce are expected to be older than 10 years of age. Despite their preference in terms of the type of cattle sold, farmers in the ZR believed that the best meat for eating came from young animals. This finding was contrary to a report by Ransom (2011) which stated that some cultures prefer old, tough meat, such as the BaTswana of Botswana. Several respondents specifically mentioned that older cattle were too tough and they therefore preferred the younger animals. The findings indicate that the decision to sell mainly older oxen to the abattoir is most probably a combination of several factors within the general production system, rendering farmers uncomfortable with selling younger animals, and/or a poor understanding of market preferences and maximum yield. These perceptions of farmers regarding sale preferences and meat quality, although tested in very simple and general terms, do indicate that targeted interventions aimed at improving perception around marketing and meat quality is required if different carcass grades are required by markets – especially that of Meatco.

The cattle types preferred by cattle farmers were strongly reflected in the carcass types and grades received by the Meatco abattoir namely that C-grade oxen dominated the carcasses slaughtered throughout the year. The extent of the fluctuation in carcass weight and price over seasons suggested that farmers were unable to buffer the impact that the natural fluctuation in rangeland quality and quantity has on carcass quality and weight. Commercial farmers and feedlots invest significantly in supplementary feeding or conditioning of animals prior to slaughter in order to maintain carcass quality, and hence profit, across seasons. In the ZR cattle are marketed directly from the rangelands, from where they are trekked on foot to one of the two quarantine stations near Katima Mulilo. The cattle remain in natural pastures (camps) in the quarantine station for 21 days prior to slaughter. The quality of the grazing in the QCs is variable, but despite having sufficient grazing in many instances (Rothauge, 2014), the period of grazing is too short for the cattle to improve – especially in the dry season – without the supplementation of at least some concentrates. The apparent inability of the pastoral farmers to buffer the effect of natural fluctuations in forage quantity and quality was substantiated by the observed decline in carcass fatness over the same period as when carcass weight and price declined. These declines coincided with the onset of the dry season and an observed drop in the vegetative greenness of the ZR (Appendix 10). At the onset of the dry season in semi-arid grasslands, growth typically ceases and the sward quality is known to decline significantly in terms of digestibility, palatability, and greenness - most notably through the process of lignification (Tainton, 1999).

The net population size of cattle in the ZR has fluctuated between approximately 156 380 and 128 900 animals in recent years (2005-2012). Before that the cattle population in the ZR grew rapidly from an estimated 50 000 animals in the 1970s to approximately 120 000 in 1996 (Mendohlson and Roberts, 1997), and then onwards to approximately 150 000 in the mid-2000s. The increase in cattle numbers in the ZR up to the mid-1990s, according to Mendohlson and Roberts (1997), was mainly linked to the removal of disease burdens, particularly *Pasteurellosis,* through successful vaccination campaigns. Secondly, cattle numbers increased due to the generally lower river levels, and reduced flooding at that time provided more access to pastures on the floodplains and supported higher production and survival rates – especially in the dry season, when forage availability would otherwise have limited animal survival (Mendohlson and Roberts, 1997; Pricope and All, 2012). The cattle population has since, over the last ±8 years, fluctuated around a mean of approximately 144 740 animals (8 years up to 2012). The two years after 2005 in which the cattle population of the ZR dropped below the mean size coincided with below average rainfall periods. In 2007 the total precipitation[14] (665.2 mm) in Katima Mulilo was 14.7% lower than the 6-year mean precipitation (779.6 mm), which was also the lowest from 2004 to 2009. The mean precipitation during the 2010-2011 rainfall season (October 2010 to April 2011) was approximately 120 mm lower than the long-term normal, and the lowest between 2009 and 2013 over the same period (Coetzee, 2013). Rainfall has been found to have an influence on cattle populations in similar pastoral systems elsewhere (Angassa and Oba, 2007; Van Schalkwyk, 2015), albeit not always significant (Kgosikoma and Batisani, 2014). Importantly, Van Schalkwyk (2015) found that vegetative productivity as measured by the mean NDVI (Normalised Difference Vegetation Index) as well as rainfall had a significant 3-month lagged effect on cattle conception rates in a communal pastoral system. Furthermore, his results showed that in areas with significantly higher mortality rates, the mean precipitation and NDVI of the preceding season were also significantly lower than in other areas. Our observations in the drop in cattle populations linked to below average rainfall periods, and the recovery of such a population between below average rainfall periods, is typical of a population at its ecological capacity (Tainton, 1999; Bothma, 2002; Angassa and Oba, 2007). It is also indicative that the farmers in this system are unable to buffer the effects of poor grazing conditions with, for instance, supplementary feeding, as has been observed elsewhere (Angassa and Oba, 2007; Kgosikoma and Batisani, 2014).

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[14] Namibia Meteorological Services, Katima Mulilo: www.meteona.com – accessed 07/12/2015

The significant variation in cattle numbers as well as cattle density across the vegetation types of the ZR confirmed the importance of accounting for landscape heterogeneity when optimal stocking rates for an area are considered (Campbell et al., 2006; Rinella et al., 2011). Previous estimations of the carrying capacity for the ZR (Mendohlson and Roberts, 1997; Mulonda, 2011) did not account for the uneven distribution of cattle across the landscape, nor for the fact that significant parts of the overall rangelands were either not available for grazing (conservation areas) or were most likely outside normal range for most of the ZR cattle. In pastoral systems cattle distribution is closely linked to the distribution of people/communities (Van Schalkwyk, 2015) and the observed cattle distribution in the ZR coincided with the distribution of people (Mendohlson and Roberts, 1997). The distribution of people in the ZR is in turn largely linked to the distribution of perennial surface water and not necessarily the distribution of grazing. This was confirmed by the significant portions of grazing that were situated outside the estimated range of cattle, which were also void of residential communities and cattle inspection points. Reliable sources for surface water are more readily available on the floodplains than in the dry, sandy Kalahari and Mopane vegetation regions, in which open surface water is limited to the rainy season when rain temporarily accumulates in 'dambos' (natural pans/depressions) (personal observations, 2011-2014). The results indicated that, even when the grazing capacity of the entire ZR was considered based on net forage production, the reference population size in most instances did not significantly exceed the carrying capacity. However, even when the net carrying capacity was sufficient, the carrying capacities (most commonly on the floodplains and to some extent in the Mopane woodlands) were significantly exceeded. Furthermore, portions of up to 80% of the floodplain can be considered overstocked at times despite the fact that at the overall level throughout the ZR forage production seemed sufficient to support the stocking rate for up to 8 months. Similar findings were reported by Rinella et al. (2011) who indicated that specific areas in a natural rangeland grazed by cattle in their study were overgrazed, despite the availability of forage in other areas. In their study they did not link the phenomenon to water distribution but rather to the entry point of cattle into the pasture and especially the homing nature of cattle. GPS data (Rinella et al., 2011) and earlier observational studies (Gillen et al., 1985; Howery et al., 1996) found that cattle established home ranges and remained in these areas despite significantly exceeding the stocking rate as the season changed and the presence of much more grazing available elsewhere. Gillen et al. (1985) specifically reported that in their experiments, cattle occupation patterns for specific rangelands did not respond to seasonal variations or to forage utilisation. These studies reported that cattle reduced their intake (to the detriment of production) rather than moving outside their preferred grazing areas (home ranges) to forage elsewhere. The only time cattle adjusted their home range was when water availability necessitated this in the dry season (Howery et al., 1996). Entry point into a pasture has been found before to have had a significant impact on cattle distribution, in that areas in the immediate vicinity of a pasture's point of entry were grazed immediately whilst it took up to 14 days for cattle to occupy more distant areas (Gillen et al., 1985). This behaviour will be more pronounced in pastoral areas such as the ZR, where most cattle are returned overnight to kraals in the villages. Cattle disperse from villages to grazing areas every morning, grazing as they go along. Invariably higher grazing pressure will be exerted on rangelands in the vicinity of villages, where signs of overgrazing will be most pronounced. This grazing-piosphere effect (gradual improvement of grazing conditions away from a central point of aggregation, such as a village or kraal or waterhole) was demonstrated in the findings of Rothauge (2014) in the quarantine stations of the ZR. Cattle in the quarantine camps are still kraaled every night, from whence they disperse into a specific grazing camp every morning. The veld conditions in the distant plots were significantly better than in the proximate sites (close to the kraal) (Rothauge, 2014). The persistent higher grazing intensity in areas near villages in the ZR will have a most severe impact on herbaceous biomass production even if grass composition is not altered (Kgosikoma et al., 2013). In the floodplains of the ZR, where the estimated carrying capacity is most severely exceeded in the ZR, according to our findings, the recent spatial analysis of satellite imaging over a 15-year period indicated a significant decline in veld condition and productivity (Pricope and All, 2012). Pricope and All (2012) indicated that the comparison of NDVI values and parameters on the eastern floodplains of the ZR of both 1992 and 2007 placed mean-variance analysis in the sector of low vegetation cover and high variance of the surface cover, which were all indicators of vegetation degradation. They also found that over the last 10 years of the study the decline in flood extent and increase in fire frequency on the eastern floodplains caused a gross decline in vegetative productivity. However, they did quantify the potential impact of herbivory as a confounding factor in the observed degradation. This paper argues that persistent excessive herbivory on the floodplains, the extent of which will fluctuate according to natural cyclic vegetative activity, might have been a confounding factor in their observations. One should also consider the known negative impacts consistent, excessive grazing pressure (and trampling) can have on sward vigour and recovery, if pastures with high residential herbivore densities are burned at the wrong frequency and time of year (Tainton, 1999). However, McGranahan and Kirkman (2013) strongly recommend the increased application of patch burn-grazing management in southern African communal systems as a means to increase landscape heterogeneity, arguing that it can result in resilient ecosystem services for both people and animals. In certain areas of the eastern ZR, such as the Linyanti area, Pricope and All (2012) did find increased vegetative productivity linked to increased fire frequency. Although burning may temporarily alleviate the grazing pressure in some areas through green flush, in large parts of the eastern floodplains the vegetation has reacted negatively in recent years to the way burning is applied (Pricope and All, 2012). We argue that the increase in the use of burning to stimulate grazing may well be due to desperate coping mechanisms employed by farmers in the wake of reduced resource availability due to land degradation (Pricope and All, 2012), and confounded by spatial and temporal fluctuation in excessive grazing pressure in large parts of the eastern floodplains.

In our study a potential gradual decline in biomass production away from villages (crush-pens) was not considered, due to a lack of data with which to account for such changes. However, the distribution of cattle, and hence grazing intensity, was included, and did reveal that grazing capacity was significantly exceeded by the stocking density, mainly in areas in proximity to villages. This was more pronounced in instances where low biomass availability was used in the model, which resulted in a significant increase in the number of cattle overstocking the area as well as a substantial increase in the amount of rangeland being overstocked. Our results indicate that cattle will compromise intake and production in most of the available grazing areas for large parts of the year, most notably in the floodplains but also in the Mopane woodlands. This effect will be least severe in the Kalahari woodlands, where the stocking rate relative to the biomass availability (carrying capacity) is most favourable.

Our results indicate that cattle with the requirements as defined in animal model A1 would be under significant nutritional stress during periods of mean to low biomass availability. At the population level, and the carrying capacity based on the requirements of animal model A1, the cattle population of the ZR will have to reduce intake to the level of animal model A2 in order to prevent the population from declining below its lowest medium-term range. The fact that the population declined as it did in 2011 suggests conditions where low rather than mean forage production levels resulted in severe cattle losses. Our data indicated that such losses would have been most severe in the floodplains. If the period of biomass production is delayed up to a full year, the population could crash, unless most are able to switch either to areas otherwise unoccupied (where substantial amounts of grazing is still available) or to intake and production levels equal to an animal at physiological maintenance level. Our results indicate that the population requirements most likely fluctuate between the production levels of animal models A1 and A2, most notably during periods or in areas with a biomass production level equal to or below the mean measured level used. We argue that the distribution of cattle population estimates of our animal models, in relation to the reference population in mean and low biomass levels, is indicative that these models are reliable estimates of the requirements, as well as the change in requirements, of the cattle population in the ZR. The results indicate significant forage surplus during periods or in areas of high biomass production.

The fluctuation in carrying capacity, based on significant variations in seasonal availability of forage, is something that ranchers adapt to by either stocking conservatively or by stocking opportunistically

(Campbell et al., 2006). Opportunistic stocking, however, requires the ability to effectively and rapidly destock at the onset of a dry period and preferably before cattle start depleting fat reserves ((Campbell et al., 2006; Symons, 2015). This is an unrealistic expectation in rural pastoral communities where farming systems mostly are not market driven, and where sufficient market linkages do not exist (Musemwa et al., 2008). Already, the abattoir in the ZR closes in the late dry season because of poor carcass quality, further limiting off-take during critical periods of fodder availability. Instead, we believe that the cattle population of the ZR fluctuates with carrying capacity as it should with opportunistic stocking regimes (Campbell et al., 2006) but rather from a fluctuation in recruitment and mortality rates than from typical and preferred commercial stocking and destocking activities. To prevent typical animal die-offs during dry cycles as reported in similar systems elsewhere (Angassa and Oba, 2007; Van Schalkwyk, 2015) animals can be actively moved to better pastures or require supplementary feeding (Rinella et al., 2011; Kgosikoma and Batisani, 2014).

Lastly, our results indicate that the estimated number of wild herbivores on the floodplains of the ZR would not make a significant impact on grazing availability if that pressure is distributed in relation to cattle distribution on the floodplains. However, a concentration of the estimated wild herbivores in fewer or a limited number of specific areas on the floodplain could have a significant impact locally, given the fact that under low biomass levels our results did show a significant effect at the 90% confidence interval.

5.5 Conclusions

We argue that the cattle population in the ZR has reached its ecological capacity in recent years under current prevailing environmental conditions, and is subsequently driven by natural fluctuations in resource availability. In the absence of mechanisms with which to adapt stocking rates timeously to spatial and temporal variations in resource productivity, the cattle population exceeds the carrying capacity of the ecosystem during periods of below average rainfall, followed by decreased population productivity and animal recruitment and an increased mortality rate. The subsequent drop in the net cattle population does substantiate the perceptions of the farmers, discussed in previous chapters: that improved grazing and supplementary feeding will improve their farming ability. It is also evident that grazing availability is one of the main constraints to farming in the ZR. We argue that the seasonal drop in animal condition, as shown in the drop in fatness grades of carcasses at the onset of the dry season, is indicative of a beef production system functioning at its ecological capacity. It is further indicative that the farmers in the ZR are not able to buffer a drop in animal condition with supplementary feeding, which results in a substantial drop in carcass weight and income. The ecological capacity reached by the cattle population in the ZR is not only based on the net amount of herbaceous biomass produced, but on the heterogenic distribution of both cattle numbers and biomass production at the local scale. Our results further support the argument against a fixed stocking rate in communal farming systems and across large heterogeneous landscapes (Scogings et al., 1999; Campbell et al., 2006; Vetter, 2013). Rather, appropriate stocking rates should be dynamic, to reflect the fluctuation of climate and vegetation type, herbivore distribution and density, as well as herbivore requirements. We estimate that large areas, especially of the floodplains, are overstocked during periods of average to below average biomass availability. This will, in periods of below average rainfall, force cattle to drop production rates to the point of maintenance levels if necessary, in order to survive and maintain population levels. Such periods coincide with substantial losses in terms of production and in increased mortalities. The forced distribution of cattle in association with human settlements and the need for open surface water renders large parts of grazing areas inaccessible and will probably cause a grazing piosphere that reflects a gradual improvement in veld conditions away from villages and their higher cattle density. This hypothesis will need to be tested through further research.

The question remains: what constitutes 'overstocking' and 'acceptable' stocking rates in extensive, heterogeneous landscapes of communal systems in TFCAs, where complex, multiple land-use systems exist? In some similar, higher rainfall areas, the seemingly overstocked communal rangelands have sustained very high animal biomass densities for extended periods without necessarily reducing rangeland vigour or botanical composition, proving rangelands to be much more resilient and productive than conventional rangeland ecology would dictate (Campbell et al., 2006; Vetter, 2013). Elsewhere, it was shown that the persistently high stocking rates in cattle ranching areas was in fact the reason that the preferred short grass lawns were maintained, albeit at the cost of woodlands and grass cover in some areas (Cingolani et al., 2014). Our study was not necessarily aimed at proposing appropriate stocking rates for the ZR, but rather at indicating appropriate adaptability in grazing and production management so as to buffer negative vegetation impacts as well as negative consequences on cattle production and carcass quality. We conclude that the ZR does have sufficient grazing available with which to sustain the current cattle population as well as wildlife requirements. However, at the current stocking rate and due to the lack of grazing strategies, and in light of a more unpredictable and erratic climate (Thornton et al., 2009; Nardone et al., 2010; Coetzee, 2013) cattle performance will be restricted, and aspirations to increase abattoir throughput (by the abattoir remaining open throughout the dry season) and improved carcass quality should not be expected. The findings highlight the importance of investigating and initiating specific strategies or processes that can make a substantial difference in livestock production and carcass quality, regardless of the resource limitations. Such strategies should primarily be aimed at the optimal utilisation of rangeland resources in underutilised areas within the ZR, or sustainable and feasible cattle finishing schemes in combination in the compulsory quarantine system. Furthermore, we suggest that perhaps the best way to begin implementing interventions would be to invest in approaches that deploy full-time herdsmen trained to adapt grazing plans according to continuous field observations, supported by improved water distribution in inland areas where grazing is rarely accessed. Holistic Planned Grazing is one such system and has proven successful under similar conditions elsewhere (Savory, 1999; Masaire, 2014; Peel et al., 2014). Such a community-driven approach will enable the exploitation of all available grazing areas and should turn the variation in vegetative production across the landscape into an advantage rather than a limitation, by means of continually updated grazing plans and grazing records. Furthermore, the uneven distribution of stocking intensity, which seems to result in consistently high stocking rates in some areas and lower stocking rates in others, could be better balanced through planned herding and grazing to effect sufficient rest, followed by appropriate grazing intensity based on the state and vigour of any particular grazing patch. Such an approach could provide an added advantage in that permanent herdsmen could adapt grazing patterns based on the seasonal distribution of wildlife – especially of disease-carrying buffalo.

Lastly, we argue that our model outputs, albeit sufficient for the purposes of this study, can be improved with expanded and more spatially representative measurements of forage availability as well as its spatial and temporal fluctuations. The use of technology such as devices fitted with global positioning system (GPS) receivers, carried by herdsmen or fitted to cattle collars (Van Schalkwyk, 2015), should improve our understanding and estimation of the spatial and temporal distribution of cattle in the ZR. Furthermore, the conversion of the spatial layers used in the KDE to a raster followed by the use of density per pixel of certain size instead of density polygons as was used in this analyses, may offer model outputs with more variation for improved statistical analyses.

6 AN ANALYSES OF THE FORMAL BEEF TRADE IN THE ZAMBEZI REGION AND ITS ACCESSIBILITY AS INFLUENCED BY SPATIO-TEMPORAL PARAMETERS AT THE WILDLIFE-LIVESTOCK INTERFACE

6.1 INTRODUCTION

It is widely recognised that market access is essential for economic growth and income generation in a country or region. In developing countries where poverty alleviation is generally regarded a top priority, it is mainly the agricultural sector that has received unrivalled attention in terms of market access (Van Schalkwyk et al., 2012). This is mainly because agriculture remains one of the dominant sectors in developing countries in terms of national wealth and employment; and because, in at least the short term, efforts to expand employment opportunities are mostly focused on agriculture in the absence of meaningful opportunities in other sectors (Van Schalkwyk et al., 2012).

There is an important link between sustainable rural development, poverty alleviation, and market access. The World Bank regards pro-poor market development as an essential element of community empowerment, in terms of which a higher income brought about by improved market access is regarded as essential (Binswanger-Mkhize et al., 2009). Such market development requires pro-market policies that enhance the capacity of poor people to benefit from participation in provincial, national, and global markets. This will only be achieved if good macro-economic and sectorial policies exist, as well as good governance and enforcement of rights that could encourage entrepreneurship (Binswanger-Mkhize et al., 2009). The World Bank sourcebook for empowerment and poverty reduction classifies pro-poor market development according to three categories (Deepa, 2002): access to information, inclusion/participation, and local organisation capacity. The sourcebook further emphasises that the macro-economic climate of an area needs to favour job creation and enterprise development, and that economic growth will not be sustainable if poor individuals are excluded from optimal engagement in productive activities. Pro-poor market development therefore requires bottom-up liberalisation of governance and resource control, through which poor individuals can attain equitable access to economic opportunity (Deepa, 2002; Swinnen and Maertens, 2007; Fowler and Brand, 2011). This is often not the case due to regulatory barriers; lack of information, connections, skills, credit, organisation as well as discrimination (Fowler and Brand, 2011). A market-oriented approach is therefore recommended and considered critical so as to avoid unsustainable and ineffective development programs (Deepa, 2002).

The risk of marginalisation, especially of small farmers and poor households, brought about by the requirements of high-value supply chains, poses important challenges in developing countries: where there is a substantial heterogeneity in farm structures and where there is a mixture of large, medium and small farms/farmers (Swinnen and Maertens, 2007). Equity that is brought about by ensuring the participation of rural farmers in high-value supply chains and the equitable distribution of benefits is therefore a concern for pro-poor development initiatives (Swinnen and Maertens, 2007).

Any obstacle in the way of a producer who hopes to gain market access is regarded a trade barrier. A trade barrier can be defined as being any inhibition to the entry to markets, and could include advantages given to other producers as well as specific disadvantages experienced by the poor in their attempts to enter the market (Ramsey and Morgan, 2009). Either way, barriers to market access are located within a complex collection of social, economic, and physical interactions – all embedded in a specific political environment (Ramsey and Morgan, 2009). If the complex of barriers that contribute to poverty and the lack of market access are not addressed effectively, it can cause the poor to be trapped in poverty. Poverty traps are defined as any environment in which poverty persists despite periodic relief (Carter and Barrett, 2006). Improved access to markets and the improved valuation of the asset base of poor farmers is critical for breaking out of poverty traps (Carter and Barrett, 2006). Similar emphasis is placed on improved market access regarding the role livestock could play as a pathway out of poverty in many developing countries (Rota and Sperandini, 2010).

In order to address barriers to trade and market access effectively, there is an urgent need for empirical data and comprehensive information on the actual circumstances under which small-scale farmers operate, and the multiple constraints they face in order to develop effective pro-poor policies (Van Schalkwyk et al., 2012). In this respect, understanding how a livestock market system works is a fundamental step towards developing policy, because policy can have either a positive or negative impact on market access (Ramsey and Morgan, 2009). Herr and Muzira (2009) as well as Nutz and Sievers (2015) have emphasised that it is essential for successful and sustainable market development that market research and analysis identify the underlying systematic causes of bottlenecks, understand market relationships, understand policy frameworks governing value chains, as well as identify incentives for market participation. In the context of the wildlife-livestock interface and for the successful development of vast transfrontier conservation areas (TFCAs) in southern Africa, sustainable land use practices and local economic development, compatible and even complementary to the conservation of biodiversity and associated economic activities, are regarded as two of the most important priorities (Osofsky et al., 2012; Cumming et al., 2013). The largest TFCA in the region, the Kavango-Zambezi (KAZA) TFCA, includes the ZR of Namibia in its entirety. In this area, beef production is an essential livelihood strategy (Nuulimba, 2012) and the successful development of the livestock sector and its compatibility with wildlife conservation can therefore be regarded as critical to the sustainability of livelihoods as well as biodiversity conservation in the ZR (Thomson et al., 2013a).

Several studies in recent years have aimed at identifying and prioritising the limitations and constraints of the beef market systems in the northern communal areas (NCAs) of Namibia (Duvel and Stephanus, 2000a; Duvel and Stephanus, 2000b; Kirsten, 2002; Shiimi et al., 2010; Hangara et al., 2011; Thomas et al., 2014). However, only two recently included the ZR in their analyses (Paskin and Hoffmann, 1996; Thomas et al., 2014). Previous studies, including that of Thomas et al. (2014) mainly collected data through questionnaire and interview instruments, after which a range of statistical models were deployed in order to try and understand the factors that determine or influence individual farmers' decisions and preferences in terms of market type, market participation, and trade volume. In many instances, especially in the case of the two studies previously conducted in the ZR, sample sizes were very small (n=60 surveys throughout the ZR by Paskin and Hoffman (1996), and n=50 surveys throughout the ZR by Thomas et al. (2014)). Although valuable contributions to our understanding of market systems in the ZR were made by these studies, their relevance to the entire beef system, especially that of the formal trade system in the ZR, is therefore questionable. This is especially true in light of the significant level of complexity that seems to be involved in farmers' decisions when it comes to beef trade, as highlighted by Shiimi et al. (2010), and the vastness and diverse nature of the ZR itself.

The focus of this part of the research was therefore mainly on the formal trade system in the ZR, in an attempt to identify important trade barriers representative of the entire ZR. Spatial data in terms of where all cattle were sourced were recorded for the first time by the Meatco abattoir in Katima Mulilo in 2011, and this data, together with cattle population data recorded by state veterinary services, provided an opportunity to investigate important spatial and temporal patterns in the trade system. Because both the quarantine stations are situated in proximity to Katima Mulilo and are only approximately 40km apart, special emphasis was put on the role that distance from the quarantine facilities may have had on market access and trade volume. Other spatial attributes of environmental and conservational importance, which emanated from earlier papers in this thesis, such as cattle-buffalo contact, vegetation type, and FMD outbreaks, were included in order to ascertain their relevance to the formal beef trade system. A range of spatial and temporal variables were included in several generalised linear models, and reduced backwards in order to identify the most important variables that influenced formal trade at crush-pen level in the ZR.

6.2 Study Area

The study areas included in the analyses of this chapter were the ZR and MCP study areas, described in Chapter 2 of this thesis.

6.3 Materials and Methods

6.3.1 Perceptions of trade barriers

Farmers' perceptions of the challenges they face in accessing mainly the formal beef market (Meatco) in selected areas in the ZR were captured during the semi-structured interviews as described in Chapter 2.

6.3.2 Spatio-temporal trends in formal sale and off-take rates

Data preparation

In order to calculate basic parameters of trade activity as well as important spatio-temporal trends, data from the Meatco abattoir and the state veterinary office in Katima Mulilo was sourced and analysed. In January 2011 the Meatco procurement office (for the first time) started to record the locations from which cattle were sourced. Cattle and owner numbers per crush-pen were captured in November 2011 by state veterinary services during their biannual FMD vaccination campaign. All information pertaining to trends of sales by farmers to the Meatco abattoir (KM) was obtained from the procurement office of the abattoir. All mapping and GIS-related analyses were conducted using ArcGIS's ArcMap version 9.3 and associated software packages. Distance calculations between crush-pens and quarantine stations were performed using Hawth's Analysis Tools[15] for ArcGIS; Spatial projection: WGS 1984 UTM 34S. Most GIS layers were either created during the study or downloaded from reliable open-access resources. Crush-pen locations were mostly obtained from the Department of Veterinary Services, Namibia. Additional point locations were individually obtained using either a GPS or sourced through software and online resources, such as Garmap Southern Africa Topographical Map version 2011.2 in MapSource (Garmin MapSource version 6.16.3). Some spatial data for specific crush-pens was obtained from the WAHID Interface[16] of the OIE (World Organization for Animal Health).

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[15] Hawth's Analysis Tools: http://www.spatialecology.com/htools/overview.php – accessed 10/03/2016

[16] World Animal Health Information Database (WAHID): http://www.oie.int/wahis_2/public/wahid.php/Wahidhome/Home – accessed 10/03/2016

A linear distance calculation was performed between each crush-pen with confirmed coordinates (n=117) and the intake gate of each of the two quarantine stations (QSs) in the ZR, Katima QS, and Kopano QS. A total of 142 crush-pens were included in the 2011 census of DVS, but not all collection points were geo-referenced and traceable. The sample size of crush-pens included in the analyses were therefore 82% of the total number of crush-pens in the ZR. In some analyses further data was included; and the additional cleaning of possible errors in values for some variables, or data outliers, reduced the sample size to 108 crush-pens (76%). The 108 crush-pens thus used in analyses represented 83.8% of the cattle population as per the 2011 census, and 85.5% of the total number of cattle procured by the Meatco abattoir in 2011. To determine the role distance between a crush-pen and a quarantine facility as played in the ZR, the linear distances between each crush-pen and each of the two quarantine camps (QCs) were used instead of distances via road. This was done because most farmers, in the absence of barriers such as fences throughout most of the ZR, took short cuts as far as possible when they trekked their cattle to quarantine camps. Cattle procured by Meatco from areas outside the ZR were not included in the analyses.

Statistical analyses

A combination of continuous and categorical variables was used in all statistical analyses. If the distribution of a variable tested normal, parametric statistical analyses were used and mainly consisted of Pearson's correlations and ANOVA analyses to test for significant differences between variables. In some instances, data was log-transformed in order to include it in parametric analyses. Many of the variables were, however, not normally distributed; in which case non-parametric analyses were performed, which mainly consisted of Spearman's Rho correlations, as well as Mann-Whitney Tests or non-parametric Paired Sample T-Tests to test for significant differences between variables.

Cohen's standard was used to interpret the strength of a relationship between variables using either Pearson's or Spearman's Rho correlations, where: $0.1 < r < 0.29$ is considered a weak relationship, $0.3 < r < 0.49$ a moderate relationship, and $r > 0.5$ a strong relationship (Cohen, 1988). Interpreting results not only based on its statistical significance but also the effect size of especially relationships is regarded important for the practical relevance and comparability of results (Kortlik et al., 2011).

Tests for significance were conducted at a 95% confidence interval, unless states otherwise. Means were provided followed by the standard deviation (SD).

In order to test whether or not distance from a quarantine station did play a role in the level of off-take at crush-pen level, and whether there was a threshold distance at which point distances were most likely playing a role, the following hypothesis was constructed:

- A null hypothesis (H_0): The number of cattle sold and the off-take rate at a crush-pen by beef producers in the ZR is not negatively influenced at any distance away from a QS; and that no threshold distance at which point distance exerted the most significant effect on these parameters, existed,
- The alternative hypothesis (H_1): The specific distances do have a significant negative effect on the number of cattle sold and off-take rate at a crush-pen and that a threshold distance at which point distance played a most significant role in the number of cattle sold or off-take rate at a crush-pen therefore existed.

The null hypothesis related to the influence of distance to a QS on sale and off-take rates at crush-pen level was tested by calculating the correlation coefficient between crush-pen and QS distance and its relationship to total sales and off-take rates as recorded per crush-pen. In order to ascertain at what point the distance from a QC had the strongest relationship with sale and off-take rates at crush-pen level, correlation analyses were performed at subsets of data progressively reduced by distance increments of 5km per subset. In other words, the relationship was tested between the distance from a crush-pen starting with a data subset of all crush-pens further than 5km away from each QC, then further than 10km, 15km, etc., until 75km. Beyond 75km the sample sizes (number of crush-pens) became too small for meaningful analysis using parametric techniques for normally distributed data. Pearson's correlations were used because distance was normally distributed between crush-pens and each QC (Kolmogorov-Smirnov: P>0.1). Sales and off-take rates were log-transformed to produce a normal distribution for inclusion in the Pearson's correlations. The correlation coefficient is an indication of the strength and direction of a relationship, and was therefore used to indicate the distance beyond which the relationship between distance and sales or off-take rate was the strongest, the most significant, and in what direction. The statistical software package IBM SPSS Statistics versions 23 (IBM Corp. © 1989) was used for all descriptive and inferential statistics.

Data for crush-pens where previous FMD outbreaks had occurred in recent years (2007-2010) in the ZR was obtained from the World Animal Health Information Database (WAHIS) Interface of the OIE (Appendix 11). High-risk buffalo contact areas were estimated by means of buffalo distribution maps (Chase, 2007; Chase, 2009; Atkinson, 2011). Crush-pens within areas where buffalo have been observed were regarded as areas with a high likelihood of buffalo contact, and crush-pens outside of buffalo range, according to available sources, were regarded as having a low likelihood of buffalo contact.

In order to determine which variables included in the analyses had the most significant influence on off-take rate at crush-pen level, a generalised linear model (GLM) was employed by using SAS statistical software version 9.4 (© SAS Institute Inc.). A GLM was used instead of a linear regression because with a GLM the outcome variable can be modelled with categorical independent variables. In the model use in this chapter the dependent variable (off-take rate) was continuous and the independent variables consisted of both continuous and categorical variables, making the GLM more appropriate. The independent variables included in the model are presented in Table 6-1. In this model, a backward stepwise regression approach was used by eliminating the variable with the highest non-significant p-value in each step before re-running the model. Steps were repeated until variables with the most significant effect on the variance of the dependent variable were retained.

Table 6-1: The independent variables and their properties that were included in the generalised linear model in which off-take rate was the dependent variable

Independent variable	Properties
Distance to Kopano QC	Continuous variable of linear distance (km) from each crush-pen to the intake gate at the Kopano QC.
Distance to Katima QC	Continuous variable of linear distance between each crush-pen and the intake gate at the Katima QC.
Number of cattle owners per crush-pen	Continuous variable, recorded number of cattle owners record per crush-pen in 2011.
Number of cattle per crush-pen	Continuous variable, total number of cattle recorded at each crush-pen in 2011.
Vegetation type	Nominal variable indicating the presence of each crush-pen in one of the four main vegetation types of the ZR.
Stocking rate	Categorical value, which indicates the presence of a crush-pen in either an under-stocked, over-stocked or optimally stocked area in the ZR. Data from Chapter 5 was used, where all biomass production levels for animal model 2 were used to indicate upper and lower thresholds of stocking rates (Chapter 5).
Buffalo contact	Nominal variable, which indicated either presence or absence in an area where there is a relatively high-risk of buffalo contact based on all available buffalo distribution maps.
FMD occurrence	Nominal variable, which indicated whether or not each crush-pen has had an FMD outbreak since 2007 to the time of the study (November 2011).
Conservation status	Nominal variable, which indicated presence/absence in an established community conservancy.

6.4 Results

6.4.1 Perceptions: constraints to market access and the quarantine system

Farmers (n=44) were asked, during semi-structured interviews by means of an open-ended question, to list and explain the challenges they experienced during marketing or trading cattle in their areas of the ZR .

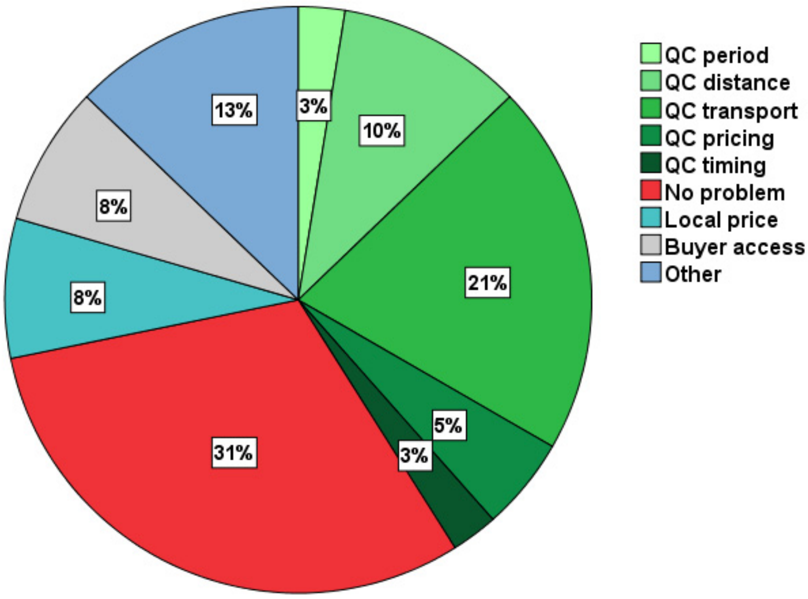


Figure 6-1: A categorical summary of the challenges farmers experience in accessing markets in the ZR. The frequency of responses per category is provided as an overall percentage. Different shades of the same colour represent a particular theme of associated categories. QC – quarantine camp. Percentages rounded off to nearest tenth

In total, 31% of the respondents did not have any issues with market access and were generally satisfied with either market access or the selling price when they sold cattle (Figure 6-1). The remaining 71% of the respondents identified a range of constraints to market access and trade in their areas. In this regard, 42% of the respondents emphasised various issues pertaining to the quarantine system (indicated in shades of green in Figure 6-1) of which 'distance' (10%) and 'transport' (21%) were the most prominent. One respondent summarised what most respondents said in relation to the distance to the quarantine camps: "*The problem is the distance to Meatco. We need to hire somebody and feed them [herdsmen]. These are all expenses that reduce the profit. The price is good but the expenses reduce the profit. It takes us 2-3 days of walking to the quarantine camp*" (Interview 21). This particular farmer was based in Mbambazi, Sangwali area, approximately 125km from the Katima quarantine camp. Farmers also had to pay herdsman to look after their cattle in the quarantine camp for the 21-day quarantine period. Although farmers often clubbed together to reduce herdsmen costs, such costs still affected profit margins. In an interview during a visit to the Kopano quarantine station in April 2011, a farmer said that herders generally charged N$250 per day to drive the cattle to the quarantine camp. Then they still had to be paid for or supplied with food during the 21-day quarantine period.

A total of 8% of the respondents either mentioned problems associated with accessing local buyers, or the often lower price they received for animals from local buyers compared to what Meatco offered.

Since it seemed that quarantine requirements were seen as a constraint by many respondents in terms of market access, it was regarded as important to understand their perceptions and level of understanding of the quarantine system. A range of open questions was subsequently asked in this regard of all respondents except those that did not have any problems with market access: 50% of the respondents didn't mind the quarantine process as such. Some felt that their animals gained weight during the quarantine period and others merely said that they did not have any other choice but to go through the process. The other 50% of the respondents who indicated that they did mind the quarantine system mostly mentioned the costs associated with driving cattle, or expenses associated with the herdsman that had to look after cattle in the quarantine area, as reasons for minding the quarantine process. Fear of theft was mentioned as one of the reasons why cattle had to be looked after in a quarantine camp. Similarly, some farmers were not happy with the fact that all the risk was theirs during the quarantine period. They had to go through the process, incur all the extra costs, as well as carry the risk if animals were either stolen or died during the process - all of which seemed unfair to them.

When the farmers that do sell to Meatco were asked if they understood why they had to put their animals in a QC, 81% said that they did understand why they had to do so. However, when asked, the reasons they gave were mostly related to the fact that they saw the QC as a place where animals first had to gain weight before they were slaughtered. Some farmers mentioned that it was an area without diseases where their animals could be kept, or that they first had to receive treatments there. Only one farmer said that it took 21 days before they (officials) could see that the animals were not diseased.

6.4.2 Variation in abattoir throughput

From the years 2007 to 2011 the Meatco abattoir was open 51.2% (43/84 months) of the time, and closed for 48.8% of the time (41/84 months). The closures were mainly as a result of lengthy FMD outbreaks in 2007, 2010, and at the end of 2011, but also due to the poor quality of carcasses in some years and seasons, which forced the abattoir to close. From 2010 to 2013 the ZR experienced an FMD outbreak every year. The movement of all cloven-hoofed animals is strictly regulated throughout the ZR because it is an FMD-infected zone, and should an FMD outbreak occur all movement of cloven-hoofed animals is banned. As a result, the Meatco abattoir closes for months at a time during and after an outbreak, until the outbreak is declared officially over.

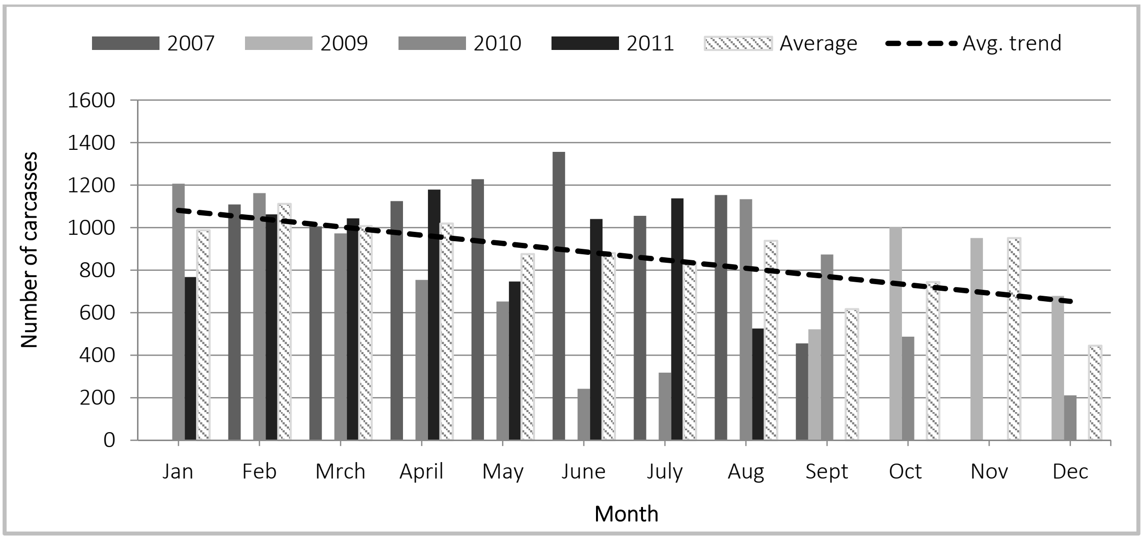


Figure 6-2: Total monthly sales (number of cattle) to the Meatco abattoir at Katima-Mulilo (2007-2011)

The trends in terms of total monthly cattle sales to the Katima abattoir over five years in the ZR (2007-2011) do indicate a general reduction from January to December despite some variation between some months (Figure 6-2). There was a significant negative relationship between total monthly sales and the month of the year progressing from 1 (January) to 12 (December) (Spearman's Rho non-parametric correlation: r=-0.465, P=0.008). The mean number of carcasses slaughtered monthly from 2007-2011 at the Meatco abattoir in Katima Mulilo per wet and dry season[17] was 849 (SD 319.5) and 746.7 (SD 365), respectively, and did not differ significantly (Mann-Witney U = 95, P=0.341, two tailed) (Figure 6-3). There was also no significant difference between the median wet and dry season slaughter numbers for the year 2011 alone (Related Samples Wilcoxon Signed Rank Test, P=0.757). However, the abattoir did operate for only 45.2% of the months in the wet season from 2007-2011, and for 57.1% of the dry season over the same period.

[17] Wet season (summer): November-April; Dry season (winter): May-October

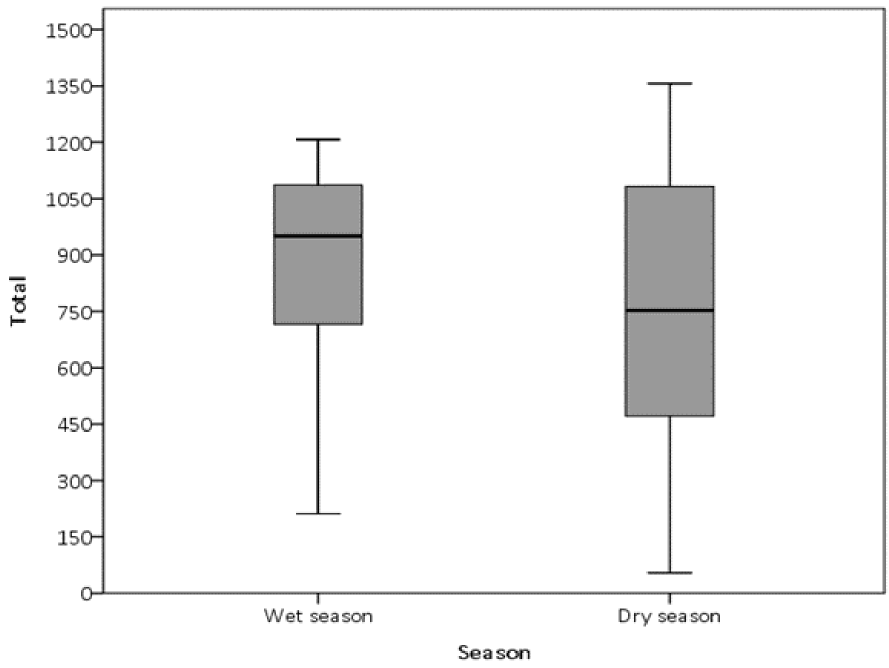


Figure 6-3: A box plot (minimum, first quartile, median, third quartile, and maximum) of the number of carcasses slaughtered monthly at the Meatco abattoir in both the wet and dry season (2007-2011)

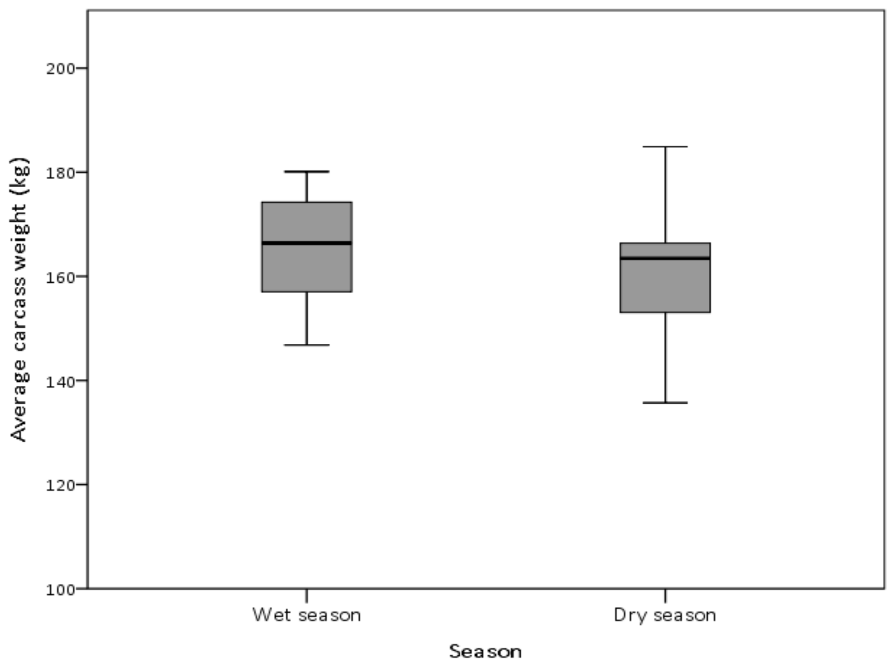


Figure 6-4: A box plot (minimum, first quartile, median, third quartile, and maximum) of the average weight of carcasses slaughtered monthly at the Meatco abattoir in both the wet and dry season (2007-2011)

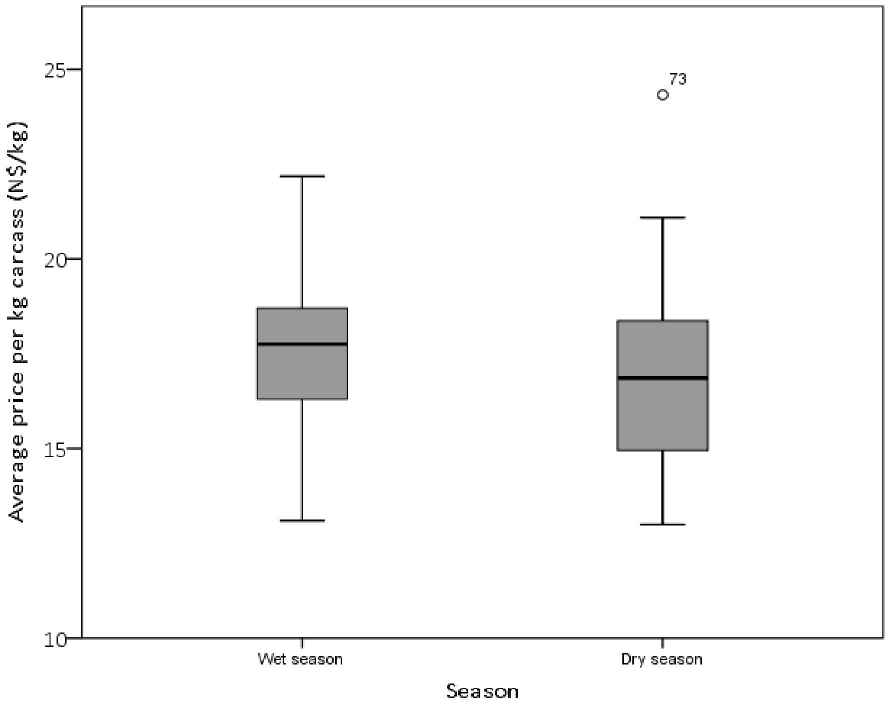


Figure 6-5: A box plot (minimum, first quartile, median, third quartile and maximum) of the average price per kg paid to farmers on a monthly basis at the Meatco abattoir in both the wet and dry season (2007-2011)

By using the monthly averages for the number of carcasses slaughtered, the average carcass weight, and the average price paid per kg, an estimated total loss of income by farmers due to the abattoir closures from 2007-2011 was calculated. The loss of income to farmers was calculated as follows: 41 months closed, x N$17.20 per kg, x 792 carcasses on average per month x an overall average carcass weight per month of 162.78kg. The total potential amount of money not paid out to farmers due to frequent abattoir closures amounted to a total of N$90 875 949 over five years, or N$18 175 190 on average per year.

6.4.3 The effect of distance and season on formal trade

A summary of the descriptive statistics of formal trade and cattle ownership at crush-pens in the ZR east of the Kwando River is provided in Table 6-2. The mean number of cattle at crush-pens sampled was 1 020 (SD 554) and ranged between a minimum of 103 cattle at a crush-pen and a maximum of 2 975 animals. The mean number of cattle owners with cattle registered at crush-pens was 21 (SD 10) and the mean herd size was 50.5 (SD 24.6) animals. A mean number of 55 (SD 76) cattle were sold to Meatco at sampled crush-pens in 2011 at a mean off-take rate of 6.16% (SD 8.56%). The maximum number of cattle sold at a crush-pen was 431 animals and the maximum off-take rate was 46.8%.

The mean distance between Katima QC and crush-pens (n=117) was 56.4km (SD 28.9); and in the case of the Kopano QC (n=117), 58.7km (SD 25.7). The maximum distance to a crush-pen from the Katima QC was 110 km and to the Kopano QC was 121km. The nearest crush-pen was 3km away in both instances. The difference in the mean distance (linear) between crush-pens and each of the two QCs was not significant (Paired sample T-Test: t=1.349, P=0.180, two tailed).

Table 6-2: The descriptive statistics of the number of cattle sold, number of cattle owners, number of cattle, offtake rate (%), and the average herd size at crush-pens, as well as the distance between crush-pens and each quarantine camp (QC) in the ZR for the year 2011

Statistic	Animals sold	No. of owners	No. of cattle	Off-take (%)	Herd size	Distance to Katima QC (km)	Distance to Kopano QC (km)
N	108	105	106	105	104	117	117
Mean	55.3	21.3	1 020	6.16	50.5	56.4	58.7
Std Deviation	76.1	9.99	554	8.56	24.6	28.9	25.7
Minimum	0	3	103	0	18	3	3
Maximum	431	56	2 975	46.8	153	110	121
Sum	5 969	2 239	108 116	-	-	-	-

Notes: *Off-take calculated as no. of animals sold/no. of cattle at a crush-pen. Herd size calculated as no. of cattle / no. of owners at a crush-pen.*

The relationship between the number of cattle sold at a crush-pen and the distance to both the Katima and Kopano QCs was negative and weak (Spearman's Rho: r=-0.218 (Katima) & -0.204 (Kopano)), yet significant (P=0.023 and P=0.035, respectively) (Table 6 3).Similarly, the relationship between the off-take rate at a crush-pen and its distance to each QC was also negative and weak (r= -0.17 (Katima); r= -0.232 (Kopano)), but only significant for distance to the Kopano QC (P=0.017). Off-take rate per crush-pen was highly correlated with the number of cattle sold per crush-pen (r=0.917, P<0.001), but not with the cattle numbers at a crush-pen (P=0.388). There was a weak yet significant relationship between the number of cattle at a crush-pen and its distance from the Kopano QC (r=0.194, P=0.046), but not the Katima QC. There was a strong positive association between the number of cattle and number of owners at a crush-pen (r=0.644, P<0.001). The relationship between the number of cattle sold at a crush-pen and the number of owners at a crush-pen was also positive and significant (r=0.239, P=0.014).

Table 6-3: Relationships (Spearman's Rho) between the distance to quarantine camps (QC), number of cattle sold, off-take rate, number of owners, herds size, and the number of cattle at a crush-pen in the ZR, 2011

Variable	Statistic	Katima QC	Kopano QC	Tot. sold	Offtake rate	No. of owners	No. of cattle
opano QC	r-value	.798*					
(n=108)	p-value	.000					
Tot. sold	r-value	-.218*	-.204*				
(n=108)	p-value	.023	.035				
Offtake rate	r-value	-.170	-.232*	.917*			
(n=105)	p-value	.083	.017	.000			
No. of owners	r-value	-.005	.080	.239*	.008		
(n=105)	p-value	.958	.415	.014	.938		
No. of cattle	r-value	-.075	.194*	.243*	-.085	.644*	
(n=105)	p-value	.442	.046	.012	.388	.000	
Herd size	r-value	-.108	.142	.087	-.108	-.144	.626*
(n=104)	p-value	.274	.150	.378	.273	.144	.000

* Significant at the 0.05 level, two tailed (p-value). Correlation coefficient = *r*-value

Results of analyses conducted to test the hypothesis that distance from a QC did not have a significant effect on beef trade in the ZR and that a threshold distance beyond which distance played a more significant role did not exist, are presented in Figure 6-6 and Figure 6-7. The relationship between the number of cattle sold at a crush-pen and its distance from each QC was mostly negative and became stronger the further away from a QC a crush-pen was situated. The exception was in summer when the relationship between the distance from the Kopano QC and the number of cattle sold at a crush-pen was positive beyond distances up to 35km, after which further distance increments returned negative relationships. The relationship between distance and the number of cattle sold was generally negative and the strongest in winter in comparison to annual numbers sold and numbers sold in summer. The point beyond which the relationship between the number of cattle sold per crush-pen and distance from the Katima QC was the strongest, was at 50km in the total number sold ($r=-0.58$, $P<0.001$) and 60km in both summer ($r=-0.43$, $P=0.017$) and winter ($r=-0.62$, $P=0.001$) cattle numbers sold. The same relationships for distances associated with the number of cattle sold at a crush-pen and the Kopano QC was the strongest beyond 55km for total number of cattle sold ($r=-0.40$, $P=0.006$), summer sales ($r=-0.34$, $P=0.03$), and winter sales ($r=-0.50$, $P=0.003$). Off-take rates per crush-pen and distance away from the Katima QC showed a negative relationship in annual, summer and winter analyses, which became positive in summer beyond 45km, and beyond 55km in winter. The point beyond which relationships were the strongest and most significant was at 30km in both annual ($r=-0.35$, $P=0.003$) and winter ($r=-0.2$, $P=0.046$) off-takes in relation to the Katima QC.

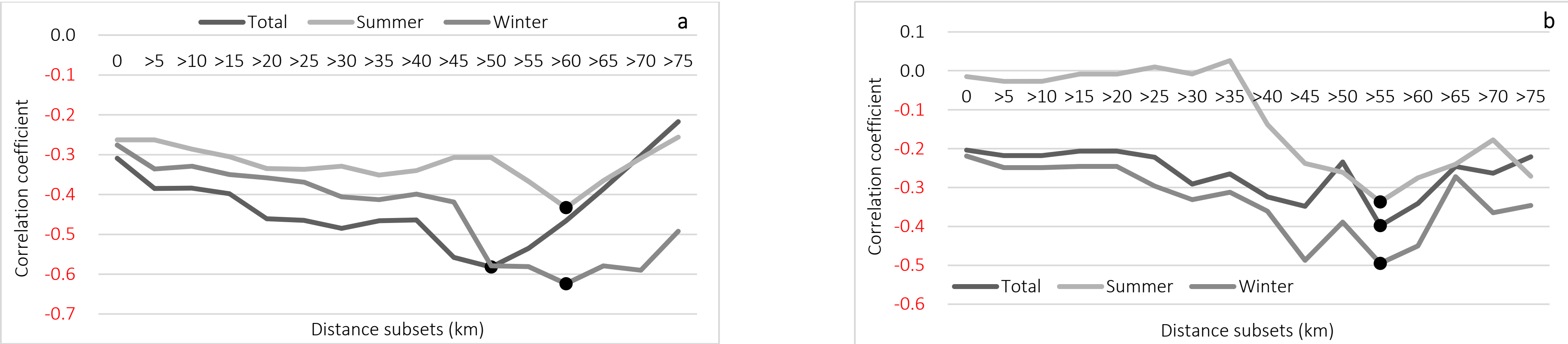


Figure 6-6: The correlation coefficients of the relationship between distance between a) Katima QC and b) Kopano QC and the cattle sold at each crush-pen (n=108) in the year 2011 and per season. Highlighted markers indicate the strongest relationship that is significant (P< 0.05)

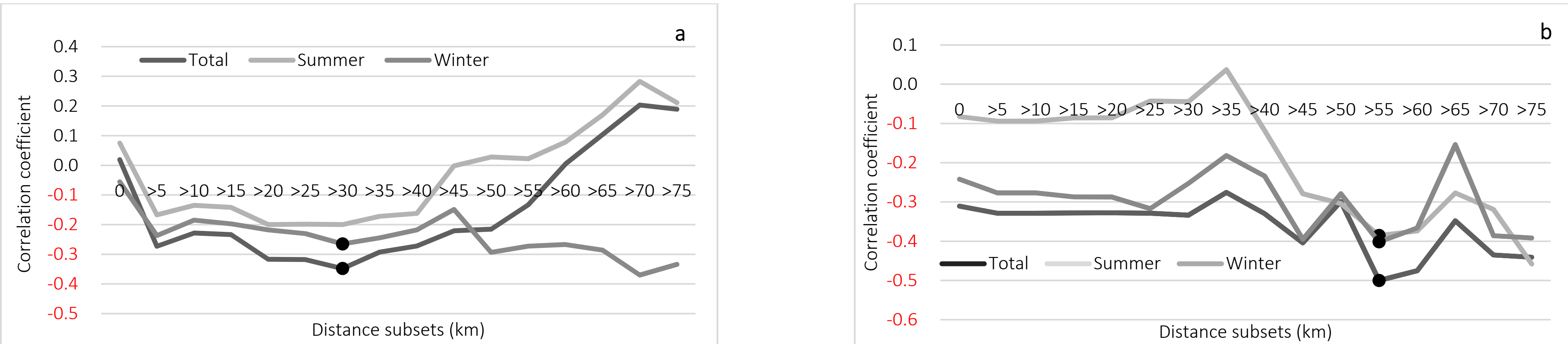


Figure 6-7: The correlation coefficients of the relationship between distance between a) Katima QC and b) Kopano QC and the off-take rate at each crush-pen (n=108) in the year 2011 and per season. Highlighted markers indicate the strongest relationship that is significant (P< 0.05)

Summer relationships between off-take and distance were not significant at any distance away from Katima QC ($P>0.05$). Relationships between off-take rates and distance from the Kopano QC were, similar to that of the number of cattle sold, also the strongest beyond 55km away from the QC for annual off-take rates ($r=-0.5$, $P<0.001$), summer ($r=-0.39$, $P=0.012$), and winter ($r=-0.4$, $P=0.02$) off-take rates. The null hypothesis (H_0) is therefore rejected for both quarantine camps across seasons and for both the number of cattle sold and off-take rates, with an exception in the case of summer off-take rates in relation to the Katima QC; in which case the null hypothesis was not rejected.

Further analyses were conducted by including a 55km distance threshold as a categorical variable in data. The 55km radius was used around both QCs. Despite the most significant and most negative relationship between distance from the Katima QC and off-take rate presented at approximately 30km, and not at between 50-60km as with the number of cattle sold and Kopano QC parameters, the relationship between annual off-take and distance from the Katima QC at 55km was still negative and significant ($P<0.1$, 90% C.I.). We therefore decided on a single 55km cut-off distance for both QCs for practical reasons. The position of a crush-pen either within or outside of this 55km radius (hereafter referred to as the trade circle) around both of the QCs was subsequently included in spatio-temporal analyses in order to test and demonstrate its possible effects on trade dynamics in the ZR even further.

The mean cattle population and number of cattle owners at a crush-pen situated either within or outside the 55km trade circle did not differ significantly (Mann-Whitney Test, $P<0.05$) (Table 6-4). 57% of the cattle population and 57.7% of the cattle owners in the ZR were situated within the 55km trade circle. Yet, 72.4% of the total cattle sales to the Meatco abattoir in 2011 originated from areas within the trade circle, compared to a total of 27.6% from outside the trade circle; where 42% of the crush-pens as well as the cattle population is situated. The mean number of cattle sold at a crush-pen within the trade circle was significantly more (Mann-Whitney Test $U=1069$, $P=0.029$) than the mean number sold at a crush-pen outside of the trade circle. The mean annual off-take rate (formal trade) at crush-pens within and outside of the trade circle did not differ significantly in the wet season (Mann-Whitney Test, $P>0.05$). However, in the dry season (winter) the mean off-take rate at crush-pens outside the trade circle ($\mu=0.014$, SD 0.023) was significantly lower than the mean off-take rate at crush-pens inside the trade circle ($\mu=0.034$, SD 0.043) (Mann-Whitney Test $U = 880$, $P=0.001$). Similarly, the number of cattle sold in the wet season (formal trade) at a crush-pen did not differ significantly within and outside the trade circle, but in winter the difference was highly significant (Mann-Whitney Test, $U = 856.5$, $P<0.001$).

Table 6-4: Descriptive statistics of the number of cattle, number of owners, and number of cattle sold in 2011 at crush-pens within and outside of a 55km radius around both quarantine stations in the ZR

Variable	Distance category	n	Mean	Std Deviation	Sum	% of Total N	% of Total Sum
Annual sales	>55km	45	36.6[A]	55.3	1645	41.7%	27.6%
	<55km	63	68.6[a]	86.0	4324	58.3%	72.4%
Cattle owners	>55km	44	21.6	9.9	948	41.9%	42.3%
	<55km	61	21.2	10.2	1291	58.1%	57.7%
Number of cattle	>55km	45	1035.6	660.5	46601	42.5%	43.1%
	<55km	61	1008.4	466.4	61515	57.5%	56.9%

A/a – Significant difference (Mann-Whitney Test U = 1069, P=0.029)

The influence of the 55km trade circle on market participation (at crush-pen level) was analysed through cross tabulations (Table 6-5). Results indicated that there was a significant probability that farmers from crush-pen areas outside the trade circle did not sell any cattle to Meatco in the winter months in 2011 (Pearson χ^2=10.97, P=0.001). This relationship was not significant, however, in summer months; nor when season was excluded.

Table 6-5: A cross tabulation of the position of crush-pens in the ZR (within or outside a 55km radius of either of the two QCs) as well as annual/seasonal market participation by farmers at crush-pens in 2011. Yes/no values given as a percentage of the number of crush-pens (n) sampled

Variable		Annual		Summer		Winter[a]		*n*
		No	Yes	No	Yes	No	Yes	
Within 55km radius[A]	No	20%	80%	31%	69%	51%	49%	*45*
	Yes	17%	83%	27%	73%	21%	79%	*63*
n		*20*	*88*	*31*	*77*	*36*	*72*	*108*

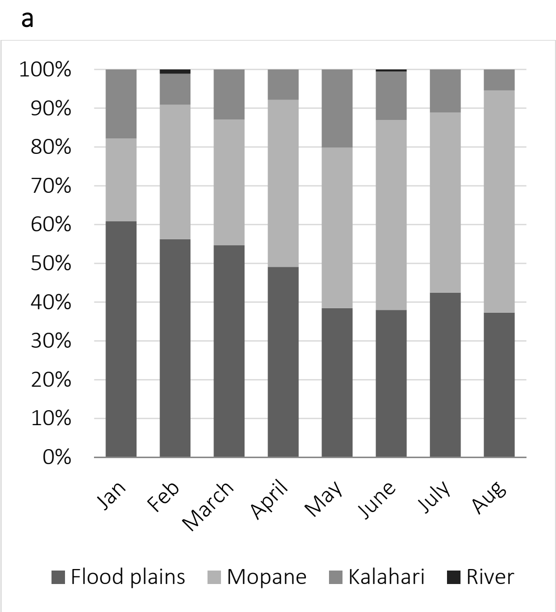
- *A/a – Significant correlation (Pearson χ^2=10.97, P=0.001)*
- *Market participation: 'yes' if sales >0, 'no' if sales = 0*

6.4.4 The effect of vegetation type on formal trade

Cattle sales from crush-pen areas situated on the floodplains of the ZR were responsible for 47% of the carcass intake by the Meatco abattoir in 2011 despite supporting less crush-pens (40%) than the Mopani woodlands did (44.4%) (Table 6-6).

Table 6-6: The descriptive statistics of cattle sales (no. of animals) to the Meatco abattoir and associated off-take rates (%) at crush-pens within each vegetation type of the ZR in the year 2011

Vegetation type	Variable	N	Mean	S.E.M.	S.D	Max	Sum	Total N (%)	Total Sum (%)
Floodplains	Sales	43	65.1	13.8	90.6	431	2 800	39.8%	46.9%
	Off-take	43	6.19	1.30	8.51	38.69			
Mopani woodlands	Sales	48	51.2	9.4	65.4	379	2 458	44.4%	41.2%
	Off-take	46	5.58	1.02	6.90	31.89			
Kalahari woodlands	Sales	15	46.4	17.3	67.1	207	696	13.9%	11.7%
	Off-take	14	8.73	3.54	13.24	46.79			
Riverine woodlands	Sales	2	7.5	7.5	10.6	15	15	1.9%	.3%
	Off-take	2	1.03	1.03	1.46	2.06			
Total								100.0%	100.0%



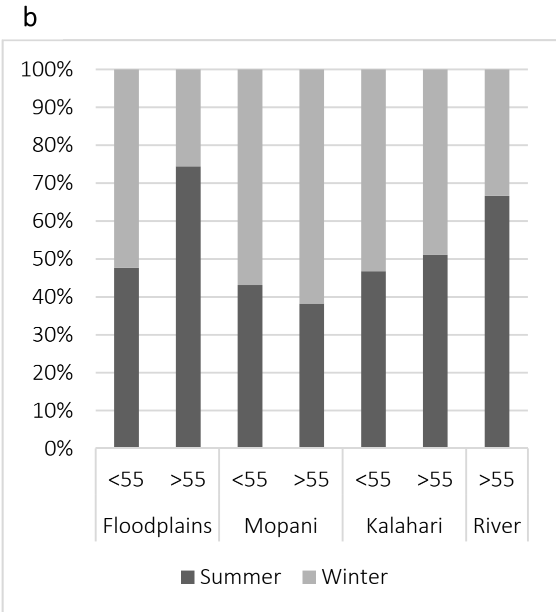


Figure 6-8: The proportional percentage of cattle sales per vegetation type in 2011 a) per month and b) per season and per distance category where; <55km include all crush-pens situated within a 55km radius of any QC, and >55km include crush-pens situated outside of a 55km radius around both QCs

A total of 41% of the total cattle sales in 2011 came from crush-pens on the Mopani woodlands; whilst 11.7% came from crush-pens on the Kalahari woodlands and only 0.3% of sales came from the two crush-pens situated in the Riverine woodlands. The mean off-take rate at crush-pens in the Kalahari woodlands was the highest (μ=8.73, SD 13.24), followed by crush-pens on the floodplains (μ=6.19, SD 8.51), the Mopani woodlands (μ=5.58, SD 6.9), and lastly the Riverine woodlands (μ=1.03, SD 1.46). There was no significant difference between the mean number of cattle sold or the mean off-take rates at crush-pens per vegetation type (Kruskal-Wallis Test for multiple independent variables: Sales; χ^2=2.7, P=0.441, Off-take; χ^2=2.21, P=0.531). However, the effect of distance and season on trade per vegetation type showed a significant mean difference in the off-take rates between crush-pens within and outside the 55km trade circle in the winter months on the floodplains only (Mann-Whitney U Test = 117, P=0.004, 2-tailed) (Figure 6-8). The position of a crush-pen within or outside the 55km trade circle had no significant effect on off-take rates in any other vegetation type in the summer months.

6.4.5 Trade dynamics in terms of conservation and FMD outbreaks

49% of the crush-pens included in the analyses (n=108) were situated in conservancies and represented 45% of the cattle in the ZR and 47% of all the cattle sales to the Meatco abattoir in the year 2011. 23% of crush-pens were situated in areas considered to have a high probability of contact between cattle and buffalo. These areas represented 22% of the cattle populations of the ZR and supplied 20.2% of the carcasses slaughtered at the Meatco abattoir in 2011. There were no significant relationships between the mean number of cattle sales per crush-pen either within or outside of conservancies, nor within or outside high-risk buffalo areas, and also not at crush-pens that either did or did not have an FMD outbreak between the years 2007 and 2011 (Mann-Whitney U Test, P>0.05). There was a significant probability that a crush-pen that falls in a conservancy will also fall in a high-risk buffalo area (Pearson χ^2=5.85, P=0.016) (Table 6-7). However, there was no significant relationship between crush-pens where FMD had occurred before and crush-pens either in conservancies or in high-risk buffalo areas. 23% of the crush-pens that had FMD-infected cattle recently (between 2007 and Nov 2011) were in conservancies and 21% were in high-risk buffalo areas.

Table 6-7: A summary of the relationships between categorical variables that indicate presence (yes) /absence (no) of crush-pens in conservancies, high-risk buffalo areas, or where FMD outbreaks occurred between 2007-2011 in the ZR. Yes/no values are given as a percentage of the total number of crush-pens

Variable		FMD			Buffalo risk[a]		
		No	Yes	Total (n)	No	Yes	Total (n)
Conservancy[A]	No	82%	18%	*55*	87%	13%	55
	Yes	77%	23%	*53*	68%	32%	53
	Total (n)	*86*	*22*	*108*	*84*	*24*	*108*
Buffalo risk	No	80%	20%	*84*			
	Yes	79%	21%	*24*			
	Total (n)	*86*	*22*	*108*			

- *A/a – Significant correlation (Pearson χ^2=5.85, P=0.016)*

Table 6-8: A cross tabulation of crush-pens from where cattle were or were not procured by Meatco in 2011, annually and per season; and the position of a crush-pen within or outside a 55km radius around each QS, in relationship with the position of crush-pens in conservancies, where FMD had occurred recently, and buffalo contact risk was high. Yes/no values given as a percentage of the total number of crush-pens (n)

Variable		FMD		Buffalo risk[a]		Conservancy[b]		*n*
		No	Yes	No	Yes	No	Yes	
Annual market participation	No	75%	25%	85%	15%	65%	35%	*20*
	Yes	81%	19%	76%	24%	48%	52%	*88*
Summer market participation	No	81%	19%	81%	19%	48%	52%	*31*
	Yes	79%	21%	77%	23%	52%	48%	*77*
Winter market participation	No	75%	25%	78%	22%	56%	44%	*36*
	Yes	82%	18%	78%	22%	49%	51%	*72*
Within 55km radius of any QS[A/B]	No	80%	20%	53%	47%	38%	62%	*45*
	Yes	79%	21%	95%	5%	60%	40%	*63*
n		*86*	*22*	*84*	*24*	*55*	*53*	*108*

- *A/a – Significant correlation (Pearson χ^2=26.67, P<0.001)*
- *B/b – Significant correlation (Pearson χ^2=5.34, P=0.021)*
- *Market participation: 'yes' if sales >0, 'no' if sales = 0*

The effect of the 55km trade circle on off-take rates per season at crush-pens with high-risk buffalo contact, previous FMD infections, and those situated in conservancies, was also tested. Results indicated no significant differences between the mean seasonal offtake rates at crush-pen level and any of the aforementioned parameters if the 55km trade circle was used as a grouping variable (Mann-Whitney U Test, P>0.05) (

Table 6-8). There was no significant relationship between the presence of a crush-pen in a conservancy, high-risk buffalo area, or where FMD had occurred recently, and the participation of farmers in the formal Meatco market in the year 2011, neither annually nor seasonally (Pearson Chi-square, P>0.05).

6.4.6 Spatio-temporal predictors of off-take

In order to determine which of the variables thus far used to analyse the variance in trade patterns over space and time had the most significant influence on off-take rates at crush-pen level in the ZR, a multiple regression was used in the form of a generalised linear model (GLM).

Model outputs indicated that, in general, the variables used accounted for very little of the variance (6.63% to 11.4%) in off-take rates at crush-pens (Table 6-9). Annual off-take rates were most significantly influenced by a crush-pen's distance from the Katima QC (P=0.01) and the total number of cattle at a crush-pen (P=0.09, 90% C.I.). These variables accounted for little (R^2=0.0818) yet significant (F=4.54, P=0.013) variance in annual off-take rates for the year 2011. The direction of the influence was negative for both a crush-pen's distance from the Katima QC and the total number of cattle at the crush-pen, meaning that off-take rates declined significantly as the distance between a crush-pen and the Katima QC increased and as the total number of cattle at a crush-pen increased.

In summer, off-take rates were influenced most by a crush-pen's distance from the Kopano QC and the vegetation type in which a crush-pen was situated. However, these variables only accounted for 6.2% (R^2=0.0616) of the variance in off-take rates and had a low significance (F=2.37, P=0.073, 90% C.I.). In winter, distance between a crush-pen and the Katima QC (P=0.002) and the total number of cattle at a crush-pen (P=0.04) both had a significant negative effect on the variance in off-take rates at crush-pens. Although highly significant (P=0.002.), these two variables were only able to account for 11.4% of the variance in off-take rates at crush-pens. In order to test the significance and the effect that only distance from each quarantine camp had on off-take rates at crush-pens in winter, the total number of cattle at a crush-pen was omitted as a variable at the last step of the stepwise linear model, upon which distances from either Kopano QC or Katima QC were included separately in the model. Results indicated that without the association between the total number of cattle at a crush-pen and the distance of the crush-pen from the Katima QC, distance of a crush-pen from the Kopano QC was responsible for slightly more of the variation in off-take rates than distance from the Katima QC (8.4% vs 7.7%; P=0.003 vs P=0.004).

Table 6-9: The model outputs and parameter estimates of the generalised linear model in which variables were reduced stepwise to those responsible for the most significant variance on annual, or seasonal, cattle off-take rates (trade with Meatco abattoir only) at crush-pens in the ZR

Variable	Parameter estimate	t Value	Pr > |t|	R-Square	Mean	Model	
						F Value	Pr>F
Annual off-take							
Katima QC	-0.0007522014	-2.57	0.0115	0.081756	0.061649	4.54**	0.0129
Total cattle	-0.0000253078	-1.72	0.0892				
Summer off-take							
Kopano QC	-0.000456	-2.16	0.0331	0.066317	0.030087	2.37*	0.0753
rVegType 1	0.001199	0.09	0.9273				
rVegType 2	-0.023311	-1.79	0.0762				
rVegType 3	0	.	.				
Winter off-take							
Katima QC	-0.000484789	-3.13	0.0023	0.113587	0.031418	6.6***	0.002
Total cattle	-0.0000161749	-2.07	0.0408				
Winter off-take without total number of cattle							
Kopano QC	-0.0005467813	-3.08	0.0027	0.083508	0.031418	9.48***	0.0027
Katima QC	-0.0004607476	-2.94	0.0041	0.076645	0.031418	8.63***	0.0041

- *Significant at the 90% confidence interval
- **Significant at the 95% confidence interval
- ***Significant at the 99% confidence interval

6.5 DISCUSSION

Perceptions towards the quarantine system

Even though the farmers did not really understand the QC process, the perception formed by some that the camps serve as a feeding station for carcass conditioning prior to slaughter could benefit the upstream supply chain. A recent evaluation of the ecological potential of the quarantine stations revealed its potential to improve cattle condition, or at least maintain better condition during the dry season (Rothauge, 2014). The proven possibility that the quarantine camps in the ZR can be used for low-input conditioning of cattle becomes a very important option for the improvement of carcass quality in order to be able to target higher end markets (local or export). However, in the absence of institutional arrangements associated with the management of the QCs, which could optimise both animal performance as well as the quarantine system, this could be seen as an additional trade barrier for beef producers. At present, farmers retain responsibility for managing cattle in the quarantine station during the 21-day quarantine period, Meatco manages cattle intake and the procurement register, and the Department of Veterinary Services (DVS) is responsible for biosecurity, infrastructure and the management of the station in general. Yet, DVS has no incentive for investing in management approaches that could benefit cattle performance whilst in quarantine, and those that do have such an incentive – the farmers and Meatco – do not have any management authority; nor do they have a mechanism to do so. Furthermore, participating farmers pointed out the fact that risk remains with the farmer during the quarantine period, with the result that risk-averse behaviour will suffice during quarantine, which necessarily reduces the likelihood that farmers will invest in improved management and feeding strategies during the quarantine period. The potential for improved animal performance during quarantine could result in an incentive for producers to take the risk of selling younger animals that could be conditioned to reach better carcass grades and thus generate better income. Even though Botswana's weaner production initiative did not always receive support from every production sector, it did prove that such a system can be implemented under extensive, communal production systems (Ransom, 2011).

Abattoir throughput

The throughput of cattle at the Meatco abattoir in the KM is generally influenced by either the availability of cattle of acceptable quality or the availability of space in its chiller-room. The chiller-room space is limited and if beef is not sold or distributed quickly enough to markets, lack of space in the chiller-room may reduce cattle throughput. The optimal throughput of the abattoir is approximately 2 200 cattle per month (110 cattle per day over 20 working days). Between 2007 and 2011 the highest monthly intake at the abattoir was in June 2007, when 1 400 cattle were slaughtered, which equalled approximately 12 slaughter days at full capacity. This suggests that the number of cattle on offer to be slaughtered is less than the capacity of the abattoir. The fact that FMD outbreaks interrupt abattoir intake regularly in the ZR is not conducive to the creation of what can be considered a reliable market system through which farmers can become increasingly conditioned to formal trade. Instead, this will most likely result in farmers opting rather to plan around more reliable markets, such as local informal trade, where they have more control over market access and timing. The fact that the best carcass weights and prices are obtained in the wet season, although not significantly so, exacerbates the impact of the abattoir closures on farmers, because the abattoir was closed more often in the wet season than in the dry season. The loss of income to farmers due to regular abattoir closures is significant in that farmers received on average, over a five-year period, approximately half the income from the formal market they were likely to receive should conditions have been more optimal. Over and above the impact on farmers' income, the frequent closure of the abattoir has dire consequences on operational profitability and could ultimately cause its total shut down. Should that happen, it will have a major impact on the entire economy of the ZR. Since 2011, every year (with the exception of 2014 to date) has seen at least one FMD outbreak in the ZR. This fact is in concurrence with reports that FMD outbreaks have been on the increase in the SADC region in recent years, which in part can be attributed to increased contact between wildlife and livestock in the region (OIE Collaborating Center, 2011).

This is despite the fact that, both over a five-year period and within the year 2011, no significant difference between wet and dry season abattoir throughput existed, which meant that at abattoir level sales volumes were maintained over seasons. However, there was a meaningful downward trend in the form of a significant negative relationship between sale numbers and the month of the year over a five-year period. This indicates that at some level, seasons do play a significant role and have to be better understood. In the absence of a feedlot to regulate carcass quality and abattoir throughput in the ZR, a decline in sales numbers would be expected in the dry season; especially in light of the findings of Chapter 5, which indicated a substantial drop in carcass quality in the ZR in the dry season. The further influence of season on formal trade in the ZR will be discussed in subsequent sections.

The role of distance and season on trade

The mean herd size at crush-pen level was in line with what was reported by the interviewed farmers (57 cattle) in Chapter 3, and that of previous studies done in the area (Paskin and Hoffmann, 1996). From the interviews with farmers in our survey, the negative effects that distance and lack of transport to the quarantine stations had on market access and profitability were clear, in that 69% of the interviewees confirmed these as challenges. As indicated in Chapter 3, the 31% of the respondents who did not regard market access as a problem most probably were not commercially orientated, or felt financially precluded from accessing Meatco in the first place and therefore regarded the informal local markets as sufficient, given the small number of cattle they have usually wanted to sell. The low average off-take rate of 6.8% for formal trade at crush-pen level further indicated that the formal market in the ZR does not serve as a generally preferred and widely supported trade system in the area. A previous study in the northern communal areas of Namibia reported a similarly low general off-take rate of 7.3%, which included all forms of off-take – not just trade to formal markets. Interviewed farmers in the ZR (Chapter 3) reported an off-take rate of 8.1% when only those farmers that had sold at least one animal were considered. This was also net off-take at herd level and not just sales to formal trade, and suggests that in terms of numbers marketed, the formal trade perhaps does make up the bulk of the cattle traded in the ZR. In a recent survey in the ZR, Thomas et al. (2014) found that the bulk of the farmers in the ZR preferred informal trade to the Meatco market. However, their survey did not compare trade volumes between the different market systems.

Our analyses of the relationship between distance to quarantine facilities and sales volumes as well as off-take rates at crush-pen level throughout the ZR, further confirmed the impact of distance on the market system. Distance had a significant negative effect on off-take rate at crush-pen level mainly in relation to the Kopano QC. However, further analyses confirmed the existence of a threshold distance, in that both sales and off-take rates were most significantly impacted in areas further than 55km away from the Kopano QC specifically, but also the Katima QC in terms of number of cattle sold. Further analyses indicated that the sales volumes and off-take rates at crush-pens within and outside a 55km trade circle around both QCs differed significantly, especially in the winter months.

In terms of market area analysis: the *market area* was defined by Rodrique (2016) as the surface area over which a demand or supply offered at a specific location is expressed. The *market threshold* is the area around a market represented by the minimum demand necessary to support the market. The *market range* is the maximum distance each unit of demand is willing to travel to reach the market, and is influenced by transport costs and time or convenience. Importantly, in order to be profitable the threshold distance of the market must be exceeded by the market range. In the ZR formal trade through the Meatco abattoir in Katima Mulilo represents a typical isotropic market scenario (Rodrique, 2016). The finding that sales volume, off-take rate as well as market participation is significantly lower beyond 55km from any of the two QCs, suggests that the 55km trade circle represents the market range, which can be indicated by a concentric circle around the market location in the case of an isotropic market system. The Katima abattoir trades through the two QCs and the market range is therefore best indicated by a concentric circle with a 55km radius around each QC (Appendix 12). All crush-pens beyond the market range (outside the trade circle) will experience resistance in connection with accessing either of the two QCs. Such resistance was demonstrated in the results. Importantly, at a mean annual sale level of 68.6 carcasses per crush-pen situated within the market range, the demand for carcasses by the Katima abattoir exceeds supply. A mean annual supply of 68.6 carcasses by the 63 crush-pens each within the market range provided a net supply of 4 324 carcasses in 8 months during 2011. Demand at capacity, reaching 110 carcasses per day, would have supplied the abattoir for approximately two to three months. It is therefore safe to say that the market threshold of the Katima abattoir exceeds its market range and the significant reduction of supply due to a range of barriers, of which distance and transport are the most significant, will result in an unsustainable (unprofitable) operation (Rodrique, 2016).

Furthermore, data indicated that the resistance to market access in areas beyond the market range around the two QCs was most significant in the winter months, and this implies that extra interventions will be required to service the demand of the abattoir with the available supply from farmers during the dry months. In our opinion, the significant seasonal effect in the form of reduced trade in the winter from areas beyond the market range of 55km can be attributed to the drop in condition of cattle in the winter (see Chapter 5) and the lack of surface water available to cattle when farmers trek their cattle to either of the two QCs. A farmer that needs to trek his animals for over 100km on foot for several days on end would therefore prefer to do so in the summer months when animals are in the best possible condition. It is a known fact that cattle lose several kilograms in carcass weight from loss of condition when trekked on hoof to a QS, especially from distant areas[18]. During an interview with a farmer from Sangwali, he explained that he preferred to market cattle to Meatco in summer months when there is enough forage and water available for the long trek (2-3 days).

The effect of vegetation type on formal trade

The mean off-take rates and sales volumes at crush-pen level did vary between vegetation types in the ZR, but not significantly so. The only significant difference was between mean cattle sales per crush-pen on the floodplains in the winter months, in that crush-pens situated in areas beyond the market range sold significantly less cattle than those within the market range. The fact that this difference was only significant for the floodplains was interesting and can be attributed to the fact that the Kopano QC is the QC farthest from crush-pens on the eastern floodplains. It was also the QC with the most significant negative relationship between distance and both sales and off-take rates. The results are therefore most likely due to the high resistance to formal trade experienced in the winter months by those farmers situated in the farthest areas of the eastern floodplains, beyond the 55km market range.

[18] Mr Berry Manda, Procurement manager, Meatco abattoir, Katima Mulilo, Zambezi Region

The fact this this area shows the most significant drop in market access is perhaps not a coincidence. The procurement manager of the Katima abattoir confirmed that when farmers from the far eastern floodplains come to register a planned sale they often withdraw the registration if they are allocated to a spot within the Kopano QC. The Kopano QC is 40km further than the Katima QC for farmers traveling form the eastern floodplains, and could easily result in an additional day of trekking. There is also substantial evidence that farmers in the eastern floodplains near the Zambezi River are trading cattle illegally with Zambia[19]. At least one recent FMD outbreak (2007) in the ZR was linked to illegal cattle movement between the ZR and Zambia. In the past, several outbreaks of CBPP in the Zambezi Region of Namibia were linked to illegal cattle movement between Zambia, Angola and the ZR (Bishi and Kamwi, 2008). The presence of significant trade barriers in the form of distance and lack of transport, further exacerbated by the poor condition of cattle in the winter months, will certainly be an incentive for farmers in the distant areas of the floodplains to trade across the river with friends and family in Zambia instead. Although illegal, the transaction costs associated with trade across the river with Zambia could be much lower than those required through the legal, formal route. However, illegal trade of cattle with Zambia can be considered a major risk for the outbreak of FMD and other diseases in the ZR.

The effect of wildlife-livestock interaction on trade

The importance of wildlife-livestock interaction in the ZR is emphasised by the fact that about half (49%) of the crush-pens surveyed were situated in conservancies. Conservancies in the ZR have been established to promote community-based conservation and to enable community beneficiation from successful environmental stewardship, whilst trying to allow for continued regular land use, such as crop and livestock farming (Nuulimba, 2012). Conservancies have been successful in the ZR, with strong evidence that communities do benefit from their objectives, as discussed in Chapter 4. Part of the success, due to the expansion and increase in community conservancies in the ZR, is that wildlife numbers have been on the increase in the ZR (Chase, 2009). Buffalo numbers in particular have increased significantly in recent years (Chase, 2009). Our results indicate that 45% of the cattle population in 2011 was situated in community conservancies and was responsible for 47% of the cattle supply to the Katima abattoir. It is therefore expected that the probability of wildlife-livestock interaction, or contact, will be higher in conservancies, and this has the potential for significant impact on the formal trade system and the livestock industry in general. The potential disease risk in terms of increased wildlife-livestock interaction in conservancies was emphasised by the significant probability

[19] Interview with two committee members of the Kasika conservancy, Kabbe, January 2013. Also detailed reports by Mr Martin Chiza in 2013, retired animal production extension officer, Ngoma, ZR

that a crush-pen within a conservancy will also fall within a high-risk buffalo contact area. Despite such a risk, the data indicates that only 23% of the crush-pens, representing 22% of the ZR cattle population where FMD outbreaks have occurred since 2007 and up to 2011, were situated within conservancies. The other 77% of crush-pens where FMD had occurred before were situated outside of conservancies and mainly outside high-risk buffalo contact areas. No significant relationship existed between crush-pens where FMD had occurred before, and their presence or absence in conservancies or high-risk buffalo contact areas. In a sense this implies that FMD outbreaks are spatially less predictable in the ZR, which will not help attempts to improve control strategies. However, the analyses did not separate crush-pens where the index case of an outbreak occurred, from crush-pens to which the disease subsequently spread. All except one FMD outbreak that occurred in the ZR between 2007 and 2013 started in areas we considered to have relatively high potential for contact between cattle and buffalo. We can therefore not separate the increased likelihood of FMD outbreaks from high-risk buffalo contact areas, which we found to be significantly associated with conservancies as well. The potential risk posed by other wild ungulate species occurring in larger numbers on the eastern floodplains of the ZR, such as impala, in the spread of FMD to cattle, cannot be underestimated. Vosloo et al. (2009) proved by means of a longitudinal study in the Kruger National Park of South Africa that impala are important to FMD epidemiology, in that they either maintain SAT-serotype infection for prolonged periods, or are susceptible to frequent re-infections by buffalo.

These findings confirm the concerns mentioned by farmers (presented in Chapter 4): the majority of interviewees regarded buffalo contact with cattle to have negative consequences in terms of disease and trade.

Spatio-temporal predictors of off-take

The importance of distance from a quarantine camp, especially that of the Kopano QC, on cattle off-take rates at crush-pen level in the ZR has already been demonstrated. The GLM was therefore constructed mainly to test the predictability of off-take rates at crush-pen level across the entire ZR, and to see if any other factors may play a role in off-take predictability in addition to the expected role distance was going to play. The result showed that the predictability of cattle off-take rate at crush-pen level in the ZR by means of a generalised linear model is limited yet significant using the variables included in this paper. It did confirm, however, that the most important predictor of off-take rate at crush-pen level was distance from a quarantine station. Although the models had a significant outcome in the case of annual and winter off-take rates, the models accounted only for 8.2% of the annual off-take variation and 11.4% of the winter variation. The role played by distance from the Katima QC in predicting off-take rates was significant in annual, summer, and winter models. The Kopano QC is not as central in the ZR as the Katima QC (Table 6-2) and the expectation was that distance to the Kopano QC would have had a more pronounced influence on off-take than distance to the Katima QC. Yet, cattle population size at crush-pen level did play an important role in the overall model by means of an additional negative influence on annual and winter off-take rates. The additive role of cattle population size in relation to distance from the Katima QC was demonstrated by omitting cattle population size from the model and including distances from Katima and Kopano QCs separately in the winter model. Although Kopano QC on its own did account for more variance than distance from the Katima QC, it was less than the effect that the distance from Katima QC added to the role of cattle numbers had on the variance in off-take rates (8.4% vs 11.4%).

The predictability of off-take rates at crush-pen level in summer proved invaluable due to low significance, which accounted for very little variance. The fact that vegetation type, situation in a conservancy, presence in a high-risk buffalo area, or where FMD outbreaks had occurred before, did not have any meaningful effect on the model outputs, indicated that these factors perhaps did not play an important role in market access, or that they played a role at the individual farmer level and not at crush-pen/population level. It could also imply that farmers' concerns with the impact of buffalo contact and market access (see Chapter 4) were linked to indirect effects on trade as affected by movement controls and the closure of the abattoir during an outbreak, rather than an impact on market participation in the absence of an outbreak. It is important to state that off-take rate at crush-pen level is a function only of farmers who participated in the Meatco market system in 2011, and is a decision made by individuals and not at crush-pen level. As shown earlier in this chapter, the mean off-take rate at crush-pen level for formal trade in the ZR was 6.8%, and in Chapter 3 it was indicated that less than half of farmers in the far-off areas of the ZR participated in formal trade. There is therefore a range of other factors that may influence an individual's decision to trade with Meatco that we were not able to account for in our model. This point was recently confirmed by Thomas et al. (2014) through a study in the ZR that indicated that only 38% of farmers participated in the formal market (Katima abattoir) and that the decision regarding which market to participate in depended on the age and level of education of the household head, access to market information, and the ability to sell large numbers of cattle. All these factors were measured at the individual level, but only through surveying 50 farmers in the entire ZR. The study areas were not indicated either. In this respect, the significance of our findings was evident in that we were able to indicate the most important factors influencing off-take at the population level (crush-pen) in the entire ZR, despite being unable to account for individual farmer decision parameters. We therefore believe that the 8-11% predictability of our models has sufficient significance in the context of formal trade in the ZR.

6.6 Conclusions

We have concluded that the formal market system in the ZR, which consists of the Meatco operated abattoir in the ZR and the two quarantine camps, Katima and Kopano, did not provide equitable market access to beef farmers throughout the ZR during our study period. The major barriers to participation in the formal market system were the physical distance farmers had to travel by trekking their cattle often over long distances whilst having to carry all risk and costs – even during the 21-day quarantine period. These higher transactional costs were generally only affordable by those with large herds, able to sell enough animals at a specific time to offset the costs. These factors were highlighted in our own surveys of farmers in the most remote areas of the ZR, as well as through several other studies throughout the NCAs, using questionnaire surveys among farmers (Duvel and Stephanus, 2000b; Shiimi et al., 2010). However, the general lack of reliable trade data for formal markets in communal farming systems resulted in most studies resorting to cross-sectional, questionnaire-based surveys. These studies have been valuable but have often lacked representation of an entire market system; were focused on individual's decisions, and often lacked important spatial and temporal inputs. We were able to account for some of these limitations in that, for the first time in at least the ZR but quite possibly in any communal farming area in southern Africa that is situated within an FMD-infected zone, procurement data for formal trade representative of the entire supply area, was analysed. The combination of trade data with important spatial and temporal parameters allowed us to confirm that distance from the market was indeed a major barrier in the formal trade system of the ZR. But, more importantly, the influence of distance from the market was spatially and temporally variable. Our results were able to confirm that distance from a quarantine camp had the most significant impact on formal market participation and trade volume in the dry season (winter) and in areas situated further than approximately 55km from a quarantine facility. The influence of distance in the summer months was in many instances less distinct. We were not, however, able to truly explain the reason that a trade barrier would exist 55km around the main market, and further research in this regard will be important. Conducting farmer surveys within and outside the 55km trade circle could assist with resolving the question. One suggestion is that it was the maximum distance farmers were able to trek with cattle in 24 hours, and therefore differentiated between those that had to travel two or more days versus those that were within one day's reach of a QC. This suggestion will have to be tested through further research.

Our findings suggest that the 55km trade circle around the two QCs is similar to the market range of an isotropic market system. If this is true, which our data suggests it is, the market threshold in the ZR was much further than the market range given the mean off-take rates at population level. This resulted in the demand for carcasses by the abattoir being larger than the supply within the market range. If the market range cannot be corrected it will impact on the profitability and sustainability of the formal trade system. Strategies to expand the market range will therefore allow for improved supply of carcasses, especially in the dry season when the abattoir often had to close because of lower supply and poor carcass quality. Higher supply during this period could possibly account for the lower quality of the carcasses produced. A possibility could be to reduce the size of the two existing quarantine facilities (Kopano and Katima) which, according to a recent assessment (Rothauge, 2014), were in many ways not being used optimally to begin with, in order to construct two more facilities beyond the 55km market range in the east and the west of the ZR. Based on these findings, we suggest the development of market systems that are spatially and temporally more flexible and accommodating. Dynamic procurement networks, with the ability to adapt to environmental as well as seasonal variability, and which will be able to provide incentives for farmers to self-organise in order to provide more equitable market access, will become important in future. The possible use of mobile abattoir technology and the development of additional performance-driven QCs based on the presence of the market range and threshold parameters, should be investigated. Such systems would potentially resolve the exclusion of farmers from the formal trade system in areas such as the eastern floodplains during winter, and in so doing, reduce the risk of illegal trade in beef across the Zambezi River, thus improving abattoir throughput.

The occurrence of regular FMD outbreaks in the ZR in recent years has had a significant impact on abattoir throughput by practically halving operational time, and hence, halving the potential income of producers and the abattoir itself in recent years. Our paper has indicated that approximately half of the cattle trade with the Meatco abattoir originates from community conservancies in the ZR. Importantly, we have indicated that high-risk buffalo contact and presence in the conservancy were significantly correlated. With all but one of the FMD outbreaks that occurred between 2007 and 2013 in the ZR originating in high-risk buffalo areas, the impact of past and potential future FMD outbreaks on trade and farmer sentiment towards conservation cannot be ignored. It confirms what farmers reported (in Chapter 4 of this thesis): the majority felt that there was a negative influence between contact with buffalo and market access. The implications of our findings for the future development of TFCAs are important in that they emphasise the urgency with which alternative trade standards, such as commodity-based trade, should be pursued in similar production systems. Value chain development, such as that which has been proposed for the implementation of a commodity-based approach at the wildlife-livestock interface, is important because of its potential to improve risk management along the value chain in order to allow access to better markets, to limit the impact on trade should an FMD outbreak occur, and to improve compatibility between livestock production and wildlife conservation.

That said, without strategies to make market access more equitable, the poor will continue to be excluded and wildlife-livestock compatibility will continue to be jeopardised. Hence, policy makers should rethink approaches to disease control and trade standards at the wildlife-livestock interface, as these have been proven over and over to be inequitable and unsustainable. The future of sustainable conservation and sustainable, resilient livelihoods at the wildlife-livestock interface is dependent upon policy changes that could facilitate and enable market access for the poor.

Lastly, given the push to expand conservation areas inclusive of livestock producers, and the subsequent need to create resilient livelihood strategies at these wildlife-livestock interfaces, the acceptance of non-geographic trade standards will continue to grow in relevance. The recent correction of a technicality within Article 8.7.25 of the Terrestrial Animal Health Code (OIE), making allowance for the use of quarantine facilities in areas where free roaming wild ungulates occur, will probably see more quarantine facilities included in market systems in the future. We believe that the factors highlighted in this paper will contribute to the more successful development of such market systems should they be considered.

7 HERDING FOR HEALTH: AN INTEGRATED MODEL TO COMMUNITY-DRIVEN VALUE CHAIN DEVELOPMENT FOR BEEF TRADE AT THE WILDLIFE-LIVESTOCK INTERFACE

7.1 INTRODUCTION

The reality of the multiple challenges and risks beef producers face on a daily basis by farming at the wildlife-livestock interface in southern Africa were highlighted in previous chapters of this thesis. In Chapter 3 the findings indicated that most cattle farmers at the wildlife-livestock interface in FMD control areas conform to a typical low input, low output farming system. Low-income farmers vulnerable to high risk and shocks often opt for low-risk activities and asset portfolios with the unintended consequence of lower returns or production outputs (Bhattamishra and Barrett, 2008; Azomahou and Yitbarek, 2014). Chapters 3 through 6 highlighted the complexity and interconnectedness of risks that exist in cattle farming systems at the wildlife-livestock interface with which each individual household needs to cope. These include small herd sizes, high mortality rates due to disease, predation, drought, and grazing competition, high levels of stock theft, and low levels of trade and off-take. Trade barriers exist in the form of high transaction costs and FMD control regulations, and the poor quality of beef offered due to a general lack of investment in grazing management, as well as higher technology uptake in the form of breeding and feeding. A further challenge is the multiple roles cattle fulfil across different asset categories (herd size). The combined effects of all these factors inevitably lead to lower market participation and/or returns from formal trade.

Persistent poverty

Under such high-risk circumstances and in the absence of some form of insurance against shocks and risk, livestock farmers at the wildlife-livestock interface are likely to remain trapped in poverty. A poverty trap is defined as a household remaining persistently poor despite possible opportunities for higher levels of income (Barrett and Carter, 2013). Farmers will continue to underinvest in livestock farming because of the high probability of loss and/or the lack of access to capital or credit; hence the vicious circle continues with little prospect of the majority of households breaking out of poverty. In fact, there is sufficient evidence to indicate that the livelihoods of farmers in areas such as the ZR are becoming more vulnerable and less sustainable in the face of growing numbers of wildlife, more FMD outbreaks, and increased climate variability (OIE Collaborating Center, 2011; Pricope and All, 2012; Nyambe, 2013). The array of risks pastoralists need to cope with increases their vulnerability. Risk, vulnerability and poverty in the developing world are all closely linked (Bhattamishra and Barrett, 2010). In the absence of effective strategies to mitigate the wide range of risks as perceived and experienced by pastoralists, at the impact of interventions to alleviate poverty are limited.

Significant numbers of human settlements exist in TFCAs in southern Africa, such as the ZR in the KAZA-TFCA, and Bushbuckridge next to the GLTFCA. These rural communities are often among the poorest in their respective countries (Monitor Group, 2006; NPC, 2015) and are for this reason vulnerable to shock and less resilient in terms of negative impacts. As such, the further development of TFCAs is complex because, on the one hand the aim is to promote and facilitate sustainable economic development of the rural poor; whilst on the other hand TFCA development is contributing to increased risk by means of bringing wildlife and livelihoods closer together. More importantly, there is little evidence of TFCAs in southern Africa specifically and meaningfully having benefitted people living at the edge of conservation and agricultural production over the past decade (Andersson et al., 2013).

The successful integration of wildlife conservation efforts with livestock production systems in remote, extensive landscapes of TFCAs in general, and specifically the ZR, is considered vital to ensuring sustainable livelihood strategies based on the optimal utilisation of all available natural resources (Osofsky et al., 2012; Andersson et al., 2013; Thomson et al., 2013a). In the ZR, for example, agriculture is recognised as the most important land use due to its contribution to livelihoods (Nyambe, 2013). Despite some benefits from local community conservancies (Nuulimba, 2012; NACSO, 2014) the multiple pressures that farmers in the ZR experience are increasing their dependence on food aid (Nyambe, 2013; Kamwi et al., 2015). Drastic intervention is required and this means that sustainable rural development and conservation will have to be approached differently in order to provide meaningful solutions for livelihoods, for farmers to cope better in future, and to alleviate poverty. Wildlife-livestock compatibility in this regard becomes important because just as eco-tourism on its own cannot be regarded a sustainable solution for poverty alleviation in this context (Osofsky et al., 2012; Cumming et al., 2013), so too livestock production on its own is insufficient (Thomson et al., 2013a; Vetter, 2013).

Foot-and-mouth disease and commodity-based trade

FMD is considered the transboundary animal disease (TAD) with the biggest trade impact globally, and as such is responsible for significant local and regional economic impacts (Thomson and Bastos, 2004; Knight-Jones and Rushton, 2013). The range of direct and indirect impacts FMD and its control has on either animals, households, countries or regions is variable and complex, making it difficult to quantify

(Perry et al., 2002; Knight-Jones and Rushton, 2013). Yet, FMD and its control can have significant impacts on the poor, and improved ways to control FMD in order to gain more reliable access to better markets are therefore regarded an important step on a pathway out of poverty for pastoralists in FMD-affected areas in sub-Saharan Africa, including the ZR (Perry and Rich, 2007; Thomson et al., 2013a; Naziri et al., 2015). Pastoralists in communal farming areas in southern Africa experience a range of challenges and barriers related to market access regardless of the presence of important TADs such as FMD (Musemwa et al., 2008; Ramsey and Morgan, 2009). The added burden that conventional, geographic-based trade standards for beef produced in FMD control zones places on vulnerable livestock owners in TFCAs is therefore a concern for proponents of both conservation and pro-poor development. For this reason, there is significant interest in non-geographic, commodity-based trade (CBT) standards for beef produced in areas that are not free from FMD.

CBT includes several alternative trade standards and approaches to FMD management that can be used to ensure that the production and processing of a commodity or product is managed so that potential food safety and animal health hazards are reduced to appropriate risk levels (Thomson et al., 2013b). It is suggested that CBT could increase opportunities for poor beef producers in FMD infected areas to access more lucrative markets, which could facilitate rural development (Thomson et al., 2004; Rich et al., 2009; Scoones et al., 2010). Important for rural development and biodiversity conservation in TFCAs such as the ZR, is that CBT could potentially improve compatibility between biodiversity conservation and livestock production systems (Osofsky et al., 2012; Thomson et al., 2013a). In recent years, regional trade structures in southern and eastern Africa endorsed the promotion of CBT and other non-geographic approaches to FMD management in an attempt to improve beef exports within and from the region: firstly by through endorsement by member states of the Common Market for Eastern and Southern Africa (COMESA) in 2008 (Thomson and Penrith, 2015), and secondly by the adoption of the Phakalane Declaration by the Livestock Technical Committee of the Southern African Development Community (SADC) (The Phakalane Declaration, 2012). Ironically, despite its regional acceptance and supposed support by governments, no national department of veterinary services in any of the before-mentioned counties has yet either formally accepted or practically implemented CBT approaches (Naziri et al., 2015; Thomson and Penrith, 2015).

Value-chain approach to CBT

Thomson et al. (2013b) suggested that the most appropriate approach to the non-geographic trade standard the OIE provides (Article 8.8.25, Terrestrial Animal Health Code) for the trade of beef in areas not free from FMD, is to integrate FMD control measures with sanitary and phytosanitary (SPS) measures along the beef value chain. In their proposed model, farmers should comply with a producer protocol that deals with on-farm risk mitigation, animal health management, and general good agricultural practices (GAPs) to ensure food safety and quality. Thereafter, FMD risk and SPS are managed by means of specific interventions at critical control points along the rest of the value chain, mainly based on the relevant international standards. This integrated value chain approach was found to allow for similar if not lower levels of risk in terms of the spread of FMD to high-value importing countries, in comparison to conventional FMD control measures (Meat Board of Namibia, 2014). Two further studies found that the integrated value chain approach proposed by Thomson et al. (2013b) compared more favourably than several alternative and conventional FMD control approaches in terms of economic and environmental feasibility and sustainability in the ZR (Barnes, 2013; Cassidy et al., 2013). However, Naziri et al. (2015) also investigated the economic feasibility of several scenarios for market access of beef produced in the ZR. Naziri et al. (2015) used the same modelling approach applied by Rich and Perry (2009) to test the financial implications of a two-phase SPS management approach for beef traded from Ethiopia to the Middle East. Naziri et al. (2015) found that the additional costs of compliance with standards for food safety and quality in the EU will not be absorbed by anticipated price premiums offered by EU countries. Similar to the findings of Rich and Perry (2009) in Ethiopia, input costs required to obtain appropriate beef quality were an issue, and both studies subsequently proposed that regional markets be targeted instead. Importantly, Naziri et al. (2015) found that an increase in FMD outbreaks in the ZR will prove CBT to be more financially feasible, and hence these authors alluded to the major impact that market disruptions linked to FMD outbreaks had on the local economy. This finding was supported by the findings documented in Chapter 6 of this thesis.

The need for a holistic, community-driven value chain development approach

An integrated value chain approach to SPS and FMD risk management requires farmers to comply with certain prerequisites. Prerequisite programs in low-income households can either be a burden in the form of additional input costs and labour, or an incentive to adopt more sustainable and higher yielding production practices that could result in higher household income (Swinnen and Maertens, 2007; Rich et al., 2009). This also implies that the requirements for compliance with commodity-based trade standards by communal beef producers can discriminate against the smallest and poorest: those with below average herd sizes are most vulnerable to risk and shocks at the wildlife-livestock interface. Earlier chapters in this thesis have already highlighted this phenomenon in the ZR and in the MSA, in that farmers with below average herd sizes were less likely to trade formally, trade at all, or invest in quality improvement, compared to farmers with above average herd sizes. A newly developed value chain that does not account for this can therefore not be regarded as pro-poor (Fowler and Brand, 2011). While the integrated value chain approach proposed by Thomson et al. (2013a) does well to address previous uncertainties in how SPS and disease risk should be addressed in CBT approaches, it does not yet make provision for an appropriate prerequisite program. In not providing a practical implementation model that would enable farmers of all risk and asset categories to address their challenges and barriers, including risk associated with the presence of wildlife, its impact on poverty alleviation and biodiversity conservation will be limited. Disease control and trade standards are traditionally driven in a top-down fashion by the relevant authorities. However, true pro-poor value chain development requires a bottom-up approach, in order to identify the barriers to participation in a value chain, and so as to find solutions for meeting the required standards (Herr, 2007; Fowler and Brand, 2011). The concepts of pro-poor value chain development (Fowler and Brand, 2011), sustainable agriculture and rural development (SARD Initiative FAO, 2007), local value chain development (Herr, 2007), as well as local and community driven development (LCDD) (Binswanger-Mkhize et al., 2009) all require bottom-up approaches that deal with local-level constraints by empowering communities to drive their own economic destinies. This includes value chains that could help them to access markets and escape poverty. In this respect, community-based risk management arrangements, in association with a tailored prerequisite program developed to facilitate broader incentives for participation, should be explored (Bhattamishra and Barrett, 2010) in order to complement the value chain approach proposed by Thomson et al. (2013b). The different forms of risk a beef producer/farming community faces must be understood entirely, and based on such an understanding, strategies and incentives can be derived for the different income/asset categories of prospective value chain participants (Carter and Barrett, 2006; SARD Initiative FAO, 2007; Bhattamishra and Barrett, 2010; Fowler and Brand, 2011). In this context, a holistic approach to all forms of risk related to a farmer and his household's participation in a value chain, otherwise called supply chain risk management, is crucial, over and above risks associated with a particular target commodity (Jaffee et al., 2008). High-risk situations or value chains will be avoided by the poor, and failing to sufficiently address participants' multiple needs and threats could therefore jeopardize value chain participation and its meaningful impact on poverty alleviation, despite otherwise obvious incentives (Bhattamishra and Barrett, 2010; Fowler and Brand, 2011). If approached correctly by means of practical and innovative strategies, based on community-driven rather than state-driven arrangements that address both the complexity as well as the necessity for risk reduction at farmer level, alternative FMD control measures could provide sufficient incentive for and support with a farmer's pathway out of poverty (DFID, 2004; Perry and Rich, 2007; Perry and Grace, 2009).

In this respect, the combined results from the previous chapters provide sufficient insight into the reasons that previous efforts to improve formal beef trade in the ZR and NCAs of Namibia have struggled to sufficiently pull households out of poverty (Meat Board of Namibia, 2013). It is therefore essential that the proposed value chain approach based on CBT standards and its integrated HACCP approach (Thomson et al., 2013b) consider a more comprehensive prerequisite program that takes the complexity of the farming and conservation systems into consideration. Most importantly, it should use a pro-poor value chain approach to develop a mechanism through which it can become community-driven whilst accounting for the needs and requirements of various asset and poverty classes at the village level. An approach that facilitates community organisation and cooperation will offer livestock farming households the opportunity to turn many of the threats and risks they face into opportunities. It will result in them being pulled towards participation rather than needing to push them into participation, as in the case of the current market system in the ZR. Furthermore, it could provide a vital platform by means of which multiple stakeholders, such as conservation entities and development NGOs, could engage communities to further facilitate market preparation that is pro-poor and pro-conservation.

In this final chapter of the thesis, the objective will firstly be to highlight the economic impact that FMD outbreaks and control measures have on farmers' income and livelihoods. Secondly, case studies of integrated village-level interventions in communal farming systems elsewhere are investigated and used in combination with the findings of previous chapters in this thesis to derive a prerequisite program that is both pro-poor and pro-conservation. The model addresses all major risks experienced by farmers, in order to enable participation in an integrated value chain approach as well as compliance with associated CBT standards.

7.2 METHODOLOGY

The structure of this chapter starts by combining quantitative analyses which then feeds into a review of literature as well as case studies in order to jointly inform a proposed integrated model.

7.2.1 FMD outbreak: Zambezi Region 2012

The FMD outbreak was reported on 26 November 2011 at the Masikili crush-pen, from where it spread to three other crush-pens in the vicinity: firstly to Ihaha, then Ngoma and finally Ikumwe (Figure 7-1). Movement restrictions were immediately imposed throughout the entire ZR with ring vaccination implemented in a 40km radius around the outbreak areas (Outbreak Report, WAHIS, OIE).

The movement restrictions caused a total halt in all cattle trade in the ZR, just as the QS reopened in November 2011 in order to resume slaughtering in December the same year, after the dry season closure of the abattoir (September – October). A group of cattle (220 animals: two batches of 110 each) owned by 35 farmers throughout the ZR had already started their 21-day quarantine period in

November in order to be ready for the abattoir when it opened in December. These cattle were not allowed to be moved from the quarantine station regardless of their place of origin relative to the new outbreak. They had to remain in the QS until the movement restrictions were lifted – which only happened six months later in June 2012. The closest location of the FMD outbreak (Ikumwe) was 42km away from the KM QS – the closest QS to the outbreak and still far beyond the 10km radius around each outbreak (Article 8.7.25). The 35 farmers had to continue to provide for the herdsmen they had appointed to look after their cattle in the quarantine camp, although they pooled funds to do so in order to reduce individual costs over the longer stay in the QC (see results).

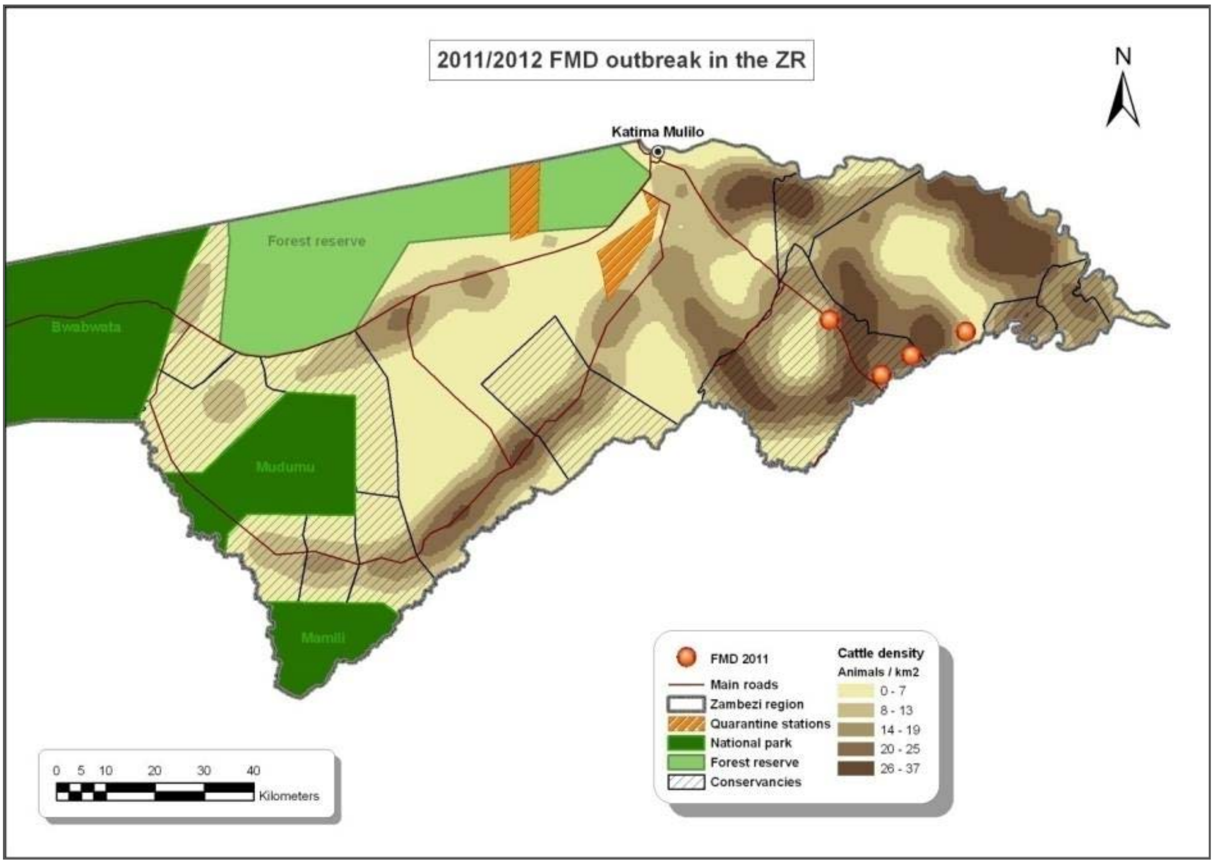


Figure 7-1: The location of the four villages in the ZR where FMD outbreaks occurred in the year 2011/2012

Estimated direct income loss to producers in the ZR (2011/12 outbreak)

Two models were constructed: firstly to estimate monthly loss of income by farmers across the entire ZR during the period the abattoir was closed as a consequence of the movement restrictions during the FMD outbreak; and secondly to estimate loss in income of farmers within the 10km radius of the FMD infected crush-pens only, based on the non-geographic based standard in Article 8.7.25 (TAHC – OIE).

This was based purely on estimated loss of income due to the inability to sell cattle to the Meatco abattoir. Calculations did not account for the possible further loss of income as a result of restricted informal trade. They also did not account for the possible role local informal trade could have played in reducing the loss of income from formal trade during the movement restrictions.

The first calculation: total loss of trade income in the entire ZR during the 2011/12 FMD outbreak

In order the quantify the estimated loss in income incurred by livestock producers during the 2011/2012 FMD outbreak, retrospective procurement data from Meatco was analysed over a five-year period (between 2007 and 2011). The data contained monthly prices paid to producers based on monthly summaries of carcass grades and weights from cattle purchased by the KM abattoir. Large gaps in the data were caused by the closure of the abattoir during a lengthy FMD outbreak from 2007 – 2009. Procurement data for every month during this period that coincided with the months during which the abattoir was closed (December 2011 to July 2012) was selected, averaged and used. Because the mean price in 2007 was significantly lower than that in 2010 and 2011, only the mean monthly prices per kilogram in 2010 and 2011 were used for the calculations (Figure 7-2). The mean carcass weights for all the months concerned during 2007-2011 were used in the calculations (Figure 7-3).

During interviews with farmers in selected areas of the ZR, they explained that in order to reduce transaction costs linked to trekking cattle and caring for them during their 21 days in a QS, a farmer had to sell at least five animals at a time. The 220 cattle that remained in the QS during the 2011 FMD outbreak were owned by 35 farmers. This amounts to an average of approximately six cattle per owner, an estimate which was corroborated by participating farmers during the interviews. A figure of five or six cattle per owner was then assumed to estimate the potential loss of income per owner during the 2011/12 outbreak.

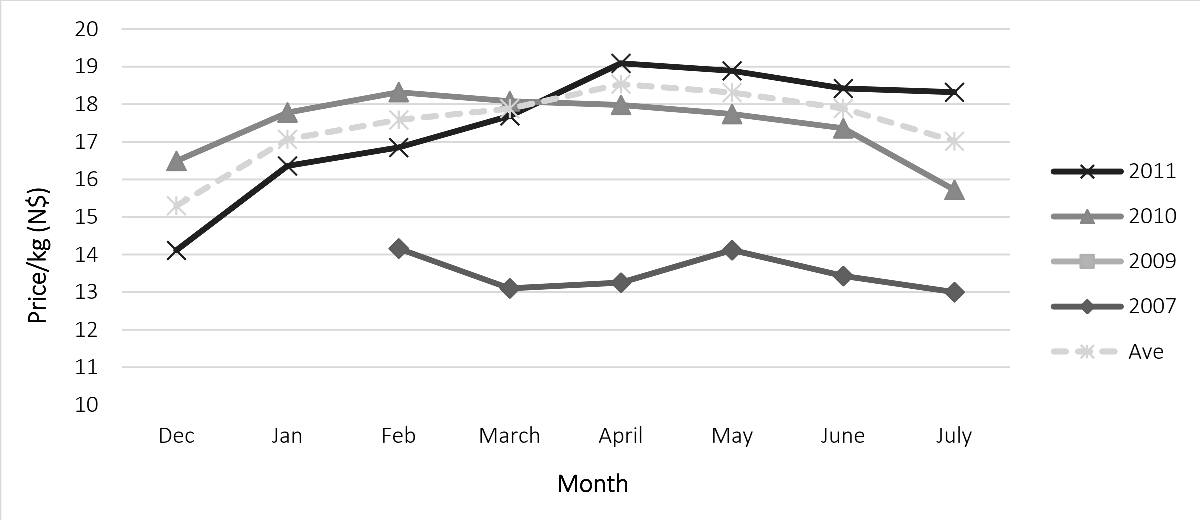


Figure 7-2: Average price/kg (N$) paid for carcasses during 2007-2011 and for the months December 2011-July 2012

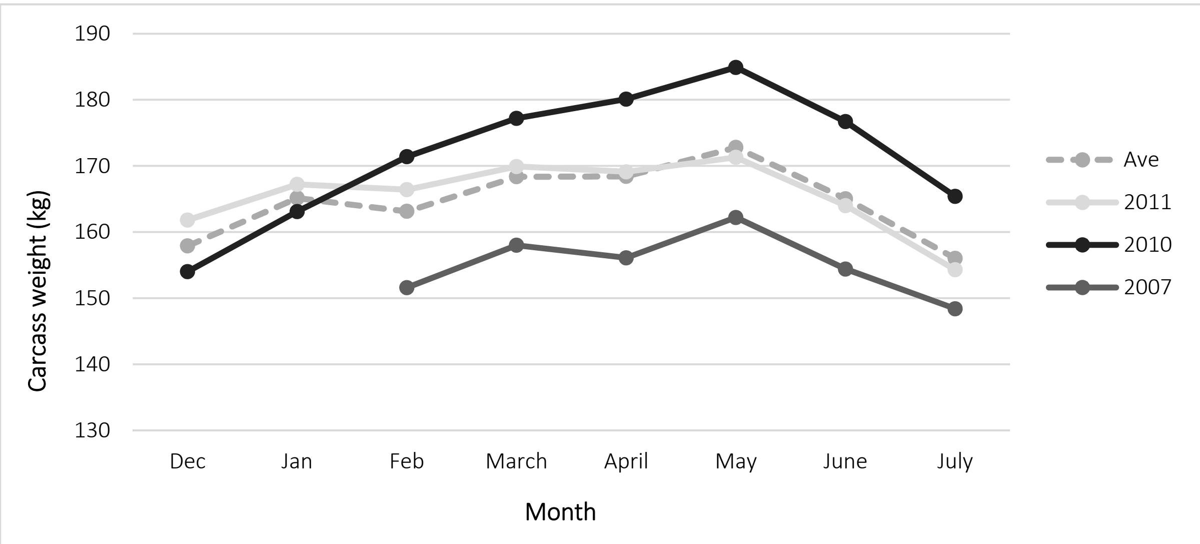


Figure 7-3: The average carcass weight (kg) of all carcasses slaughtered per month (December – July) in the years 2007-2011

The following assumptions were made in the calculations: 1) Similar trade levels would have occurred during the outbreak period as in the years before the outbreak, and 2) the 2012 price per kilogram would not be significantly different than prices paid out in 2010 and 2011.

The second calculation: Total loss in trade income of villages within a 10km radius in an outbreak area

Until mid-2015, Article 8.7.25 existed in the TAHC of the OIE, and paragraph 1(d) stipulated that a bovine animal could only be slaughtered if it occurred in an establishment (such as a crush-pen) where no FMD had occurred within a 10km radius in the 30 days before slaughter, and therefore quarantine was not required. However, due to the technical and practical difficulty of certifying that no FMD outbreak existed, either clinically or sub-clinically in either free roaming antelope and buffalo, or in cattle in a 10km radius around a crush-pen in areas such as the ZR (Thomson and Penrith, 2015), this paragraph was amended.

The most recent standard makes provision for the use of a quarantine station in areas such as the ZR where free-roaming wildlife occurs and in which FMD is endemic (Article 8.8.22) (Appendix 13). This analysis was initially based on the scenario linked to the previous standard (Article 8.7.22) in that cattle within a 10km radius of an outbreak cannot be moved to an abattoir for slaughter. However, although the updated standard makes provision for the presence of wildlife by including the quarantine station as an option, no guideline was provided for moving cattle from areas near an outbreak to a quarantine station. In this respect, we have assumed that the competent authority (Department of Veterinary Services or DVS) will not allow cattle from within a 10km radius of an active outbreak to be moved to a quarantine station for the purpose of being slaughtered 21 days later. The OIE TAHC does not make any provision in this regard either[20], but instead of omitting it from the analysis, this study has assumed the use of the same 10km radius around an active outbreak in the ZR from where cattle will not be allowed by DVS to be sent to a quarantine camp in the ZR. Crush-pens situated within a 10km radius of an active outbreak are indicated in Figure 7-4. The total number of cattle sold per month to Meatco in 2011 from each of the villages within the 10km radius was used for the period the abattoir was closed in 2012 as a proxy of the number of cattle that might have been sold. The value of trade per village per month was determined by using the same average weights and prices/kg used in the first calculation. The December 2011 cattle numbers were calculated based on a percentage of the annual trade numbers for December in previous years, because no trade data per village was available prior to 2011.

[20] Dr Gavin Thomson, TAD Scientific. Personal communication, 8 April 2016.

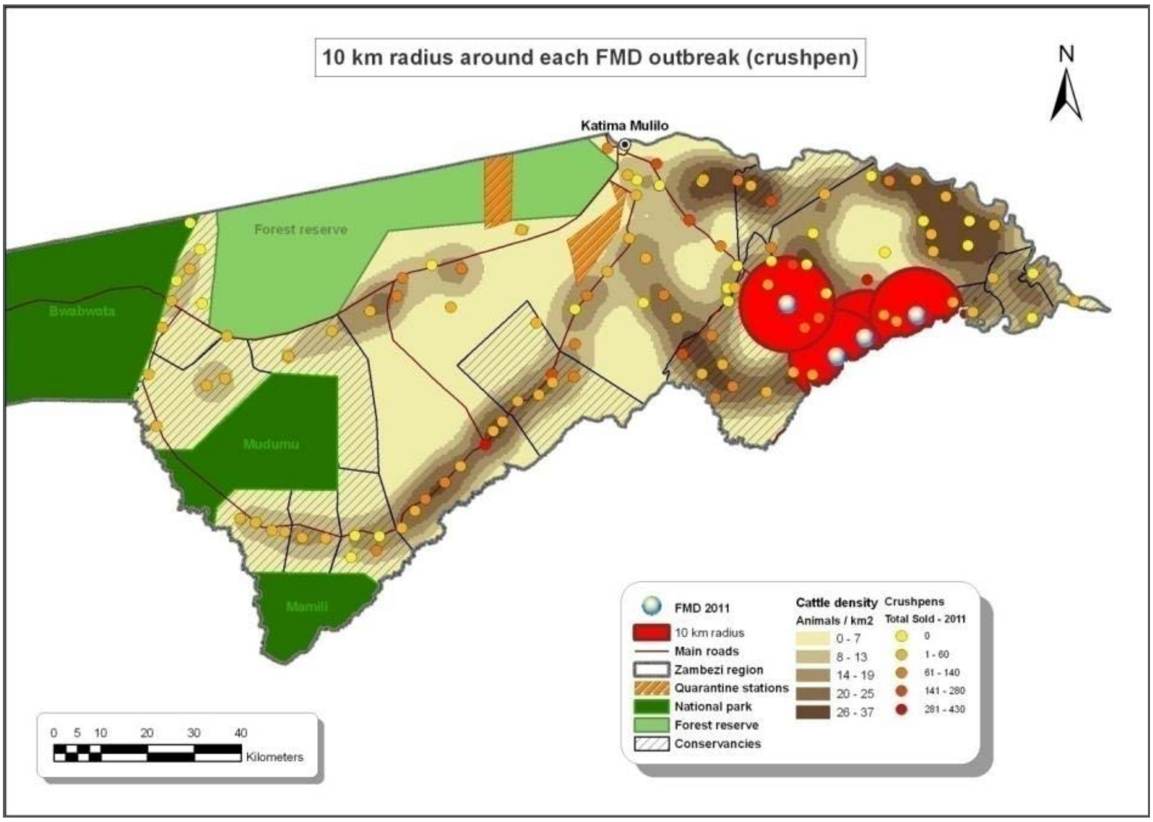


Figure 7-4: A map of the level of formal trade from each crush-pen in the ZR (2011 Meatco figures), as well as the villages that fell within the 10km radius around each affected crush-pen during the FMD outbreak of November 2011

The following assumptions were made in the model:

- The number of cattle that would have been sold from each crush-pen in the corresponding months of 2012 would have been the same as in 2011.
- Crush-pens were assumed to be in the immediate presence of cattle owners. A crush-pen in the ZR is an arbitrary 'establishment' in communal systems because an owner's kraal can be several kilometres away from the nearest government crush-pen. However, because cattle from the same village generally occupy the same grazing areas, they are considered an epidemiological unit; and stock registers and vaccination campaigns are conducted at the crush-pen level – not at individual kraals.

All calculations were conducted in Excel (Microsoft Office 2013).

7.2.2 Socio-economic impact of FMD outbreak and compliance to producer protocols

In 2013, several farmers in the ZR who wanted to register cattle for slaughter at the Meatco abattoir in Katima Mulilo were asked to participate in an experiment designed to quantify risk of FMD transmission, by managing food safety and disease risk along the beef production value chain. The objective was to prove equivalence in the level of risk posed by the alternative commodity-based approach to beef, in the form of managing risk along the value chain; as opposed to conventional trade standards associated with FMD control. Farmers wanting to supply cattle to the Meatco abattoir between April and July 2013 were randomly approached and asked to participate. The cattle belonging to these farmers had to be transported to the quarantine stations by truck (as opposed to being trekked on foot) and had to be vaccinated against FMD, before transport and again before slaughter, in addition to routine bi-annual vaccinations. Farmers willing to participate were asked to sign and comply with a basic producer code, which stipulated the farmer's responsibility to take certain measures to manage on-farm animal health risk as well as food safety and quality. The seven terms that the farmers agreed to were as follows:

1. Record keeping
2. Animal identification – branding and tagging
3. Vaccination for FMD (i.e. presenting cattle for vaccination)
4. Treatment for internal and external parasites
5. Grazing management
6. Preventing buffalo contact (herding and kraaling)
7. Reporting disease to the Department of Veterinary Services

The quantitative risk assessment was executed by a research team closely associated to this study and reported separately (Meat Board of Namibia, 2014). However, 10 of the 22 farmers who signed the producer protocol were interviewed in October 2013 in order to evaluate challenges they have faced in complying with the terms of the producer code. The results of this evaluation will be referred to in the next section and were included in an unpublished report linked to an associated study (Van Rooyen, 2014). However, during the interviews of October 2013, as well as during a feedback session with farmers that took place earlier in 2013, interviewees were asked to explain the way in which the FMD outbreak in 2012 had affected them. Such a question was not asked in the November 2011 interviews, because at that point there had not been an FMD outbreak in the ZR for approximately two years.

7.3 Results and Discussion

7.3.1 FMD impact

Calculations presented in Table 7-1 indicate that an estimated total amount of N$19 263 941 in direct revenue was lost by communal farmers during the FMD outbreak of November 2011 – July 2012. An estimated total of 7 165 cattle could not be slaughtered at the abattoir. Trade was already possible from June 2012, but because cattle need to be quarantined for 21 days prior to slaughter at the Meatco abattoir, there was a delay of a month. The 220 cattle that were in the Katima quarantine camp (QC) when the outbreak started in November were slaughtered in May 2012. As previously discussed, based on the assumption that farmers generally sell five or more cattle at a time to Meatco, an estimated value for income lost per farmer was calculated, based on the estimated number of cattle slaughtered per month. The results indicated that a beef farmer would have lost an estimated N$13 340 per month. The most significant loss would have been experienced by individuals who wanted to sell in the month of January, at an estimated loss of N$14 184.

Table 7-1: The estimated loss in direct income (N$) due to the inability of communal beef producers in the ZR of Namibia to trade formally with the Meatco abattoir in Katima Mulilo during the 2011/12 FMD outbreak in the ZR

Description	Dec	Jan	Feb	March	April	May	June	July	Total
Estimated monthly loss in income (N$)	1 102 985	2 801 303	3 003 998	2 779 067	2 857 609	2 457 288	2 234 135	2 027 555	19 263 941
Estimated number of cattle	445	988	1 112	1 008	1 019	876	880	837	7 165
									Average
Estimated average income per animal (N$)	2 478.62	2 836.76	2 702.25	2 757.92	2 803.41	2 805.12	2 538.79	2 421.44	2 668.04
5 animals per owner:									Total
Est. number of owners*	89	198	222	202	204	175	176	167	1 433
									Average
Est. income per owner (N$)	12 393	14 184	13 511	13 790	14 017	14 026	12 694	12 107	13 340

**Calculated by dividing the estimated number of cattle sold per month with five, based on the assumption that generally farmers market at least five animals at a time with Meatco*

Table 7-2: The estimated loss in direct income (N$) due to the assumed inability of communal beef farmers situated within a 10km radius of the crush-pens where FMD outbreaks occurred in the 2011/12 FMD outbreak in the ZR

Area	Constit.	Dist.	*Dec	Jan	Feb	March	April	May	June	July	Total
Ihaha	Kabbe	54km		0	10	0	0	0	0	18	11
Masikili	Kabbe	59km		0	10	15	20	3	10	9	51
Ikumwe	Katima	42km		36	11	6	38	15	40	50	115
Ngoma	Katima	56km		41	71	10	22	0	18	54	154
Liangwe	Kabbe			0	0	0	0	0	0	0	0
Kabbe	Kabbe	39km		6	45	28	43	7	76	9	139
Mudaniko	Kabbe			0	0	0	0	0	0	0	0
Mukanwa	Katima	37km		0	0	0	0	0	10		0
Malimina	Kabbe			0	0	0	0	0	0	0	0
Izimwe	Katima	49km		6	14	8	8	0	10	37	40
Limai A	Katima	47km		47	17	0	0	35	0	6	103
Ioma	Katima	51km		0	8	0	12	0	0	0	21
Isuswa	Katima			0	6	0	40	0	0	0	48
Nakabulelwa	Kabbe	63km		0	9	0	29	0	0	0	40
Ivilivinzi	Kabbe	72km		0	4	34	0	0	0	0	40
Total sold per month			**47**	**136**	**205**	**101**	**212**	**60**	**164**	**183**	**761**
Average weight per animal (kg)			158	165	163	168	168	173	165	156	
Average Price/kg (N$) (2010/11))			15.30	17.07	17.59	17.89	18.54	18.32	17.89	17.02	
Total income loss (estimated) (N$)			113 541	383 399	588 083	304 135	661 845	189 890	484 201	485 991	**3 211 086**
Estimated no. of owners (5 animals/owner)			9	27	41	20	42	12	33	37	**222**

Table 7-3: A summary of the responses of farmers (n=10) interviewed in the ZR in 2013 to explain the effect of the 2011/12 FMD outbreak on their livelihoods

No.	Place	Respondent	Response
B5	Lusese	Middle-aged man, cattle owner Total herd: 200	B5 stated that many people are not working. They can't support children at school/varsity or even buy maize meal without selling cattle. People start discriminating against Ngoma area. B5 wanted to sell some older animals but couldn't and ran the risk of losing them.
B6	Kanono	Old man, cattle owner Total herd: 120	B6 wanted to sell 20 but couldn't. Ended up selling 3 cattle to the local market just to buy medicine.
B7	Linyanti	Young man, cattle owner and entrepreneur Total herd: 70	B7 wanted to sell 10 to start a new business but couldn't. Had to wait until this year - 6 cattle sold in January - did start the business thereafter.
B8	Lianshulu	Middle-aged man, entrepreneur and cattle owner Total herd: 106	B8 had cattle in the QC during the outbreak, had to sell to pay university fees. They kept them for 5 months. B8 had to run around to borrow money and sold cattle afterwards to pay money back. It was Katima QC. Condition of cattle was good. Farmers clubbed together to pay herdsmen to look after the cattle.
B9	Muyako	Middle-aged woman, widow, cattle owner and entrepreneur Total herd: 45	B9 needed cash for herd boys, food etc. and wanted to sell any 5 cattle but could not do so. When the outbreak started B9's husband was alive. He wanted to sell old animals before they died. When her husband passed away B9 couldn't sell his cattle and wanted to sell some of her own (separately owned but within the same kraal) for her son's university fees, but the 5 old ones died before they could be sold. B9 had to sell 7 of her animals and 2 belonging to

			her son in the beginning of this year. She couldn't sell them after the outbreak because the register was full: she went twice and only got an opening at a QS in the beginning of 2013.
B10	Linyanti	Young woman, co-owner with her family and student at UNAM Total herd: 500	B10 planned to sell 20 but couldn't: arrived at QC then the outbreak started. B10 had to keep them for 6 months in the QC and lost 6 during the time in the QC. The money from the sales was to be invested, to buy more cattle and to help the family. After outbreak B10 let some be slaughtered and some were taken back.
A1	Malindi-West	Older man, entrepreneur, livestock owner and community leader Total herd: unknown	During an outbreak A1 has to sell locally. It is not sufficient to sell locally. For example, A1 wanted to sell four old cattle to Meatco, couldn't sell and ended up having to sell many more cattle locally for a lower price in order to cover costs of his children's tertiary education. *'My friend Justus: his child has a scholarship in India but it is N$10,000 for his transport to go there. He couldn't sell cattle and after the outbreak those cattle had died.'*
A2	Sangwali	Older man, livestock owner Total herd: unknown	A2 planned to sell in summer because there is water and grass along the way. A2 tries to sell 10 three times a year. Sold some locally but some died. A2 was a mentor for some farmers and they registered around 10 cattle with him. Due to the outbreak some were not able to send their children to school.
A3	Lizauli	Group of three middle-aged men, cattle owners Total herd: unknown	*'The outbreak had a big impact on people. We get punished for other people's sins! Some people slaughter and sell local. The meat coming from animals gives little money.'*

- Interviews A1-3: Opportunistic interviews during feedback sessions with farmers in February 2013
- Interviews B5-10: Opportunistic interviews with farmers that participated in a value chain pilot, October 2013

The total estimated loss of income to communal beef producers within a 10km radius of each of the four FMD infected crush-pens in the 2012 FMD outbreak was N$3 211 086 (Table 7-2). The results indicate that approximately 761 cattle owned by 222 owners could not have been traded due to the FMD outbreak and their proximity to the infected crush-pens. If only those farmers within a 10km radius of the active FMD outbreak were not allowed to trade, and all other areas continued to trade with the KM abattoir as per normal, the loss of income to cattle owners in the ZR would have been reduced by an estimated total of N$16 052 855, or 83%. Additionally, 85% fewer cattle owners would have been affected in the ZR and the abattoir would have been able to continue to operate despite receiving an estimated 28 animals per month less from the affected areas. Such a small number could easily have been procured elsewhere.

The impact that the 2012 FMD outbreak had on cattle-owning households that normally traded with the KM abattoir is summarised in Table 7-3. Most of the farmers can be considered large farmers with above average (approximately 50 animals) herd sizes, with the exception of one woman (Interview B9). It was clear that all the farmers interviewed in October 2013 planned on selling to Meatco in 2012 but could not due to the outbreak and the subsequent abattoir closure. None of the farmers was situated within a 10km radius of one of the infected crush-pens in 2012. The reasons that they wanted to sell varied, but most needed the income to pay for education – especially tertiary education for children at university. The fact that they had large herds and the ability to sell a big enough number of cattle annually was most probably the reason their children could attend a university in the first place. It also meant that not being able to sell the animals was an immediate household shock. University fees have to be paid annually and farmers had to either borrow the money or sell their cattle to local villagers at a much lower price. It also meant they either could not sell enough due to the limited absorption capacity of the local market, or they had to sell more than they intended to make up for the lower price. The farmer that needed the income to start a business was able to delay his plans until early 2013, when he was able to sell his cattle and start his business.

Evidence of substantial secondary impacts are seen in the fact that almost all farmers recalled mortalities among the cattle they could not sell, which added a significant extra burden on their households. This burden is especially significant for farmers with smaller herd sizes, such as the woman in interview B9. She ended up losing all five of the animals they planned on selling initially and was forced to borrow the money. She had to pay the salaries of herders and use the money for other household and business expenses. In the end she had to sell five of her own and two of her son's animals to pay the debt and cover her expenses after two unsuccessful visits to the abattoir procurement office after the outbreak, to register her animals for slaughter. A further knock-on effect of the FMD outbreak she and other farmers experienced was their inability to invest money back into their cattle to maintain herd health, condition, and management practices such as herding. This implies a downward spiral where returns on inputs and management cannot be turned into profit through trade in order to reinvest, improve, and progress out of poverty (Perry and Rich, 2007; Barrett and Carter, 2013). Furthermore, as indicated in previous chapters and in studies conducted elsewhere in the northern communal areas of Namibia, the local informal market does not have the ability to absorb trade meaningfully in the absence of more formal trade (Duvel and Stephanus, 2000). There is therefore sufficient evidence to suggest that a substantial number of the estimated 7 165 cattle that were not slaughtered during the 2012 FMD outbreak were not absorbed by the informal market and most likely died due to the high local stocking rates in many areas (Chapters 3 - 5).

A household such as that of B9 (Table 7-3), who planned to sell five cattle in order to generate an estimated income of N$13 340 (Table 7-1), experienced a significant shock due to the inability to trade during the FMD outbreak. The ZR was one of only three regions in Namibia that experienced an increase in the number of impoverished individuals between 2001 and 2011 (NPC, 2015). In this period the total estimated direct loss of income to farmers in the ZR due to their inability to trade with the Meatco abattoir was estimated at approximately N$91 million (see Chapter 6). Even more significant is the fact that this figure could potentially have been 83% lower if alternative non-geographic standards for FMD risk management had been implemented. Two recent estimates have indicated that when an integrated value-chain approach to SPS and FMD risk management based on CBT standards is applied, results are more favourable economically and in terms of multiple land use approaches (Barnes, 2013; Cassidy et al., 2013). A third economic evaluation (Naziri et al., 2015) did not account for the potential added benefits of a trade system that allows for multiple land use systems and risk management approaches. It did, however, find that the significant economic impact of regular market disruptions linked to abattoir closures based on conventional FMD control approaches significantly favoured the economic potential of CBT.

The qualitative accounts of farmers provide a glimpse of the significant negative social and financial knock-on effects the control of FMD can have on farmers in the ZR, especially the most vulnerable, such as widows. Farmers will therefore remain reluctant to trade if they have a smaller number of cattle, because the high risk of not being able trade during a sudden outbreak may increase their vulnerability, due to retaining cattle for longer and competing in a very saturated local market. For many farmers, the stakes in meeting the current requirements and associated benefits that formal trade may offer in the ZR will be too high. They will rather remain risk averse, reluctant to increase management inputs and most likely be tempted to trade illegally if favourably positioned to do so (see Chapter 6). It will most certainly increase their resistance towards biodiversity conservation based on the acknowledged link between higher buffalo numbers in some areas and the increase in FMD outbreaks (see Chapter 4).

7.3.2 A village-level prerequisite program

The need for a community-driven approach

In Chapter 1 of this thesis a synthesis of literature in terms of approaches to conservation, farming systems, health management, rural development, poverty alleviation, and value chain development in FMD control areas at the wildlife-livestock interface emphasised the need for holistic, integrated approaches that address the complexity of the challenges faced. The importance of community-driven approaches in order to equip and empower the poor so as to determine and own their economic destiny was highlighted (Binswanger-Mkhize et al., 2009). However, in TFCAs where these multiple approaches (including their associated stakeholders and role players) need to be considered at multiple scales, the complexity involved in the development of community-driven GAPs for trade in CBT may be overwhelming (see Figure 7-5). Yet, if the objective is for CBT approaches to address poverty alleviation and biodiversity conservation simultaneously, a unique strategy that goes beyond the requirements of trade standards and animal health and production is needed.

Pro-poor development requires a combination of higher income *and* the equitable distribution of income despite the on-going debate regarding potential trade-offs between the two elements (Whitfield, 2008). In order to promote pro-poor growth findings, the Operationalizing Pro-Poor Growth Research Program (OPPG., 2005) suggested improved market access and reduced transaction costs, strengthened property rights for land, the development of an incentive framework that benefits all farmers, expansion of the technology available to smallholder producers, and helping poorer and smaller farmers to deal with risk as illustrated in Figure 7-5. The UK Department for International Development (DFID) had similar recommendations for accelerated pro-poor development (DFID, 2004): the creation of strong incentives for investment, the fostering of international economic links, broad access to markets, and reduced risk and vulnerability.

Will the prospect of improved market access alone, as offered by CBT in areas such as the ZR and the MSA, be enough incentive for all the poor farmers in a village to participate in the value chain? The answer is no, quite simply because for the very poor the prospect of market access and improved income generation is secondary to the importance of the mitigation of major risks and threats to their livelihoods (Fowler and Brand, 2011).

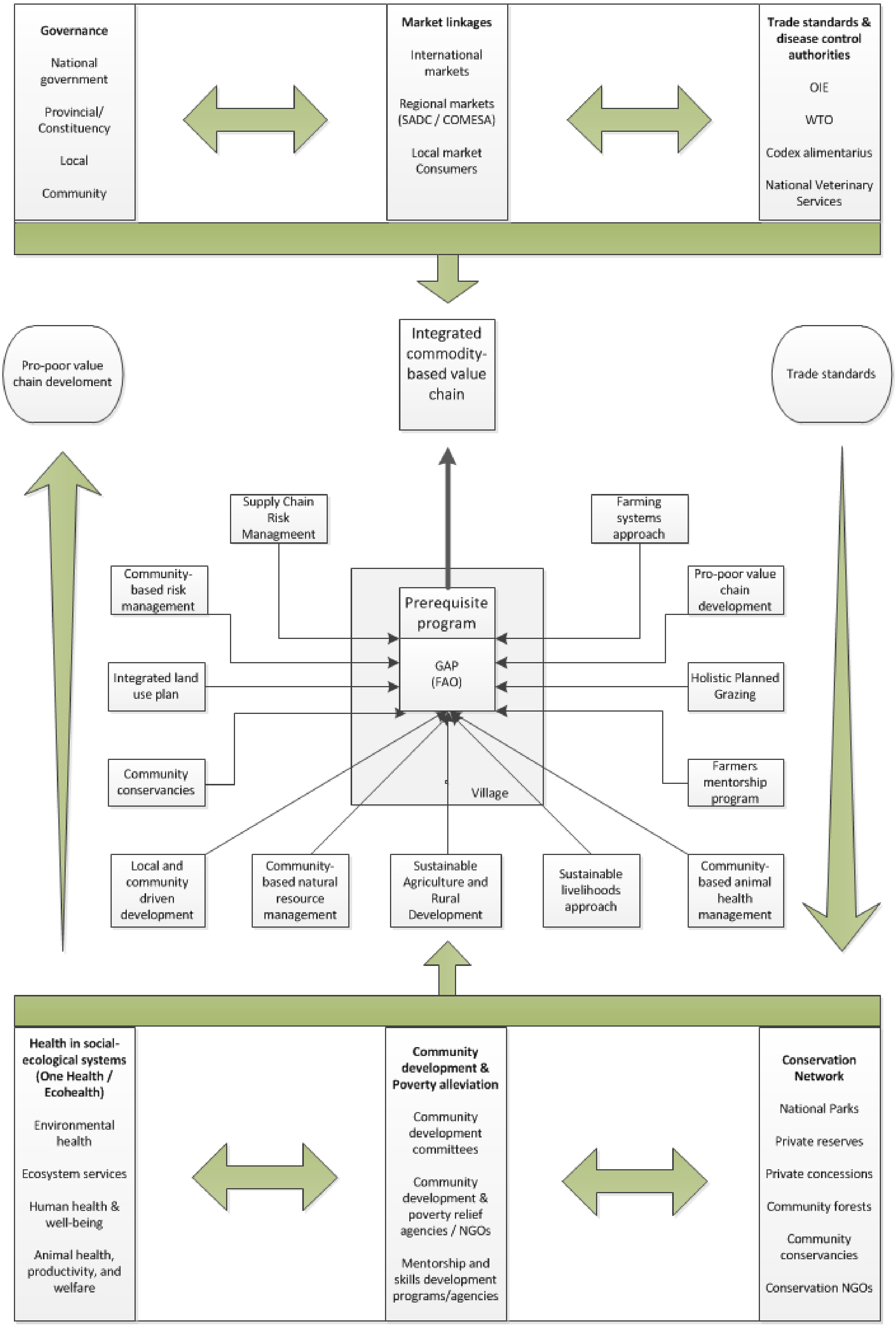


Figure 7-5: Complexity of approaches, strategies and policies within the FAO framework as part of a community-driven prerequisite program feeding into a CBT-based value chain that considers both bottom-up (pro-poor value chain development) and top-down (trade standards) mechanisms

A case in point is the proposed basic requirements with which a farmer needs to comply prior to entering a value chain based on CBT standards. An HACCP approach to managing risk along a value chain, as proposed by Thomson et al (2013b) and suggested for use in the case of CBT, is established upon a functional prerequisite program (Schmidt and Newslow, 2013). A prerequisite program implemented at the site of production typically includes a set of Good Agricultural Practices (GAPs) that should be tailored to meet the market requirements, the farming system, as well as the need for certification (SARD Initiative FAO, 2007). In order to comply with the minimum requirements for sanitation and disease risk management, as well as product quality at the site of production, Thomson and Penrith (2015) proposed several actions that a beef producer in the ZR should be able to apply (Table 7-4).

Table 7-4: Example of actions that could be required from beef producers

Location	Suggestions		
	Improvement of product quality and quantity	Achievement of appropriate level of protection for food safety	Achievement of appropriate level of protection for animal disease control
On-farm (field)	•Animal identification and record keeping • Compliance with producer protocol adapted to area (grazing strategy, supplementary feeding practices, herd management/breeding practices, and general health management) • Provision of essential infrastructure such as loading ramps for cattle	• Animal identification, record keeping, and effective traceability systems • Avoidance of undesirable feeding practices (e.g. use of meat/bone meal), observance of treatment recommendations for control of parasites and infectious diseases (including withdrawal periods of drugs used for treatment)	• Animal identification, record keeping and movement records/control • Grazing and kraaling strategies that avoid contact with buffalo as far as possible • Compliance with vaccinations programmes aimed at control of specified diseases including FMD • Monitoring of compliance at farm level (animal health/extension services)

Most of these activities (Table 7-4) were actions included in a producer protocol piloted in the ZR during an associated study in 2013 (see section 7.2 of this chapter). While several of the requirements were services provided by the local Department of Veterinary Services (DVS) in the ZR, such as FMD vaccination and animal identification (traceability), an evaluation of farmers' ability to comply with these challenges indicated that all farmers experienced challenges in this regard (Van Rooyen, 2014). The biggest constraint was in keeping records, most notably due to a lack of skills and tools. Herding and avoidance of contact with buffalo was the second biggest constraint despite the fact that all participating farmers employed full-time herdsmen. Firstly, farmers did not spontaneously think of herding as a potential strategy to avoid contact with wildlife, such as buffalo, although they admitted its potential application in this regard if training were to be provided. Secondly, they found the lack of skilled and reliable herdsmen to be a problem. Lastly, they were very concerned about broader compliance with the requirement of full-time herding, especially for smaller farmers, due to the costs associated with this practice. Half of the farmers experienced problems with treatment and disease control because of a lack of skills, funding, as well as access to the necessary drugs. Three farmers indicated that they did not have a grazing strategy, and after further discussion, it was found that those who thought they had grazing strategies were referring merely to seasonal movements. Only one farmer grazed different areas every day in the vicinity of his village, as part of an informal rotational grazing strategy.

How would CBT, in the form of its proposed integrated value chain approach, enable pro-poor poverty alleviation and rural development that is equitable, sustainable, as well as pro-conservation? This study proposes that the solution lies in the establishment of a village-level and community-driven initiative that will mobilise collective action based on an incentive framework for cattle farmers that will 1) address major risks, 2) enable compliance and market participation, and 3) enable wildlife-livestock compatibility. In a review by Barrett (2008) on the limitations for market access of small-scale farmers in eastern and southern Africa, the author concluded that interventions aimed at facilitating smallholder organisation reducing costs of intermarket commerce, and improving access to technologies as well as productive assets, are central to stimulating market participation by the poor in order for them to escape poverty. The ability of farmers to cooperate in some form of organised collective action has been shown to significantly improve their ability to manage risk, cope with shocks, reduce vulnerability, facilitate market engagement, and comply with food/market standards (Bhattamishra and Barrett, 2010; Van Schalkwyk et al., 2012; Naziri et al., 2014; Hawkins, 2016).However, the same authors also indicated that factors such as sufficient capacity building and training, appropriate corporate governance linked to auditing, as well as compliance with certification, were all essential requirements in various contexts, and determined the level of successful group action.

The question then becomes: what are the most important elements that should be addressed in an incentive framework in the context of trade at the wildlife-livestock interface in TFCAs, as suggested for community-based development approaches that are pro-poor?

Table 7-5 lists a number of the risks and requirements that both communal beef producers in the ZR and the MSA highlighted. It also includes the requirements for participating in a CBT value chain as well as some of the important disease/food safety risks that must be controlled in such a value chain (Thomson et al., 2013b; Thomson and Penrith, 2015). It can therefore be argued that strategies that will enable beef producers to mitigate such risks can also be included in an incentive framework, if participation is financially feasible. Without a strategy to feasibly mitigate risks, these risks will continue to prevent action and limit market access and/or a poor household's potential pathway out of poverty.

Livestock Farmer		Beef Market	
Risks	*Requirements*	*Risks*	*Requirements*
Disease / injury / damage	More grazing / grazing management	Infectious agents	Basic infrastructure (animal handling)
Stock theft	Access to veterinary drugs	Food safety	Record keeping
Predation	Training and skill development	Cattle-buffalo contact	Carcass quality & quantity
Wildlife competition	Market access and trade	Disease outbreak	Motorised transport
Buffalo contact	Improved carcass quality	Drug residue	Contact avoidance with buffalo
Trade costs	Record keeping		Vaccination & health management
Movement control	Animal genetics		Traceability
Drought (grazing and water shortages)	Improved health management		
Lost animals	Improved productivity		
	Conservation beneficiation		
	Enterprise development		

Table 7-5: A summary of the risks, challenges, and requirements of both beef producers at the wildlife-livestock interface as well as the beef trade value chain has (based on CBT standards). A summary of findings from previous chapters in this thesis.

Combined herding and/or kraaling

Holistic Planned Grazing (HPG) is a collective strategy that cattle farmers in all risk/asset categories can implement at the village level in communal farming systems. HPG follows the principles of holistic management as developed by Allan Savory (1999), in order to enable communal farmers to implement improved rangeland management strategies regardless of their skill, income, or education levels. The strategy requires collective action by farmers sharing the same rangeland by means of non-random, combined herding of cattle according to a basic grazing management plan. Strategic kraaling is further used as a tool to rehabilitate damaged or degraded patches of grasslands. Although holistic management applies to an entire farming operation or household, its approach to planning rangeland management in communal systems will be discussed, as this has particular relevance to risk reduction, conservation and community empowerment.

HPG is based on the multiple benefits to rangeland health and productivity that large herds of wild herbivores experience, due to their natural way of moving across grasslands whilst grazing and avoiding predators. In mimicking the way large herds of wild herbivores have utilised rangelands throughout millennia to effect vital nutrient distribution across terrestrial landscapes (Doughty et al., 2015), HPG designed a range of tools and training packages to mobilise collective action at village level and to manage available rangelands by means of one combined herd of all livestock in a village (cattle, sheep, and goats) (Savory, 1999). The advantage of HPG is that it addresses a pertinent need of all pastoralists – the management of their grazing and their livestock, in terms of which poorer livestock owners often do not have the necessary resources and skills. Grazing areas and associated fodder supplies are managed according to a grazing plan, adapted daily by a team of trained herders and a grazing committee at village level. The best combination of trampling, dung, urine, cropping, as well as rest is applied in order to specifically rehabilitate overgrazed areas and improve the grass sward productivity of intact areas (Savory, 1999; Peel et al., 2014). It also allows farmers to provide for the dry season when fodder would otherwise be limited. Crucial to the success of HPG in communal systems is its tools and systems, to enable unskilled full-time herdsmen to keep meticulous records of grazing, land use, stocking rates, rangeland quality, and fodder reserves. Based on a decision tool, herders are able to collect information needed to make decisions that enable them to manage their rangelands in a better, sustainable manner.

Despite the criticism that HPG applied to high-density grazing scenarios in commercially farmed pastures (ranching systems) can result in undesired effects on grass composition and productivity (Tainton, 1999; Hawkins, 2016), it has been found to have favourable effects in communal systems (often transhumant systems) (Peel et al., 2014). The merit of this unique system in terms of assisting communal farmers to keep records and make decisions is also widely acknowledged (Tainton, 1999). Furthermore, there is evidence that on many of the commercial farms where HPG failed, this was due to a lack of rangeland insight by the farmers themselves, who often applied HPG as a recipe rather than a tool within a flexible decision-making framework[21]. It is this decision-making cycle, which even

[21] Rolf Pretorius, Holistic Management Hub South Africa, Pretoria. Personal communication, March 2015.

communal farmers follow, that has proven to be a vital tool for the successful implementation of HPG in rural pastoral systems at the wildlife-livestock interface in southern and eastern Africa (Appendix 14).

Several other initiatives that use HPG principles will be discussed briefly, followed by their possible link to GAPs.

Community-based livestock and rangeland management, northern communal areas of Namibia: 2010 – 2013 (GOPA, Millenium Challenge Account (MCA) – Namibia (USAID))

HPG, which mainly focuses on grassland restoration and management rather than on animal production and health management itself, has been built into a community-based rangeland and livestock management (CBRLM) model. A CBRLM initiative focuses on combining the principles of HRM with improved cattle management, production, and health management, and ultimately market access (Masaire, 2014). A very large CBRLM program has been implemented over the past four years in most of the NCA of Namibia, west of the ZR (Nott, 2013). The program is an MCA-Namibia USAID funded initiative implemented by GOPA.[22] Its success has been evident in the many positive reports from farmers in areas where communities have decided to adopt the initiative, and from the monitoring and evaluation of rangeland and herd performance (Masaire, 2014). The project did, however, struggle with improved market access, most notably because there was significant pressure to improve off-take rates within a short time frame; which did not allow for farmers to adapt and prepare for different market options (Masaire, 2014). There was also no evidence of a differentiated approach to farmer support and market access based on the different needs and perceptions of small, medium, and large cattle owners within the combined intervention at village level.

Meat Naturally Initiative (MNI), Conservation South Africa (CSA)

The MNI of the CSA (www.conservation.org) is an NGO linked to the Conservation International (CI) network. The CSA takes a landscape-level approach within selected biodiversity hotspots in South Africa so as to develop and implement sustainable land-use practices that are pro-poor and pro-conservation. Integrated Landscape Initiatives (ILIs) have become popular, as they acknowledge that local-level approaches are vulnerable to impacts on ecosystem services in the broader landscape, and therefore aim rather to target entire catchment areas or landscapes (Milder et al., 2014). The MNI initiatives of

[22] GOPA Worldwide Consultants: http://www.gopa.de

the CSA strive for the development of sustainable red meat production practices that enable both biodiversity conservation and communal farmer development. They have targeted two communal systems in South Africa in recent years: the Succulent Karoo (Northern Cape) and the Matatiele area in the Eastern Cape (Nel et al., 2014). Farmers are enabled to initiate HPG within their grazing areas and the program provides training for selected herdsmen. MNI has developed an innovative approach to full-time herdsmen at village level, called *eco-rangers*. Eco-rangers are selected in each village, and are enrolled in a government Expanded Publics Work Program, which provides a basic salary based on the numbers of hours worked (CSA, 2013b). Eco-rangers are trained to plan and map grazing areas and to continuously collect data to monitor biodiversity indicators in rangelands through the use of mobile devices (CSA, 2013a). The program supports predator-friendly livestock keeping strategies for small-stock areas next to conservation areas in the Karoo (CSA, 2013b). Combined kraaling and herding is used in some areas, where teams clear invasive species to help rehabilitate damaged rangelands by means of cattle and HPG principles. MNI developed a standard for good rangeland management practices, which they hope to promote nationally through biodiversity management entities in government. MNI recently established an MNI brand for red meat produced in their project areas, which can feed into selected major retail systems in South Africa (CSA, 2013b). This approach will lead to good agricultural practices while creating essential consumer awareness for sustainable, pro-poor and pro-conservation red meat production practices. They have also made significant progress in the development of an innovative Eco-ranger training curriculum, which will include components of HPG, data collection, livestock record-keeping and production approaches, as well as aspects of animal health care[23].

Community Conservancy/Cattle Post Initiative, IRDNC, ZR - Namibia

The Integrated Rural Development and Nature Conservation (IRDNC) NGO in Namibia has been instrumental in the establishment and support of many community conservancies (Nuulimba, 2012). Since legislation was passed in Namibia that allowed communal land users to benefit from eco-tourism initiatives on collectively managed land, many community conservancies have experienced substantial benefits in terms of biodiversity, natural resources, and households (Nuulimba, 2012; Cumming et al., 2013; NACSO, 2015). In the ZR, the IRDNC realised (as was shown in this study as well) that significant amounts of rangeland exist in distant areas of the Mopane and Kalahari woodlands, which are inaccessible to livestock due to their distance from water. Due to the success of HPG approaches in the

[23] Rosanne Stanway, CSA. Personal communication, December 2015.

Kunene region of Namibia, they started to provide the necessary capacity and support for its implementation in the ZR in the form of a cattle post scenario (Nuulimba, 2012). A cattle post is established deeper inside conservancies, away from villages and associated natural water sources, in areas outside the normal range of both domestic and wild grazers (see Chapter 5). Farmers from nearby villages who are willing to commit to the principles of HPG are supported and trained by the IRDNC, and the project pays for the establishment of a borehole, pump, generator, and tanks with troughs (Nuulimba, 2012). Farmers then establish their kraals around the borehole, from where they can graze the surrounding rangelands. Herdsmen (often the farmers themselves) stay at the cattle post. Farmers are responsible for maintaining the borehole and pump infrastructure. There is, however, no support provided in terms of livestock production, health, or marketing. Neither is the initiative linked to the Farmers Mentorship Program of the Meat Board of Namibia, which is also operational in the same areas. There is no reward-based incentive for participating in a cattle post by linking the intervention with opportunities in the conservation market.

The findings in Chapters 3-6, together with experiences from the aforementioned case studies, suggest that combined, planned herding and kraaling at village level in communal farming systems at the wildlife-livestock interface has the potential to link positively to most of the farming requirements identified in this and other studies (Table 7-5; Figure 7-6). It also has the potential to serve as a village-level incentive framework for equitable participation, on a platform that enables farmers to comply with the requirements of a prerequisite program, based on the principles of Sustainable Agriculture and Rural Development (FAO, 2004; SARD Initiative FAO, 2007).

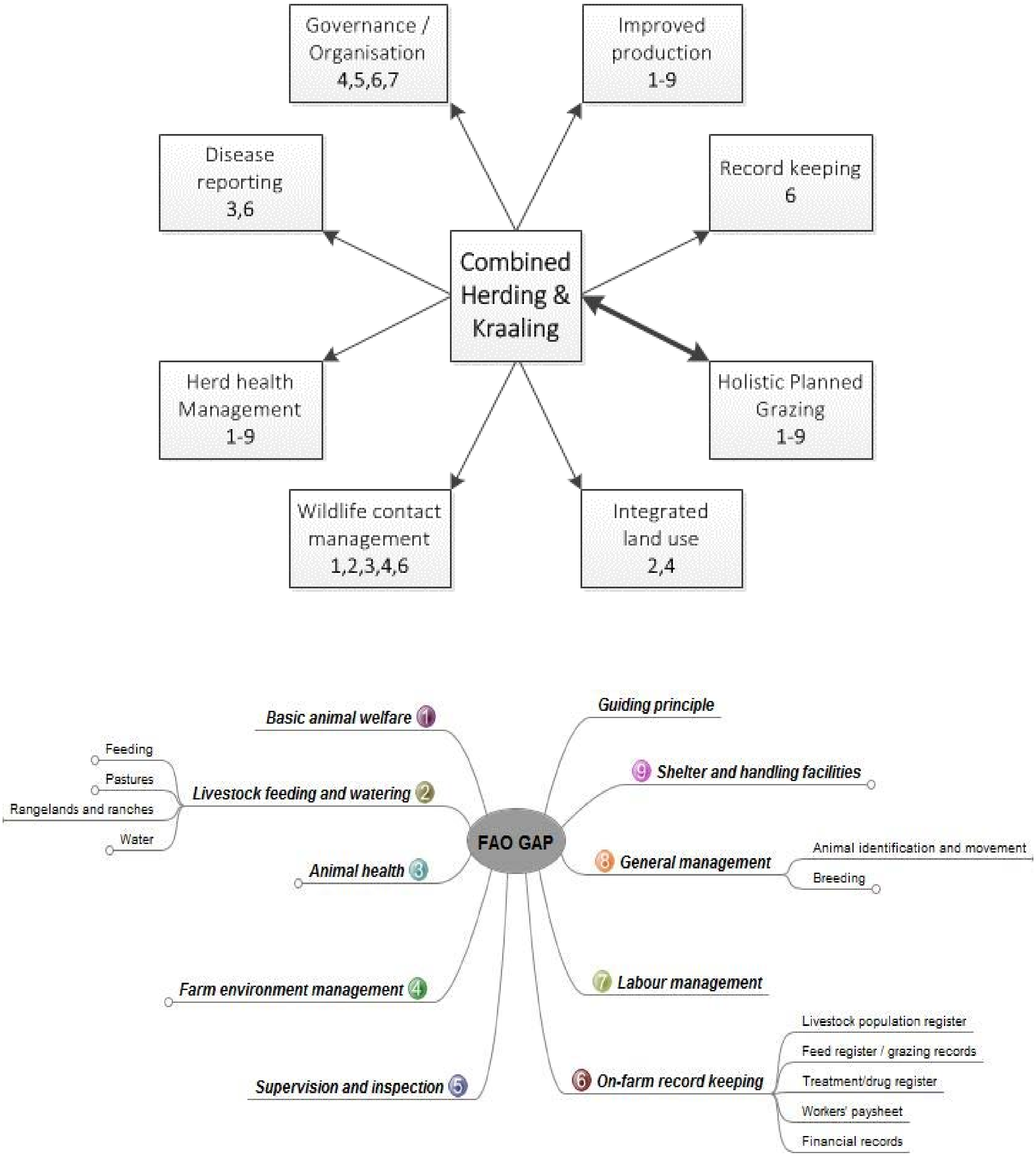


Figure 7-6: A diagrammatic representation of the main risks/challenges/requirements that combined herding/kraaling at the village level in a communal farming system could help resolve (FAO, 2004; SARD Initiative FAO, 2007).

In summary, combined herding and kraaling (where beneficial) through HPG implemented at village level has the potential to:

1. Improve *rangeland health and fodder production* (Peel et al., 2014).
2. Improve *livestock productivity* unless herding is conducted incorrectly and unnecessary intra-species competition leads to a drop in animal condition (Savory, 1999; Masaire, 2014).
3. Improve animal health through a *herd health management* approach that enables appropriate vaccination coverage, treatments, and parasite control by all – not just farmers with the requisite financial resources (Masaire, 2014).
4. Improve *record keeping* at multiple levels (Savory, 1999; Tainton, 1999; CSA, 2013b; Masaire, 2014), including the financial records of a grazing committee/cooperative, labour records of paid herdsmen, cattle demographic and identification records, production records, grazing and rangeland records, presence of wildlife, trade and movement records, supplementary feeding records (with the help of individual farmers if combined kraaling is not practised). Importantly, vaccination, treatment, and disease records must be kept for the entire herd. Such records can be made available for auditing purposes and for certification of compliance with GAPs, to ensure market access.
5. Improve *integrated land use* (Bedelian et al., 2007; GAP, 2008), especially at the wildlife-livestock interface in areas such as the conservancies in the ZR, in order to allow for multiple land uses (wildlife and livestock) linked to wildlife and resource distribution. Strategic kraaling in communal systems results in substantially improved crop yields for up to three subsequent seasons (Pers. Communication, Dibangombe Ranch, March 2015).
6. Improve the *management of risks associated with livestock-wildlife contact* (Muthiani, 2001 in Mizutani et al., 2005; Bedelian et al., 2007; Lamarque et al., 2009; CSA, 2013b), such as disease transmission, resource competition, predation, and injury. It must be acknowledged that in certain conditions, combined herding and kraaling could increase the spread of certain infectious diseases within a herd. Such a risk should, however, be weighed against the advantages combined herding can have in terms of general herd health management, disease prevention and surveillance by properly trained, professional herders.
7. Combined herding and kraaling has the further potential to *reduce stock theft* significantly (Masaire, 2014). In Chapter 3 of this thesis, farmers in the ZR reported losing many cattle to unknown causes, in that cattle just never returned. In the MSA in particular, stock theft has been a major concern. In the GOPA program in Namibia, permanent combined herding had a dramatic reduction in stock theft.

8. Improve herd mobility and hence *adaptability to variable resource distribution* (spatial & temporal) as a result of, for example, climate change and herbivore densities (Butt, 2010; Butt, 2011; McGahey, 2011; Samuels et al., 2013).
9. Improve *village-level organisation of producers,* which can have a significant positive effect on market interaction and compliance with trade standards, reduction of input costs, including related risk reduction strategies such as community insurance and finance schemes (Ortmann and King, 2006; Bhattamishra and Barrett, 2010; Van Schalkwyk et al., 2012; Naziri et al., 2014).
10. Implement *low stress animal handling techniques* that improve herding and animal handling in general (Cote, 2004; CSA, 2013b)
11. Contribute to wildlife crime prevention / intelligence based on the fact that herder and cattle movement will be known and predictable. Signs of unknown movement of people near conservation areas where, for example, rhino poaching is rife, may be more distinct. Also, if herders have the necessary background they can assist community game guards with finding and removing things like snares and gin traps.

Herder skill development

Despite the multiple benefits of combined herding, none of the case studies enable the realisation of all these potential benefits at the wildlife-livestock interface, especially in FMD control areas. Perhaps the closest to fulfilling this has been the GOPA project and the CSA MNI program, albeit still on a very small scale and not in an FMD control area in the case of the CSA project. For the full realisation of a combined herding strategy linked to HPG that effectively feeds into GAPs, appropriate training of herders will be essential (CSA, 2013b). The opportunity therefore exists for the career development of trained, professional herders who can be employed by community cooperatives/grazing committees to train other village herders. Each village requires a minimum of two such professional herders, depending on the capacity and availability of other village herders, who could support one another by alternating shifts. The CSA MNI program's Eco-ranger concept is perhaps at the most advanced stage in this regard and could see the realisation of a complete curriculum through which the full set of benefits of combined, strategic herding and kraaling can be unlocked by professional herders in the near future. The professionalization (empowerment) of staff associated with community-based initiatives, such as the staff administrating a community cooperative, grazing committee or herders, has resulted in improvements to service delivery at village level as well as improved corporate governance and sound financial/administrative management in Ethiopia (Dorsey and Assefa, 2005).

The skills professional herders should have, and which should be tailored to address the main requirements of GAPs, include the following:

1. *Community mobilisation*, as offered by the Africa Centre for Holistic Management (ACHM)[24]
2. *HPG skills and management approaches*, as offered by the ACHM. This includes the ability to collect data on rangeland conditions and the ability to apply herding and kraaling methods to improve rangelands where required.
3. *Tactics to avoid buffalo and large predators through herding and kraaling:* formal training has yet to be developed, although much experience in this regard is available from farmers, as reported in Chapter 4, which could be explored further and built into a training module. Professional herders at the ACHM do have experience in predator-safe kraaling and herding. There is also ample experience of herders in a range of other areas with different predator species and dynamics that could be harnessed and tailored for herder/community awareness and training (Mizutani et al., 2005; CSA, 2013b). In the ZR, the participation of the Caprivi Carnivore Programme and their affiliation with *Panthera* for the promotion of predator-friendly livestock husbandry practices is important (Caprivi Carnivore Project, April 2013). Continuous data collection on actual predator and priority wildlife movements, conducted by professional herders, is very important for adapting herding and grazing plans.
4. *Primary Animal Health Care (PAHC)* skills can be taught to a herder in order to fulfil the role of a community-based animal health worker (CAHW) (Hüttner et al., 2001; Ngeiywa and Masake, 2009). Afrivet Training Services in partnership with the University of Pretoria's Chair in Primary Animal Health Care, Faculty of Veterinary Sciences, has developed an innovative PAHC training model that includes all necessary tools to train herders/farmers with low literacy levels (Figure 7-7). The model has been tested successfully among cattle farmers in the MSA (Moerane, 2013). The model has also been used for training farmers as part of a pilot in the ZR that involved communal farmers who planned to trade with the Meatco abattoir in 2013. The training was adapted to address the requirements of the producer protocol (see section 7.2 of this chapter) and farmers provided very positive feedback (Meat Board of Namibia, 2014). This model specifically assists with identifying early signs of disease, using thermometers, calculating appropriate treatment dosages, awareness of withdrawal periods, and the keeping of records of ill health, treatments, and vaccinations. It also has sections related to animal production and trade that could be used if required. Complete training packages like this PAHC model fit naturally into the training and skills of HPG, and are essential to the training of

[24] ACHM, Dibangombe, Victoria Falls – Zimbabwe: http://www.africacentreforholisticmanagement.org/

professional herders in the context of HPG as a platform that links into GAPs and a CBT value chain.

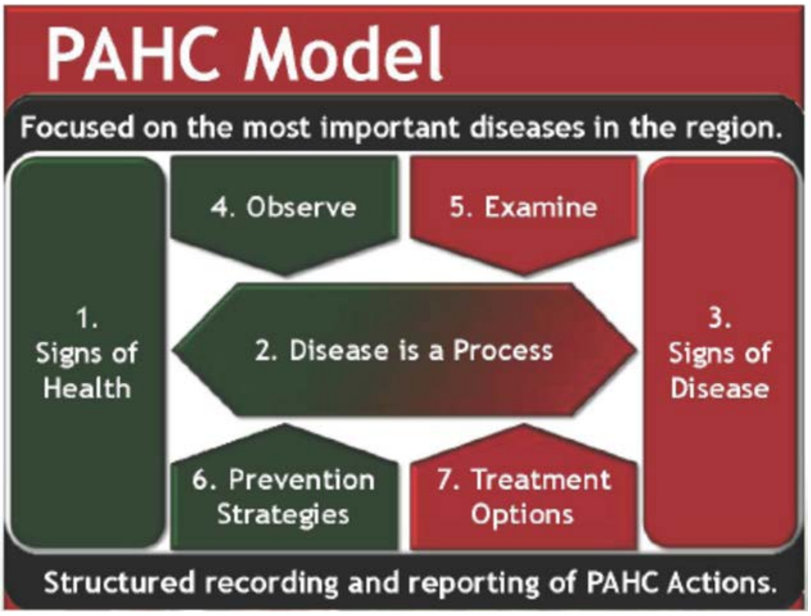


Figure 7-7: The Primary Animal Health Care training model developed by Afrivet Training Services and the Faculty of Veterinary Sciences, University of Pretoria (Moerane, 2013)

A critical contribution of this particular training model is its record-keeping tools, be means of which farmers/herders can communicate more effectively with government animal health technicians, and can keep records that are auditable for certification.

5. *Basic animal production skills* consist of appropriate record keeping and animal identification procedures to improve traceability and animal movement records at village level. In both the MSA and the ZR local government has started to implement traceability systems. However, insufficient animal health officials, poor management of national databases, and the need for continued, rapid follow-up of herds, have led to poor results and are a cause for concern[25]. There are doubts as to the ability of government to sustain traceability systems with the support of other stakeholders, such as markets and farmer groups who will benefit from having traceable records. Having a system at village level that can improve the capacity of such traceability efforts by delegating transparent record keeping to trained herders can contribute substantially to fulfilling this requirement for market access in a feasible way. The use of records

[25] Personal observation, October 2013 – two years since the system has been rolled out in the ZR there was no skill or ability to trace an animal locally. Farmers had to phone the national office to enquire about animal ownership and farmers complained that no-body was able to assist them, saying they couldn't retrieve data.

to determine which animals should be sold to an abattoir, based on reproduction/production records, has made a major difference elsewhere in similar circumstances (Masaire, 2014). However, support from production extension officers (government) and mentorship programs that can be formalised through engagement with village-level professional herders will be essential for providing adequate support in animal production technologies and inputs. In the ZR, the local Farmer Mentorship Program, in partnership with the Meat Board of Namibia (Negussi, 2012) will improve its impact substantially by linking into a village-level combined herding strategy with professional herders (Meat Board of Namibia, 2013).

6. *Data collection for the use in research and monitoring* of rangelands, wildlife movements, and animal performance is an essential contribution if linked to an NGO, project, or institution that can use such information for continued support. This has proven very important in the Eco-ranger initiative of the CSA in South Africa (CSA, 2013a; CSA, 2013b).
7. *Reporting signs of wildlife crime* can serve a major support function for conservation entities at the wildlife-livestock interface. Rangelands are the areas through which poachers move in order to enter conservation areas, or to set traps, or to track down targeted species. Herders trained to identify signs of wildlife crime can contribute to efforts to fight the surge in wildlife crime in most wildlife-livestock interface areas in southern Africa. Close collaboration and communication between community game rangers (Nuulimba, 2012) or conservation officials could improve the surveillance efforts in protected areas, thus building mutually beneficial relationships between conservation and community structures.

Over and above the training of herders, cooperative grazing committee members will require training to enable them to manage their responsibilities and portfolios. Conservation agencies such as the IRDNC in Namibia, which supports the training of conservancy committees, can play an important support role in this regard.

The model and environment

The link between a range of important risks as experienced by farmers at the wildlife-livestock interface in FMD control areas, and strategies that could mitigate such risks in an equitable, feasible way, is evident from the synthesis thus far. In addition, there is evidence that an intervention such as HPG could be a vehicle as well as an incentive to drive risk mitigation while simultaneously enabling all farmers to comply with prerequisites for equitable and sustainable participation in a CBT value chain. A schematic model in this regard is provided in Figure 7-8.

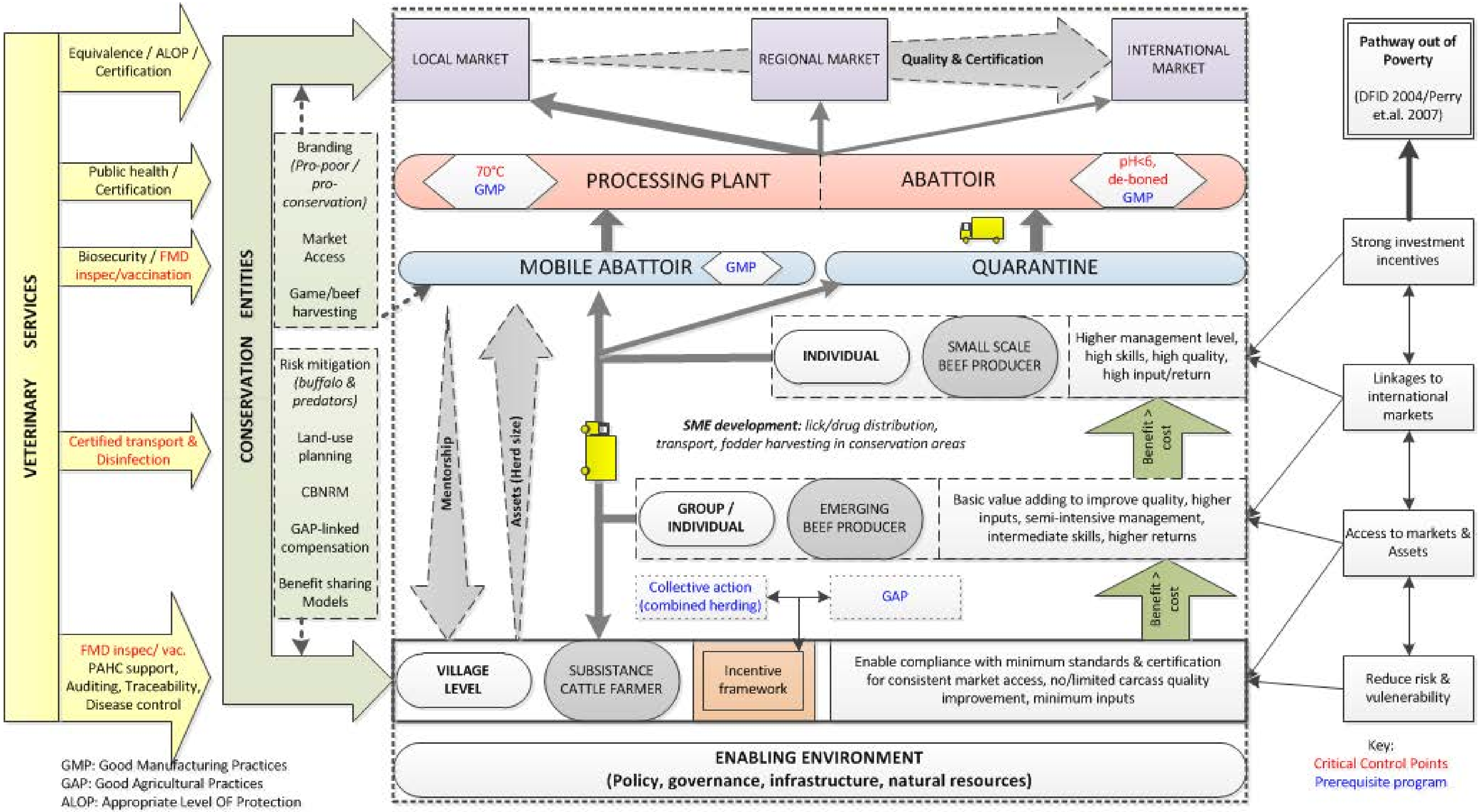


Figure 7-8: A model for the implementation of a village-level farmer-driven intervention that will enable equitable, pro-poor and pro-conservation development of the red meat value chain in an FMD control area, such as the ZR, based on an integrated CBT value chain (Thomson et al., 2013b).

In 2007, the Organisation for Economic Cooperation and Development (OECD), which consists of the governments of 30 countries, called for a new global agenda for agriculture. This agenda must, among other things, shift from the traditional, sectorial agenda for agricultural production to a broader agenda for the agricultural sector and rural livelihoods. It should do this by means of reducing risk and vulnerability across the rural world, and not just risk in association with a particular agricultural sector, commodity, or product (OECD, 2007). It calls for a good understanding of the realities and dynamics of both the agricultural sector and rural livelihoods, to which policies and strategies must respond by effectively dealing with the diversity and complexity of poor rural households (OECD, 2007). Lastly, the OECD (2007) suggests that, when dealing with the diversity in income and asset categories in rural households, the development of such livelihoods must provide for this diversity, must address market access and labour pools, access to information, infrastructure, training, health care, and social support networks, in order to enable all households to benefit from their participation in interventions.

In an attempt to meet the challenge put forward by the OECD (2007) in the H4H model, a holistic incentive framework feeds into tailored GAPs, for which compliance by all farmers is made possible through a strategy based on collective action, such as HPG. Progression out of poverty is linked to the improvement of carcass quality/quantity, rather than certification, through strategic interventions that are pursued by sub-groups /individuals. Product quality improvement could result in market diversification and higher returns, which will stimulate higher investment.

Based on the context of a village in the ZR, the model (called Herding for Health, or H4H) aims at the establishment of a village-level, community-driven intervention that involves all cattle farmers regardless of herd size or financial status (OECD, 2007). An enabling environment is one of the five triggers for the development of a local value chain (Herr, 2007) and consists of a wide range of elements, from governmental policies and services and natural resources, to availability of skilled labour and regulations associated with markets (OECD, 2007). In the context of this model, an enabling environment at village level will require strong leadership and traditional governance structures, access to basic services that can support interventions, basic skill levels related to the development of a value chain, access to natural resources such as water and grazing, and the necessary basic infrastructure, such as watering and handling facilities for livestock (OPPG, 2005). In the absence of any of these elements, training or development interventions will be required in order to successfully implement the model.

Holistic incentive framework

The creation of an incentive framework that benefits all farmers has been found to be a critical policy intervention for improving agricultural income (OPPG, 2005; Whitfield, 2008). In terms of poor and vulnerable livestock producers, an incentive framework that addresses the major risks to their livelihoods and farming operations will only result in participation if benefits exceed costs (Perry and Grace, 2009; Fowler and Brand, 2011). Furthermore, an incentive framework should include options to improve returns and inputs, such as better market access and associated returns from better quality beef (Perry and Rich, 2007). Two elements will feed into the incentive framework. Firstly, a tailored prerequisite program consisting of GAPs and a producer code will guide village level compliance with both trade standards (Thomson and Penrith, 2015) as well as fair, equitable labour management, biodiversity conservation/environmental stewardship, and poverty alleviation (FAO, 2004; SARD Initiative FAO, 2007; Thomson et al., 2013a). Secondly, collective action in the form of HPG enables all farmers to comply with GAPs. It has been shown that, with the implementation of HACCP along an entire value chain, as is proposed for a CBT value chain, an appropriate prerequisite program properly implemented at farm level will control most disease/food safety risk which otherwise will have to be managed at critical control points along a commodity value chain (Horchner et al., 2006).

H4H proposes that, in pastoralist areas at the wildlife-livestock interface where rangelands are under communal tenure, combined herding as promoted through HPG provides a feasible and practical platform to mobilise equitable participation in a tailored, holistically designed prerequisite program, with which all farmers can comply. Herding and kraaling are traditional practices that need no introduction to local pastoralists, which new technology would require. If applied correctly, this has the potential to address all major risks in ways that are practical, community-driven, and sustainable. Furthermore, such an intervention makes compatibility with biodiversity conservation possible, and provides the flexibility as well as the tools needed to adapt to local environmental conditions and resource distribution (see Chapter 5). Such a platform fits into existing conservation agendas without bringing conflict; it provides mechanisms for practical, community-driven solutions at the local level without compromising the need to comply with basic market standards. Adapting grazing areas or herd movements to buffalo presence can be done relatively easily by trained herders (Chapter 4), thereby greatly reducing the spread of infectious diseases such as FMD, which requires close contact between animals to spread (Thomson and Bastos, 2004). Furthermore, close surveillance of all cattle on a daily basis will significantly enhance early detection, treatment and control of important animal diseases and will thus lead to improved herd health. A combined herding strategy should improve vaccination coverage and the ability of farmers to maintain adequate herd immunity in terms of diseases such as

FMD, brucellosis, and black quarter. The combined herding strategy and its associated record-keeping tools, as discussed in previous sections, will enhance communication and collaboration with local animal health technicians, which can significantly extend the ability of veterinary services to control priority diseases and support animal health efforts in communities. An important feature will be the ability for a village to adapt a herding framework that will work for all, but that still complies with the principles and requirements of an H4H prerequisite program. This will empower communities to take ownership of the intervention, and ultimately interventions can become community-driven (Binswanger-Mkhize et al., 2009).

Collective action governed by an appropriate village-level structure, such as a cooperative, livestock or grazing committee, or farmer's association linked to the proposed HPG platform, has the potential to facilitate farmer organisation, and could reduce costs and resolve barriers to escaping poverty. Given the nature of communal farming systems, farmers with small herd sizes are reluctant to trade due to enhanced risk and a different objective for having cattle when compared to farmers with larger herds (see Chapter 3). A trade mechanism that excludes the poorest from the potential to comply with market access will limit their ability to escape the poverty trap and thus they will remain in their high-risk, highly vulnerable situations (Barrett and Carter, 2013). However, if compliance with market requirements is integrated with the mitigation of important risks as experienced by poor farmers in a way that is practical and addresses multiple challenges, participation by all, including the poorest of farmers, will be incentivised. H4H therefore proposes that compliance with GAPs and a prerequisite program that sets farmers up for participation in a CBT value chain should be aimed at a strategy that could see all farmers comply at village level because of favourable linkages with general risk reduction and not just disease and food safety risks. An integrated, combined herding strategy as discussed in previous sections could fulfil this need in a practical and feasible way if multiple stakeholders work together. From such a platform of inherent compliance, farmers with the means and vision (aspiration) can embark on a pathway out of poverty by investing more in animal quality and trade quantity within the available market system to the extent which returns outweigh input costs.

Several authors have questioned the financial feasibility of compliance with CBT standards, should it be considered a trade option in the context of poor communal producers in marginal, high-risk production areas renowned for weak public (veterinary) service delivery (Scoones et al., 2010; Naziri et al., 2015). However, if additional benefits are considered in terms of more conservation-friendly disease control mechanisms, overall benefits outweigh the costs of conventional trade standards in areas not free from FMD. However, this study and its associated H4H model (Figure 7-8) suggests that if a holistic, pro-poor and pro-conservation approach is taken to value chain development in which disease control and food safety is but one of the objectives, costs of compliance are weighed against the combined risks of not participating in a holistic risk management system tailored to the needs of a local farming community. Incentive for compliance involves multiple stakeholders, among whom the conservation fraternity could potentially play the biggest role, rather than local veterinary services or even abattoirs. By involving stakeholders strategically via a holistic risk management platform such as a farmer mentorship program (Negussi, 2012), and by including a range of conservation entities such as community conservancies, protected area management, tourism enterprises, as well as wildlife crime prevention units and sustainable land use stewardship programs, multiple benefits can be unlocked. Compliance with more than just market access can be achieved, and priorities for sustainable land use practices and stewardship, biodiversity conservation, and rural development objectives, can be met. Such a system could then make the objectives of TFCA development, in light of challenges associated with wildlife-livestock compatibility, rural development, and diversified economic opportunities, more feasible.

Conservation involvement in the beef value chain

The H4H model makes explicit provision for conservation entities to become practically involved at village level in a proposed incentive framework that will be mutually beneficial. It also provides for an opportunity to link good practices with policy and the creation of pro-conservation market linkages, either within conservation enterprise (lodges and tourism outlets within protected areas), or local/regional/international markets. A significant role that conservation entities such as NGOs and animal welfare organisations could play in support of biodiversity conservation, is to develop and lobby for market linkages that will incentivise the poor living at the wildlife-livestock interface to participate in sustainable, conservation-compatible practices. The recently created MNI brand for red meat produced through the projects of the CSA is a good example in this respect. To this end there is a need and opportunity for Payment for Ecosystem Services (PES), or carbon markets to offset environmental impacts with incentives or support for livestock-wildlife compatible practices that could improve ecosystem resilience and alleviate poverty (EM, 2009). In Mongolia, an innovative program looks to access carbon finance through the Ecosystem Marketplace, to support livestock herding practices that will curb the rapid rangeland degradation and desertification of the Mongolian grassland plains (Kett, 2010). The creation of similar platforms could compensate for risks and losses that farmers face by coexisting with wildlife – especially if they participate in mutually beneficial platforms such as the H4H model.

Protected area management and tourism enterprises could provide controlled access to natural resources such as grazing, seed, or fodder, through models like H4H, to the benefit of both conservation areas and communities. Similarly, by making the participation in a model like H4H a prerequisite for accessing resources or markets in protected areas by communities living adjacent to or within protected areas, mutually beneficial practices can be incentivised. The same applies for compensation for loss of livestock through predation: if livestock farmers know they are only eligible for compensation if they participate in a model like H4H, if proven fair and feasible in a local context, farmers are encouraged to reduce risk to the benefit of both protected areas and farmers alike, whilst automatically also practising conservation-friendly farming (Lamarque et al., 2009).

In the MSA, through a pilot involving the H4H model, protected area management by means of the Kruger National Park (South African National Parks) the Kruger to Canyons Biosphere Reserve, the University of Pretoria as well as several community-based and conservation oriented NGOs are working with communities to restore overgrazed and encroached rangelands. Through the pilot plans are made to provide access to slaughter facilities as well as meat markets within tourism enterprises, such as the game abattoir and processing facility in the Skukuza, Kruger National Park, for farmers who participate in conservation-conscious practices. There are also plans to work together on a mobile abattoir system that can be beneficial for both game harvesting and livestock off-take in that particular context where infrastructure for cattle harvesting does not exist. However, there are still some public health policy challenges that need to be overcome[26]. If the full implications in terms of the expectation that farmers live in harmony with wildlife, and produce safe beef, are fully comprehended by proponents of biodiversity conservation, support for products from such areas will most likely increase. In the absence of better incentives, the costs of living with wildlife will continue to outgrow the benefits. This will result in more local political pressure for separation of land uses, or for local communities to disregard wildlife with negative consequences for the development of TFCAs or the promotion of a wildlife economy.

The study acknowledges that there are pertinent risks associated with collective action initiatives and that mitigating such risks would require a shared vision by all stakeholders and substantial inputs from multiple role players in skill and capacity development at village level (Van Schalkwyk et al., 2012). However, due to the potential multiple benefits of H4H for a range of stakeholders, the costs of achieving this could be shared, and support roles could be designed so as to not overburden a particular sector, such as state veterinary services. For example, it is estimated that the loss in income due to the 2012 FMD outbreak in the ZR alone equals the estimated annual salary of two professional herders per

[26] Dr Tertius Bergh, Meat Safety Consultant. Personal Communication, 22 April 2016.

crush-pen in the ZR, as well as the estimated costs for basic training in HPG and PAHC[27]. The costs of training could be co-funded because different skill packages will appeal to different role players.

7.4 Conclusions

The impact of market disruptions due to FMD outbreaks in the ZR and the current geographic-based approach to its control is significant. This study determined that the potential income foregone by farmers who might have traded with the Meatco abattoir over the period that the abattoir was closed due to the 2012 FMD outbreak might have been 84%, or N$16 052 million lower if CBT standards are used. The cascade of economic and social impacts on households that planned to trade beef but could not because of the total lockdown of all animal movements throughout the ZR, was often dramatic. In light of the increase of FMD outbreaks in southern Africa since the turn of the century (OIE Collaborating Center, 2011), there is no doubt that current FMD control mechanisms increase the likelihood of rural pastoralist households remaining trapped in poverty. Farmers' attitude towards wildlife conservation is likely to deteriorate due to the effects of wildlife and FMD control because the link between wildlife and FMD control impacts does exist (see Chapter 4). Yet, the opportunity for resolving these issues through innovative strategies, such as integrated village-level strategies that reduce multiple risks and provide multiple benefits for all, offers new opportunities for exploring CBT standards.

H4H suggests that a more holistic, integrated approach to managing risks and compliance with trade standards at the village level is plausible and feasible. It will depend, though, on integrating a range of skills, strategies, and stakeholders in a simple, traditionally acceptable platform anchored to a form of collective action, such as combined herding, that serves the purposes and needs of the broader community or stakeholder group. If implemented successfully in this way, the dual expectation that CBT can contribute towards biodiversity conservation and rural development in the context of TFCAs, could be met. In fact, it could serve as a much needed catalyst that will bring stakeholders together at multiple levels in order to achieve multiple objectives, in any particular landscape where both wildlife conservation and livestock production enterprises should receive priority.

[27] Annual salary of N$40 000 (approximately N$160/day), which is based on the South African government rate for Expanded Public Works Program employees. N$25 000 for training per herder where one is trained in HPG and one in PAHC per village. 150 crush-pens as reference. Some crush-pens serve multiple villages.

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APPENDIXES

APPENDIX 1

Ref: V055/13

28 August 2013

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Prof EC Webb
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Dear Prof Webb

PROTOCOL V055/13: LIVESTOCK PRODUCTION AND ANIMAL HEALTH MANAGEMENT SYSTEMS IN COMMUNAL FARMING AREAS AT THE WILDLIFE-LIVESTOCK INTERFACE IN SOUTHERN AFRICA – ***Mr J van Rooyen***

I am pleased to inform you that the abovementioned protocol was approved by the Research Committee.

Kindly take note of the attached document.

Kind regards

NIESJE TROMP
SECRETARY: RESEARCH COMMITTEE

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APPENDIX 2

A primary assessment of problems and challenges related to cattle keeping in the Mnisi tribal area, Bushbuckridge, RSA

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Introduction

As rural engagement is an important aspect of the mission of this Veterinary Faculty a community development project was created with its main objective being to increase the livelihood security and sustainability of rural people living in the Mnisi community. This tribal area is situated in the Mpumalanga Province and covers approximately 30,000 hectares. It contains a population of approximately 40,000 people. This community was chosen because of its challenging geographical position, which is behind the foot-and-mouth disease red line, the high importance of agriculture in local livelihoods, the widespread presence of well-developed veterinary services and the long-term good relationship between the tribal authorities and University of Pretoria. The project contains several pillars and research focuses. In this poster we focus on the livestock production and animal health pillar.

Objective

One of the main priorities of this pillar is to assess the most important challenges and problems faced by the livestock owners in the area.

Material & Methods

To identify these main challenges we used a qualitative research method called focus group discussions. From 3-8 March 2009 five diptanks in the area were visited. Every morning after dipping a discussion was held with the cattle owners who were present. Specific questions were asked to identify the main challenges and problems that they associated with the keeping of cattle, and to learn about their perceptions towards the constraints and opportunities in the area.

Results and Conclusions

The different problems identified during the discussions are represented in Table 1.

The people seemed to have positive attitudes towards installing a camp system. During the discussions several advantages were named for using a camp system instead of the current free ranging system: 1) less labour intensive, 2) better water management, 3) better management of grazing land, 4) more theft prevention opportunities, 5) better fire detection opportunities, 6) better overall cattle management, and 7) ability to initiate a breeding season with marketing and nutritional advantages.

A next step in the project is to quantify and describe the issues related to the identified problems and challenges using a quantitative questionnaire. Results from this preliminary work have therefore provided an important source of information to fine-tune and focus the questionnaire. A thorough description of problems and challenges will allow for the creation and development off appropriate intervention activities.

Table 1: Different problems and challenges identified during the discussions

4 out of 5 discussions	3 out of 5 discussions	1 out of 5 discussions
Water	Ticks/dipping	Availability of veterinary assistance
Grazing	Marketing problems	No acces to camps
	Cattle diseases	Low quality of bulls
	Drought	Dehorning
	Stocktheft	Elephants
	Veldfires	

APPENDIX 3

MNISI QUESTIONNAIRE.

Form No………………

PART 1: ANIMAL PRODUCTION.

(Q1) Name of Diptank ……………………..
(Q2) Name of cattle owner (respondent)……………………………………..
(Q3) Stock card number…………………

SECTION A – Land Use

(Q4) In GENERAL, do you have sufficient grazing available for your cattle?

1	**2**	**3**
Yes	No	Don't know

(Q5) If NO to Q4, Why is there not enough grazing in the area?

V1	Not enough grazing land	
V2	Not enough grazing in winter	
V3	Not enough grazing during droughts	
V4	Too many cattle in the area	
V5	Too many crop lands	
V6	Too many houses	
V7	Too many veld fires in winter	
V8	Too dry	
V9	Don't know	
V10	Other	

(Q6) Do you ever use fenced-camps to control the grazing movements of your cattle?

1	2	3
Yes	No	Don't know

(Q7) If NO to Q6; Name all the reasons why you don't want to use fenced camps for your cattle.

V1	Afraid of stock theft	
V2	I want to select grazing myself	
V3	I'm afraid of veld fires	
V4	Camps are too far from my kraal / house / dip tank	
V5	Afraid of diseases from other animals	
V6	Don't want other farmers' bulls to breed with my cows	
V7	Afraid of problems with the water supply	
V8	Afraid of poor fence management	
V9	Poor grazing in camps	
V10	Don't know	
V11	No camps available	
V12	Other	

(Q8) If NO to Q6, Would you be willing to use fenced camps if available?

V1	V2	V3
Yes	No	Don't know

(Q9) If YES to Q8; would you put your cattle in a fenced camp with cattle of other farmers?

1	2	3	4
Yes	No	It depends on various factors	Don't know

(Q10) If YES to Q8; what are the main reasons why you would want to use fenced camps?

V1	Better/more grazing available	
V2	Safer for my cattle	
V3	Know where to find them – less time searching	
V4	Can send the children to school	
V5	Don't need herd boy	
V6	Better water provision	
V7	Control cattle theft better	
V8	Control veld fires better	
V9	Don't know	
V10	Others…………	

(Q11) Who do you think should maintain the camp fences and water points in the camps?

V1	Government	
V2	Myself	
V3	Farmers / Farmers' unions	
V4	Animal Health Technicians	
V5	Don't know	
V6	Agricultural Extension Officer	
V7	Others:______________________________	

(Q12) Who do you think should manage the camps and the grazing in it?

V1	Government	
V2	Myself	
V3	Farmers / Farmers' unions	
V4	Animal Health Technicians	
V5	Don't know	
V6	Agricultural Extension Officer	
V7	Others:______________________________	

(Q13) Will you leave your cattle in a camp overnight?.

1	Yes	
2	Only if somebody looks after them	
3	No	
4	Don't know	
5	Other……….	

(Q14) If NO to Q13, why would you not leave your cattle in a camp overnight?

V1	Afraid of stock theft	
V2	Afraid of predators	
V3	Cattle need to be milked	
V4	I want to see my cattle every morning	
V5	Don't know	
V6	Others	

(Q15) If YES to Q6; what are the main reasons why you use fenced camps?

V1	Better/more grazing available	
V2	Safer for my cattle	
V3	Know where to find them – less time searching	
V4	Can send the children to school	
V5	Don't need herd boy	
V6	Better water provision	
V7	Control cattle theft better	
V8	Control veld fires better	
V9	Keep animals off roads	
V10	Don't know	
V11	Others…………	

(Q16) If YES to Q6, When do you use fenced camps for grazing?

1	Always	
2	Only winter	
3	Seldom	
4	Only summer	
5	Only during droughts	
6	Don't know	
7	Other................	

General water provision for Livestock

(Q17) What are the sources of water for your cattle?

V1	V2	V3	V4	V5	V6	V7
Borehole	Spring	Dam	River	Village tap/pump	Don't know	Other……*

(Q18) Do you also drink water from the dams and rivers?

1	2	3	4
Yes	No	Don't know	Other

(Q19) Is there always enough water available for your cattle?

1	2	3
Yes	No	Don't know

(Q20) If NO to Q19, when do you usually have water shortages for your cattle?

V1	V2	V3	V4	V5	V6	V7
Always	Winter/dry season	Summer/rain season	Droughts	Late winter/ late dry season	Don't know	Other

(Q21) Do you ever fetch drinking water for your cattle?

1	2	3
Yes	No	Don't know

(Q22) On average, How far does your cattle walk daily to get to water?

1	2	3	4	5	6	7	8
<1 km	1-2 km	3-4 km	5-6 km	7-8 km	9-10	>10	Don't know

(Q23) Do you think the water available to your cattle is healthy?

1	2	3
Yes	No	Don't know

(Q24) If NO to Q23, why do you think the water is not healthy?

V1	V2	V3	V4	V5	V6
Polluted(bottles, plastics, etc)	Polluted with chemicals	Makes animals sick	Water full of mud/ soil.	Don't know	Other

(Q25) Do you think the dams are being well maintained?

1	2	3
Yes	No	Don't know

Cattle management

How many cattle do you own?

(Q26)	Bulls	
(Q27)	Oxen	
(Q28)	Cows (have calved)	
(Q29)	Heifers (not yet calved)	
(Q30)	Calves (still suckling)	

(Q31) What is the dominant breed in your cattle herd?

V1	None	
V2	Indigenous	
V3	Mixed breed	
V4	Bonsmara	
V5	Nguni	
V6	Brahman	
V7	Afrikaner	
V8	Simmental	
V9	Don't know	
V10	Other……	

(Q32) If you could choose, which breed would you like to have?

V1	V2	V3	V4	V5	V6	V7	V8	V9	V10
None	Nguni	Brah man	Bons mara	Sim men tal	Afrika ner	Indigenous breed	Mixed breed	Don't know	Other…..

(Q33) What are your main reasons for keeping cattle?

V1	Selling / commercial use	
V2	Bank (Saving/ Education)	
V3	Traditional ceremonies	
V4	Own consumption	
V5	Draught power	
V6	Emergencies	
V7	Prestige/status	
V8	Don't know	
V9	Other	

(Q34) In general, are the cattle herded or allowed to walk freely?

V1	V2	V3	V4	V5
Herded	Walk freely	Are in camps	Don't know	Other…

(Q35) If herded in Q34, who is herding the cattle every day?

V1	V2	V3	V4	V5	V6
Nobody	Myself	Paid herdsman	Children	Don't know	Other……

(Q36) Do you wean your calves?

1	2	3
Yes	No	Don't know

(Q37) If NO to Q36; why don't you wean your calves?

V1	Lack of knowledge	
V2	Not necessary	
V3	Not possible	
V4	No camps	
V5	Nose rings are too expensive	
V6	Nose rings are not available	
V7	It is unnatural to wean	
V8	Don't want to	
V9	Don't know	
V10	Other	

(Q38) If NO to Q36; would you want to wean your calves if you could?

1	2	3
Yes	No	Don't know

(Q39) If YES to Q36; at what age do you wean your calves?

V1	V2	V3	V4	V5	V6
6 months	8 months	10 months	12 months	Don't know	Other

(Q40) If YES to Q36; How do you wean your calves?

V1	V2	V3	V4	V5
Keep and feed in kraal	Nose rings	Separate camps	Don't know	Other…

(Q41) How do you identify your cattle?

V1	V2	V3	V4	V5	V6	V7
No identification	Bells	Horns/coat patterns etc.	Tagging/marking/ numbering	Just know them	Don't know	Other

(Q42) If Tagging/ marking in Q41; how do you mark/tag your cattle?

V1	V2	V3	V5	V6	V7
Ear tags	Ear notches	Specific branding	Tattoos	Don't know	Other……

(Q43) If Tagging/ marking in Q41; which cattle do you mark?

V1	V2	V3	V4	V5	V6	V7	V8	V9
Main cow	Main bull	All cows	Dominant animal	Best animal	All animals	Oldest animal	Don't know	Other

(Q44) Do you use a specific bull for breeding with your cattle?

1	2	3
Yes	No	Don't know

(Q45) Are you satisfied with the quality of bulls available for breeding with your cows?

1	2	3
Yes	No	Don't know

(Q46) Would you want all your cows to calve at the same time in a year?

1	2	3
Yes	No	Don't know

(Q47) If YES to Q46; when should they calve?

V1	V2	V3	V4	V5
Winter	Summer	Doesn't matter	Don't know	Other…

(Q48) If YES to Q46; Why would you want them to calve at the same time in a year?

V1	Better for marketing (higher prices)	
V2	Better for the cow	
V3	More food available	
V4	More water available	
V5	Animal is in better condition	
V6	Less diseases that reduce the value of the animal	
V7	It is natural	
V8	Don't know	
V9	Others…..	

(Q49) If NO to Q46; Why don't you want them to calve at the same time in a year?

V1	Want to market an animal at any time in a year	
V2	Not possible	
V3	Too expensive	
V4	Too many bulls around to control	
V5	No camps to control breeding	
V6	Don't have enough knowledge	
V7	Don't think it is necessary	

V8	Don't know	
V9	Other	

(Q50) Will you be willing to change the way you farm if that is the only way to improve cattle production?

1	2	3	4
Yes	No	Depends on what the changes would be	Don't know

(Q51) Do you receive any guidance/ advice in how to farm with cattle?

1	2	3
Yes	No	Don't know

(Q52) If YES to Q51, from whom?

V1	V2	V3	V4	V5	V6
Local extension officer	Animal Health Technician	Consultant	Other farmers	Don't know	Other……

(Q53) If YES to Q51; Is the guidance/ advice you receive good enough?

1	2	3
Yes	No	Don't know

(Q54) If NO to Q51; would you like to receive more guidance/ advice in your farming operations?

1	2	3
Yes	No	Don't know

Supplementary feed

(Q55) Do you give extra feed to your cattle?

1	2	3
Yes	No	Don't know

(Q56) If YES to Q55; When do you give extra feed to your cattle?

V1	V2	V3	V4	V5	V6	V7	V8
Winter	Summer	Always	Droughts	When in kraal	When necessary	Don't know	Other

(Q57)	**Product bought**				**Amount used *(Q58-Q63)*:**	
V1	Crop rests	***(Q58)***		V1	Bundle	
V2	Hay	***(Q59)***		V2	Small bale(30kg)	
V3	Lucerne	***(Q60)***		V3	Large bale(500kg)	
V4	Cut grass	***(Q61)***		V4	Bakkie load	
V5	Licks	***(Q62)***		V5	Truck load	
V6	Don't know			V6	Kg	
V7	Other	***(Q63)***		V7	Ton	
				V8	Other	

(Q64) If NO to Q55; why don't you give extra feed to your cattle?

V1	V2	V3	V4	V5	V6	V7
Too expensive	Not available	Not necessary	Too far	Lack of knowledge	Don't know	Other……

(Q65) Do you plant any kind of feed specifically for your cattle? If YES specify………………………..

1	2	3

Yes	No	Don't know

Production and marketing

(Q66) Do you milk your cows?

1	2	3
Yes	No	Don't know

If YES to Q66:

(Q67)	On average how many cows do you milk in a year?	________ cows
(Q68)	How much milk (litres) do you obtain from one cow on average per day? (a bucket = 10L)	________ litres
(Q69)	On average for how many months per year is each cow milked	________ months

(Q70) Do you sell part of your milk to other people?

1	2	3
Yes	No	Don't know

If YES to Q70**:**

(Q71)	On average how much milk do you sell per day?	___________ litres
(Q72)	For how much do you sell your milk?...................	R___________/L

(Q73) Do you ever slaughter your own cattle?

1	2	3
Yes	No	Don't know

(Q74) If YES to Q73; what do you do with the meat of your slaughtered cattle?

V1	V2	V3	V4	V5	V6
Food for household	Sell	Give it away (donate)	Use for traditional ceremony	Don't know	Other……

(Q75) If SOLD in Q74; To whom did you sell the meat?

V1	V2	V3	V4	V5
Family/friends	Local people	Butcher	Don't know	Other……

(Q76) If SOLD in Q74; On average for how much (Rand/kg) do you sell the meat?

R../kg?

(Q77) What do you do with the hide of dead or slaughtered cattle?

V1	V2	V3	V4	V5
Nothing	Sell it	Use it myself	Don't know	Other…

(Q78) If you SOLD the hide in Q77; what is the average price you received per hide?....................(R/hide).

(Q79) Did you use or receive animals during the past 12 months for any of the following reasons? Specify the number for each.

	Reasons *(Q79)*		**Number of animals *(Q80-Q86)*** Animal codes (name all)	Codes for stock classes*(Q80-Q86)*	
V1	Used for lobola		*(Q80)*	Bulls	V1
V2	Received as lobola		*(Q81)*	Oxen	V2
V3	Used for other ceremonial purposes		*(Q82)*	Cows (have calved)	V3
V4	Given to relatives		*(Q83)*	Heifers (not yet calved)	V4
V5	Received from relatives		*(Q84)*	Calves (still suckling)	V5
V6	Received for other reasons		*(Q85)*		
V7	Used for other reasons		*(Q86)*		
V8	Did not receive or use any animals				

(Q87) Name all the reasons for which you have lost (death or disappeared) any cattle during the past 12 months? Specify the number.

	Reasons for losing cattle	**Number of cattle**
V1	Stock theft	
V2	Disease (any kind of disease)	
V3	Abortion or born dead	
V4	Drought (lack of feed/water)	
V5	Old age	
V6	Injury	
V7	Difficulty during birth	
V8	Predators	
V9	Unknown	
V10	Other…………………………	

(Q88) Do you eat the meat of cattle that have just died?

1	2	3	4
Yes	No	Depends on cause of death	Don't know

(Q89) Did you sell any of the following cattle during the last 12 months?

V1	V2	V3	V4	V5	V6
Bulls	Oxen	Cows (have calved)	Heifers (not yet calved)	Calves (still suckling)	Didn't sell any

(Q90) If BULLS in Q89; To whom did you sell BULLS?

V1	V2	V3	V4	V5	V6
Feedlot	Auctioneer at auction	Butcher	Other farmers	Don't know	Other

If *FEEDLOT* in Q90;	
(Q91) How many BULLS did you sell?	
(Q92) What was the average price per animal?	
If *AUCTIONEER* in Q90;	
(Q93) How many BULLS did you sell?	
(Q94) What was the average price per animal?	

If *BUTCHER* in Q90;	
(Q95) How many BULLS did you sell?	
(Q96) What was the average price per animal?	
If *OTHER FARMERS* in Q90;	
(Q97) How many BULLS did you sell?	
(Q98) What was the average price per animal?	
If *OTHER* in Q90;	
(Q99) How many BULLS did you sell?	
(Q100) What was the average price per animal?	

(Q101) If OXEN in Q89; To whom did you sell OXEN?

V1	V2	V3	V4	V5	V6
Feedlot	Auctioneer at auction	Butcher	Other farmers	Don't know	Other

If *FEEDLOT* in Q101;	
(Q102) How many OXEN did you sell?	
(Q103) What was the average price per animal?	
If *AUCTIONEER* in Q101;	
(Q104) How many OXEN did you sell?	
(Q105) What was the average price per animal?	
If *BUTCHER* in Q101;	
(Q106) How many OXEN did you sell?	
(Q107) What was the average price per animal?	
If *OTHER FARMERS* in Q101;	
(Q108) How many OXEN did you sell?	
(Q109) What was the average price per animal?	
If *OTHER* in Q101;	
(Q110) How many OXEN did you sell?	
(Q111) What was the average price per animal?	

(Q112) If COWS in Q89; To whom did you sell COWS?

V1	V2	V3	V4	V5	V6
Feedlot	Auctioneer at auction	Butcher	Other farmers	Don't know	Other

If *FEEDLOT* in Q112;	
(Q113) How many COWS did you sell?	
(Q114) What was the average price per animal?	
If *AUCTIONEER* in Q112;	
(Q115) How many COWS did you sell?	
(Q116) What was the average price per animal?	
If *BUTCHER* in Q112;	
(Q117) How many COWS did you sell?	
(Q118) What was the average price per animal?	
If *OTHER FARMERS* in Q112;	
(Q119) How many COWS did you sell?	
(Q120) What was the average price per animal?	
If *OTHER* in Q112;	
(Q121) How many COWS did you sell?	
(Q122) What was the average price per animal?	

(Q123) If HEIFERS in Q89; To whom did you sell HEIFERS?

V1	V2	V3	V4	V5	V6
Feedlot	Auctioneer at auction	Butcher	Other farmers	Don't know	Other

If *FEEDLOT* in Q123;	
(Q124) How many HEIFERS did you sell?	

(Q125) What was the average price per animal?	
If *AUCTIONEER* in Q123;	
(Q126) How many HEIFERS did you sell?	
(Q127) What was the average price per animal?	
If *BUTCHER* in Q123;	
(Q128) How many HEIFERS did you sell?	
(Q129) What was the average price per animal?	
If *OTHER FARMERS* in Q123;	
(Q130) How many HEIFERS did you sell?	
(Q131) What was the average price per animal?	
If *OTHER* in Q123;	
(Q132) How many HEIFERS did you sell?	
(Q133) What was the average price per animal?	

(Q134) If CALVES in Q89; To whom did you sell CALVES?

V1	V2	V3	V4	V5	V6
Feedlot	Auctioneer at auction	Butcher	Other farmers	Don't know	Other

If *FEEDLOT* in Q134;	
(Q135) How many CALVES did you sell?	
(Q136) What was the average price per animal?	
If *AUCTIONEER* in Q134;	
(Q137) How many CALVES did you sell?	
(Q138) What was the average price per animal?	
If *BUTCHER* in Q134;	
(Q139) How many CALVES did you sell?	
(Q140) What was the average price per animal?	
If *OTHER FARMERS* in Q134;	
(Q141) How many CALVES did you sell?	
(Q142) What was the average price per animal?	
If *OTHER* in Q134;	
(Q143) How many CALVES did you sell?	
(Q144) What was the average price per animal?	

(Q145) In general, are you satisfied with what you received for selling your cattle?

1	2	3
Yes	No	Don't know

(Q146) Name all the places where you have bought cattle over the past 12 months?

V1	Didn't buy any	
V2	Local farmer	
V3	Auction in Bushbuckridge	
V4	Auction/Farmer outside Bushbuckridge	
V5	Commercial breeder	
V6	Unknown	
V7	Don't know	
V8	Other…..	

(Q147) If LOCAL FARMER in Q146; How many did you buy?

V1	V2	V3	V4	V5	V6
Bulls	Oxen	Cows (have calved)	Heifers (not yet calved)	Calves (still suckling)	Didn't sell any

(Q148) If AUCTION IN BUSHBUCKRIDGE in Q146; How many did you buy?

V1	V2	V3	V4	V5	V6

Bulls	Oxen	Cows (have calved)	Heifers (not yet calved)	Calves (still suckling)	Didn't sell any

(Q149) If AUCTION/FARMER OUTSIDE BUSHBUCKRIDGE in Q146; How many did you buy?

V1	V2	V3	V4	V5	V6
Bulls	Oxen	Cows (have calved)	Heifers (not yet calved)	Calves (still suckling)	Didn't sell any

(Q150) If COMMERCIAL BREEDER in Q146; How many did you buy?

V1	V2	V3	V4	V5	V6
Bulls	Oxen	Cows (have calved)	Heifers (not yet calved)	Calves (still suckling)	Didn't sell any

(Q151) If UNKNOWN in Q146; How many did you buy?

V1	V2	V3	V4	V5	V6
Bulls	Oxen	Cows (have calved)	Heifers (not yet calved)	Calves (still suckling)	Didn't sell any

(Q152) If OTHER in Q146; How many did you buy?

V1	V2	V3	V4	V5	V6
Bulls	Oxen	Cows (have calved)	Heifers (not yet calved)	Calves (still suckling)	Didn't sell any

(Q153) Are you satisfied with the prices you paid for the cattle you bought?

1	2	3
Yes	No	Don't know

(Q154) Name the reasons why you usually buy cattle:

V1	Replacement animals	
V2	Increase breeding stock	
V3	Improve breeding stock	
V4	Investment	
V5	Unknown reasons	
V6	Don't know	
V7	Other	

(Q155) Are you satisfied with the access you have to markets for selling your cattle?

V1	V2	V3
Yes	No	Don't know

(Q156) Would you prefer a local auction where you can sell your cattle?

V1	V2	V3
Yes	No	Don't know

(Q157) If YES to Q156; why would you prefer a local auction?

V1	V2	V3	V4	V5	V6
Better prices	More buyers	Can sell more at a time	They use kg	Don't know	Other...

(Q158) If YES to Q156; when do you think such auctions should be held?

V1	Once a year	
V2	Every 6 months	
V3	Every 3 months	
V4	Every month	
V5	Summer/Spring	
V6	Winter/Autumn	
V7	Times of drought	
V8	Every 2 years	
V9	Whenever necessary	
V10	Don't know	
V11	Other...	

(Q159) If NO to Q156; why don't you think an auction is the best place to sell your cattle?

V1	Pay too much commission	
V2	Difficult to transport cattle	
V3	Don't get good prices	
V4	Not enough cattle for sale	
V5	Not enough buyers	
V6	No proper facilities	
V7	Auction kraal is too far	
V8	They cheat	
V9	Don't know	
V10	Other...	

(Q160) What cattle would you prefer to sell from your herd?

V1	V2	V3	V4	V5	V6	V7	V8
Bulls	Oxen	Cows	Heifers	Calves	Weaners	Don't know	Other…

Wildlife Ranching

(Q161) Do you have a problem with the surrounding reserves?

1	2	3
Yes	No	Don't know

(Q162) Do you think the surrounding reserves are helping the community?

1	2	3
Yes	No	Don't know

(Q163) In what ways do you think the surrounding reserves can best help the Mnisi community?

V1	Used as grazing	
V2	Used for tourism	
V3	Used for cultivation	
V4	Sold and money used in community	
V5	Job creation	
V6	Training and skills development	
V7	Don't know	
V8	Other...	

Socio - economics

Household member Contributing To Household Income)		What is […]'s relationship to the *household head*? (FOR HOUSEHOLD HEAD FILL IN RELATIONSHIP CODE 01 or 02; FOR OTHER FILL IN RELATIONSHIP CODE)		AGE		What is the highest level of education completed by the household member? (FILL IN LEVEL OF EDUCATION CODE)		What is the household members' main occupation / source of income? (FILL IN CODE)		What is the main industry of the household member? (FILL IN CODE)		What is the household member's monthly income?		How much money does the household member contribute to the household income?	
Q164		Q165		Q166		Q167		Q168		Q169		Q170		Q171	

RELATIONSHIP CODES

It's me(Male)	1	Daughter	8	Mother-in-law	15	Lodger(Female)	22
It's me(Female)	2	Father	9	Father-in-law	16	Grandfather	23
Friend(Male)	3	Mother	10	Son-in-law	17	Grandmother	24
Friend(Female)	4	Sister	11	Daughter-in-law	18	Don't know	25
Husband	5	Brother	12	Brother-in-law	19	Other	26
Wife	6	Granddaughter	13	Sister-in-law	20		
Son	7	Grandson	14	Lodger(Male)	21		

LEVEL OF EDUCATION CODES			
None	1	Standard 9 / Grade 11	6
Pre-primary	2	Standard 10 / Grade 12	7
Primary	3	Tertially (post matrix)	8
Standard 6-7/Grade 8-9	4	Don't know	9
Standard 8/Grade 10	5	Other	10
MAIN INCOME SOURCE CODES			
Regular formal employment	1	Social grant; disability support	10
Retired/ pension	2	Selling wild animals products	11
Temporary casual employment	3	Don't know	12
Student/ Scholar	4	Other	13
Self-employed business	5		
Self employed farmer	6		
Unemployed	7		
Home maker	8		
Social grant; child support	9		

MAIN INDUSTRY CODES			
Agriculture, hunting, forestry and fishing	V1	Financial, insurance, real estate and business	V8
Mining and quarrying	V2	Community, social and personal services	V9
Manufacturing	V3	Private households with employed persons	V10
Electricity, gas and water supply	V4	Exterritorial organizations (foreign government; aid)	V11
Construction	V5	Hospitality	V12
Wholesale and retail trade	V6	Don't know	V13
Transport, storage and communication	V7	Other (specify)	V14

Questions of a separate Animal Health questionnaire included in this thesis:

Q.31) What are the **biggest constraints/challenges** you face in farming with cattle here in Mnisi?

What are the **biggest constraints/challenges** you face in farming with cattle here in Mnisi?

V1	Nutritional problems	
V2	Access to water	
V3	Marketing problems	
V4	Stock theft	
V5	Veld fires	
V6	Animal Diseases	
V7	Drought	
V8	Ticks/Dipping	
V9	Problems with wildlife	
V10	I don't know	
V11	Other...	

Are the problems/challenges related to:

		1 Of minor importance	2 Relatively important	3 Important	4 Very important	5 Extremely important
Q.31)	Nutrition					
Q.32)	Access to water					
Q.33)	Marketing					
Q.34)	Stock theft					
Q.35)	Veld fires					
Q.36)	Animal diseases					
Q.37)	Drought					
Q.38)	Ticks/dipping					
Q.39)	Wildlife					
Q.40)	Other 1					
Q.41)	Other 2					

We would like to know more about the **most important livestock diseases** that you encounter in your cattle.

Can you name the **most important cattle diseases?**

Important diseases/ clinical signs *(use CODE from list below)*		
Most important	**Q.42)**	
2nd most important	**Q.43)**	
3rd most important	**Q.44)**	

CODES FOR DISEASES

1	Abortion	**20**	LSD (Lumpy skin disease)
2	Anaplasmosis	**21**	Male fertility
3	Anthrax	**22**	Malnutrition
4	Babesiosis	**23**	Mastitis
5	Black quarter	**24**	Milk fever
6	Brucellosis	**25**	None
7	Calf mortality	**26**	Other
8	Corridor disease	**27**	Other skin problems
9	Cough	**28**	Pneumonia/ Respiratory
10	Diarrhoea	**29**	Poisoning
11	Dystocia	**30**	Red water
12	Fever	**31**	Reproduction problems
13	FMD	**32**	Swelling at hooves
14	Foot rot	**33**	Swollen lymph nodes
15	Gallsickness	**34**	Three days stiffness
16	I don't know	**35**	Tick infections (ulcers, abscesses)
17	Injuries	**36**	Udder problem
18	Lack of appetite	**37**	Worms (internal parasites)
19	Lameness	**38**	Wounds

APPENDIX 4

CAPRIVI SEMI-STRUCTURED INTERVIEW

Section 1: Owner infromation

(Q1) Date:

(Q2) Surveyor:

(Q3) Crush-pen

(Q4) Respondent name (optional)

(Q5) Male (1)or female (2)

(Q6) Are you a cattle owner?

1	Cattle owner	
2	Herdboy	
3	Family member	
4	Other	

Section 2: Demographics

(Q7) How many cattle do you have?

(Q8) How many cattle in each of the following categories:

V1	Bulls	
V2	Oxen	
V3	Calves	
V4	Cows (& heifers if not sure to distinguish)	
V5	Heifers	

(Q9) According to you, what are the biggest constraints to farming with cattle in the Caprivi?

1	Grazing shortages	
2	Floods	
3	Poor markets	
4	Diseases	
5	Predation	
6	Contact with wildlife	
7	Bushfires	
8	Stock theft	
9	Other	

(Q10) If GRAZING: why is grazing a problem?

(Q11) If GRAZING: when is grazing a problem?

(Q12) If FLOODS: why is floods a big problem?

(Q13) If MARKETS: why are markets considerd a big problem?

(Q14) If DISEASES: what diseases are considered a big problem?

(Q15) If PREDATION: which predator is the biggest problem?

(Q16) If WILDLIFE CONTACT: why is that considered a problem?

Section 3: Socio-economics & trade

(Q17) Why do you keep cattle?

V1	Our livelihood	
V2	Bank	
V3	Emergency cash	
V4	Start business	
V5	Selling for cash (school fees, clothes, food etc)	
V6	Draught power	
V7	Other	

(Q18) Do you consider cattle as being the main source of income for your household?

(Q19) If not – what is?

(Q20) What do you use your cattle for?

V1	Draught work (ploughing, transport etc…)	
V2	Sell	
V3	Milk for home consumption	
V4	Meat for home consumption	
V5	Milk for selling	
V6	Meat for selling	
V7	Lobola	
V8	Traditional ceremonies	
V9	Other	

(Q21) Have you lost any cattle during this year?

(Q22) If YES, how many did you lose in each category.

V1	Bulls	
V2	Oxen	
V3	Calves	
V4	Cows	
V5	Heifer	
V6	Unknown	

(Q23) What were the causes of your cattle losses and how many in each?

V1	Crocodile	
V2	Hyena	
V3	Unknown	
V4	Disease	
V5	Got lost	

(Q24) Did you sell any cattle this year?

(Q25) If YES, to whom did you sell cattle?

V1	Local people	
V2	Meatco	
V3	Agents	
V4	Unknown	
V5		
V6		

(Q26) How many and of what category?

V1	Bulls	
V2	Oxen	
V3	Calves	
V4	Cows	
V5	Heifer	
V6	Unknown	

(Q27) In general, are you satisfied with the prices you receive for your cattle?
(Q28) If not, why not?
(Q29) If he didn't sell any to Meatco (Q25) – do you ever sell to MEATCO?
(Q30) If not – why not?
(Q31) What do you think is the biggest problem with selling cattle in Caprivi?
(Q32) Do you mind putting your cattle in the quarantine camp before it is taken to MEATCO?
(Q33) Why do you mind?
(Q34) Do you understand why they have to be in the quarantine camp?
(Q35) Did you buy any cattle this year?
(Q36) If YES, from whom?
(Q37) What time of the year are your calves born?
(Q38) Do you wean your calves?
(Q39) If NO – why not?
(Q40) If you would receive more money for weaners per kg when you sell to MEATCO, would you be willing to sell weaners rather than other animals?
(Q41) What animals do you prefer to sell?
(Q42) According to you, what animal gives the best meat to eat? (sex & age)?

V1	Male	
V2	Female	
V3	Young	
V4	Medium	
V5	Old	
V6	Unproductive	

Section 4: Cattle husbandry

(Q43) Do you think you have good quality animals or do you think their quality can be improved?
(Q44) How do you think it could be improved?
(Q45) Are your cattle kraaled every night of the year?

(Q46) If NOT, why en when not?
(Q47) Why do you kraal your cattle?
(Q48) Are your cattle being herded or allowed to walk freely?
(Q49) If HERDED, why do you herd them?

Section 5: Wildlife interaction

(Q50) Do you or your herdboys ever encounter wildlife such as elephant and buffalo while herding your cattle?
(Q51) Any other species?
(Q52) How often do you encounter buffalo?
(Q53) What time of the year?
(Q54) Do you have a problem with buffalo grazing with or close to your cattle?
(Q55) If YES - Why?
(Q56) What do you or your herdboys do when they encounter buffalo while grazing with the cattle?
(Q57) Do the cattle and the buffalo graze seperately or do they mix completely? Why?
(Q58) In your opinion, did the wildlife numbers increase or decrease in the area over the last five years?
(Q59) In general - Do you consider wildlife as a threat to your cattle?
(Q60) If YES, Why?
(Q61) What do you think is the answer to the wildlife being a problem?
(Q62) Do you think there are advantages also of having wildlife in the area?
(Q63) Why?
(Q64) Do you think the presence of animals like buffalo around your cattle prevents you from getting better market prices when you sell your cattle?

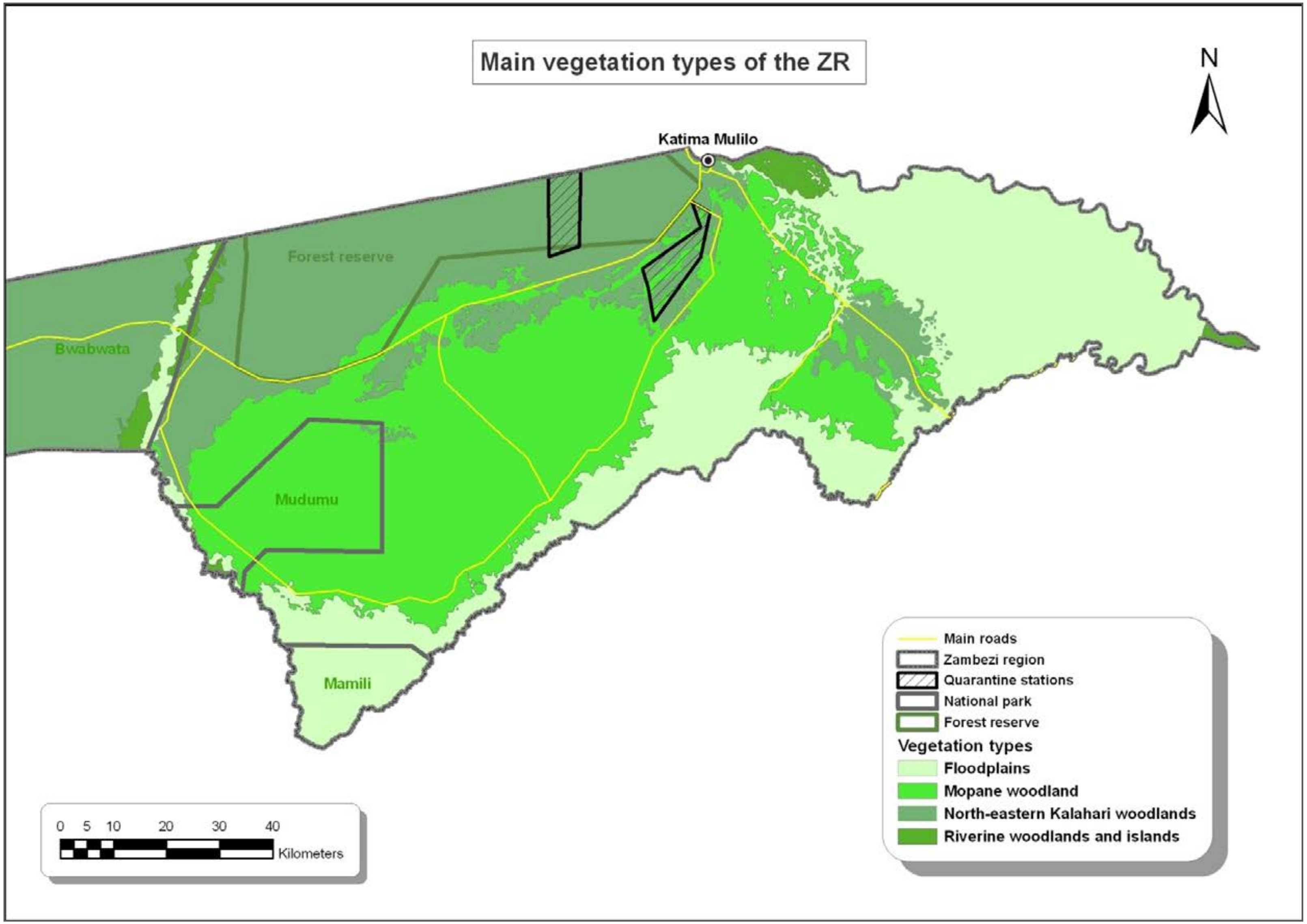
Section 6: Conservancies & mentorship

(Q65) Is there a conservancy in your area?
(Q66) Which one?
(Q67) What is your view of the community conservancies?
(Q68) Why?
(Q69) Do you think the community bennifit from the conservancies?
(Q70) If YES – how?

Section 7: Interventions:

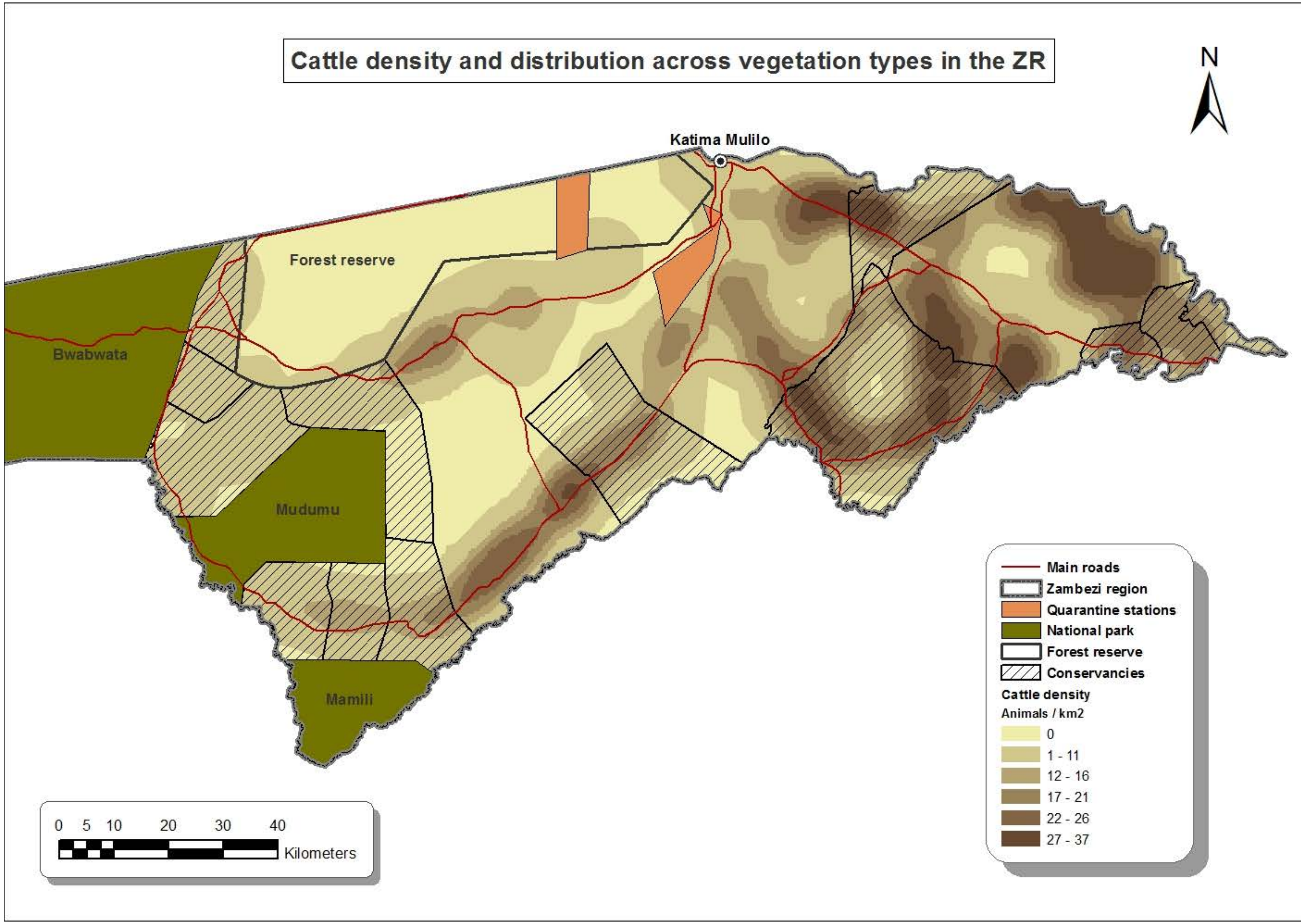
(Q71) If there is a cattle post in the area where all the farmers could take their weaners to graze properly in order to be marketed together, will you be willing to participate?
(Q72) Do you think you will benefit from a mentor who can teach you better farming practises?

APPENDIX 5[28]



[28] Source: Vegetation types of the Caprivi region, Namibia 2004. Environmental Information Service, Namibia, *http://www.the-eis.com/*

APPENDIX 6



Cattle density and distribution across vegetation types in the ZR
N
Katima Mulilo
Forest reserve
Bwabwata
Mudumu
Mamili
0 5 10 20 30 40
Kilometers
Main roads
Zambezi region
Quarantine stations
National park
Forest reserve
Conservancies
Cattle density
Animals / km2
0
1 - 11
12 - 16
17 - 21
22 - 26
27 - 37

APPENDIX 7

Model estimates of the current and appropriate cattle stocking rates for the ZR

	Animal Models A(1-4)		Only animal present areas						Animal absent areas included
			p-models (all available rangeland areas)						*z-models*
Biomass	Animal model	Vegetation Type	Estimated Capacity (Animals)	[a]Actual Animals (2011)	Reference (Animals)	Stock rate at Capacity (AU/ha)	Reference Stock rate (AU/ha)	[b]% over(-) /under (+) reference	[b]% over(-) /under(+) reference
Low vegetative biomass level	LA1								
	N=38	FP	46 597	65 952	74 400	0.15	0.24	-37.4	-31.3
	N=33	MW	34 985	45 509	51 339	0.12	0.17	-31.9	-10.2
	N=35	KW	29 756	15 534	17 523	0.20	0.12	69.8	220.0
	N=31	RW	2 208	1 910	2 155	0.15	0.15	2.4	7.1
	N=137	Total	113 546	128 905	145 418	0.15	0.20	-23.6	-6.0
	LA2								
	N=38	FP	60 778	65 952	74 400	0.20	0.24	-18.3	-10.4
	N=33	MW	45 633	45 509	51 339	0.15	0.17	-11.1	17.2
	N=35	KW	38 812	15 534	17 523	0.26	0.12	121.5	317.4
	N=31	RW	2 879	1 910	2 155	0.20	0.15	33.6	39.7
	N=137	Total	148 103	128 905	145 418	0.20	0.20	-0.4	22.6
	LA3								
	N=38	FP	72 934	65 952	74 400.44	0.24	0.24	-2.0	7.5
	N=33	MW	54 760	45 509	51 338.86	0.18	0.17	6.7	40.6
	N=35	KW	46 575	15 534	17 523.47	0.31	0.12	165.8	400.9
	N=31	RW	3 455	1 910	2 155.23	0.24	0.15	60.3	67.7
	N=137	Total	177 724	128 905	145 418	0.24	0.20	19.5	47.1
	LA4								
	N=38	FP	93 193	65 952	74 400	0.30	0.24	25.3	37.4
	N=33	MW	69 971	45 509	51 339	0.24	0.17	36.3	79.7
	N=35	KW	59 512	15 534	17 523	0.40	0.12	239.6	540.0
	N=31	RW	4 415	1 910	2 155	0.30	0.15	104.9	114.3
	N=137	Total	227 092	128 905	145 418	0.31	0.20	52.7	88.0
Mean vegetative biomass level	MA1								
	N=38	FP	59 318	65 952	74 400	0.19	0.24	-20.3	-12.6
	N=33	MW	56 204	45 509	51 339	0.19	0.17	9.5	44.3
	N=35	KW	35 553	15 534	17 523	0.24	0.12	102.9	282.3
	N=31	RW	2 810	1 910	2 155	0.19	0.15	30.4	36.4
	N=137	Total	153 885	128 905	145 418	0.20	0.20	0.4	22.0
	MA2								
	N=38	FP	77 371	65 952	74 400	0.25	0.24	4.0	14.1
	N=33	MW	73 310	45 509	51 339	0.25	0.17	42.8	88.3
	N=35	KW	46 374	15 534	17 523	0.31	0.12	164.6	398.7
	N=31	RW	3 666	1 910	2 155	0.25	0.15	70.1	77.9
	N=137	Total	200 720	128 905	145 418	0.26	0.20	30.9	59.2
	MA3								
	N=38	FP	92 845	65 952	74 400	0.30	0.24	24.8	36.9
	N=33	MW	87 972	45 509	51 339	0.30	0.17	71.4	125.9
	N=35	KW	55 648	15 534	17 523	0.37	0.12	217.6	498.4
	N=31	RW	4 399	1 910	2 155	0.30	0.15	104.1	113.4
	N=137	Total	240 864	128 905	145 418	0.32	0.20	57.1	91.0

	MA4								
	N=38	FP	118 635	65 952	74 400	0.39	0.24	59.5	74.9
	N=33	MW	112 408	45 509	51 339	0.38	0.17	119.0	188.7
	N=35	KW	71 106	15 534	17 523	0.48	0.12	305.8	664.7
	N=31	RW	5 621	1 910	2 155	0.39	0.15	160.8	172.7
	N=137	Total	307 770	128 905	145 418	0.41	0.20	100.7	144.0
High vegetative biomass level	HA1								
	N=38	FP	75 720	65 952	74 400	0.25	0.24	2	12
	N=33	MW	78 999	45 509	51 339	0.27	0.17	54	103
	N=35	KW	42 509	15 534	17 523	0.29	0.12	143	357
	N=31	RW	3 587	1 910	2 155	0.25	0.15	66	74
	N=137	Total	200 815	128 905	145 418	0.26	0.20	30	57
	HA2								
	N=38	FP	98 765	65 952	74 400	0.32	0.24	33	46
	N=33	MW	103 043	45 509	51 339	0.35	0.17	101	165
	N=35	KW	55 446	15 534	17 523	0.37	0.12	216	496
	N=31	RW	4 679	1 910	2 155	0.32	0.15	117	127
	N=137	Total	261 933	128 905	145 418	0.34	0.20	70	105
	HA3								
	N=38	FP	118 518	65 952	74 400	0.39	0.24	59	75
	N=33	MW	123 651	45 509	51 339	0.42	0.17	141	218
	N=35	KW	66 535	15 534	17 523	0.45	0.12	280	616
	N=31	RW	5 615	1 910	2 155	0.39	0.15	161	172
	N=137	Total	314 319	128 905	145 418	0.41	0.20	104	146
	HA4								
	N=38	FP	151 439	65 952	74 400	0.50	0.24	104	123
	N=33	MW	157 999	45 509	51 339	0.53	0.17	208	306
	N=35	KW	85 017	15 534	17 523	0.57	0.12	385	814
	N=31	RW	7 175	1 910	2 155	0.50	0.15	233	248
		Total	401 630	128 905	145 418	0.53	0.20	160	214

Notes:

z – column: model output percentage above or below the reference population calculated with total surface areas available per vegetation type

p – column: model output percentage above or below the reference population calculated with animal presence surface areas per vegetation type, only. Detail of actual population estimates were not included in the table

[a] 'Actual' is still an estimate, based on the mean population size from annual DVS cattle census data within the ZR. The 'actual' figure used was corrected according to the medium term mean population size

M, H, L = Mean, Highest, and Lowest herbaceous biomass estimates per vegetation type {{782 Mulonda, Oscar. 2011}}

A1, A2, A3, A4 = Various animal models used

N = number of cattle density gradients per vegetation type ranging from 1 animal per hectare to a maximum density of 38 animals per hectare (FP), 33 animals per hectare (MW), 35 animals per hectare (KW), and 31 animals per hectare (RW).

Totals = total excess or deficit in population stocking rate for each animal model across all vegetation types were weighted based on the cattle population distribution across each vegetation type which was reflected in the mean density estimates for each vegetation type. This was done to give a more accurate reflection of overall difference in stocking rates.

Particular model inputs:

Vegetation type	Biomass (kg/ha) {{782 Mulonda, Oscar. 2011}}			
	Mean	Highest	Lowest	
Floodplains	1018.4	1300	800	
Mopane woodland	996.03	1400	620	
Kalahari woodland	1254.56	1500	1050	
Riverine woodland	1018.4	1300	800	*(used same as FP)*

	Total available rangeland (z-model)			
	Area (Km2)	Area (ha)	Cattle	Cattle corrected
Floodplains	3353	335310	48291	74400
Mopane woodland	3905	390467	33323	51339
Kalahari woodland	2803	280309	11374	17523
Riverine woodland	151	15148	1 399	2 155
	10 212	**1 021 234**	**94 387**	**145 418**

	Total unused rangelands (0 animal presence)	
Floodplains	296	29589
Mopane woodland	943	94287
Kalahari woodland	1316	131563
Riverine woodland	7	664
	2562	**256102**

	Total animal present areas (p-models)	
Floodplains	3057	305721
Mopane woodland	2962	296180
Kalahari woodland	1487	148746
Riverine woodland	144	14484
	7650	**765131**

Animal Model	LW	Intake (%)	Period	Daily intake (kg)	Tot. Intake (kg)
A1	360	3	243	10.8	2624.4
A2	360	2.3	243	8.28	2012.04
A3	300	2.3	243	6.9	1676.7
A4	360	1.5	243	5.4	1312.2

APPENDIX 8

The descriptive statistics of the mean animal numbers of all model outputs, including the P-value of comparisons between mean output values and the mean reference population in A) total population per biomass level in both p- and z-models, and B) the model outputs per vegetation type

A	p-models					z-models				
Model	Mean	N	S.D.	S.E.M	P-value	Mean	N	S.D.	S.E.M	P-value
Reference	1 093	133	1 092	95		1 061	137	1 091	93	
LA1	854	133	817	71	0.000	1 136	137	2 493	213	0.001
LA2	1 114	133	1 065	92	0.224	1 482	137	3 252	278	0.498
LA3	1 336	133	1 278	111	0.400	1 778	137	3 902	333	0.191
LA4	1 707	133	1 633	142	0.000	2 272	137	4 986	426	0.000
MA1	1 157	133	1 096	95	0.385	1 526	137	3 162	270	0.730
MA2	1 509	133	1 430	124	0.022	1 991	137	4 124	352	0.007
MA3	1 811	133	1 716	149	0.000	2 389	137	4 949	423	0.000
MA4	2 314	133	2 193	190	0.000	3 052	137	6 324	540	0.000
HA1	1 510	133	1 438	125	0.024	1 979	137	3 967	339	0.007
HA2	1 969	133	1 876	163	0.000	2 581	137	5 174	442	0.005
HA3	2 363	133	2 251	195	0.000	3 097	137	6 209	530	0.000
HA4	3 020	133	2 877	249	0.000	3 052	137	6 324	540	0.000

B		p-models					z-models				
V.type	Model	Mean	N	S.D.	S.E.M	P-value	Mean	N	S.D.	S.E.M	P-value
	Reference	2 010	37	1 133	186		2 010	37	1 133	186	
	LA1	1 259	37	527	87	0.000	1 345	38	740	120	0.001
	LA2	1 643	37	687	113	0.049	1 754	38	966	157	0.106
	LA3	1 971	37	824	136	0.822	2 105	38	1 159	188	0.936
	LA4	2 519	37	1 053	173	0.046	2 690	38	1 480	240	0.028
	MA1	1 603	37	670	110	0.025	1 712	38	942	153	0.060
	MA2	2 091	37	875	144	0.827	2 233	38	1 229	199	0.627
	MA3	2 509	37	1 049	173	0.049	2 680	38	1 475	239	0.030
	MA4	3 206	37	1 341	220	0.000	3 424	38	1 885	306	0.000
	HA1	2 046	37	856	141	0.946	2 185	38	1 203	195	0.733
	HA2	2 669	37	1 116	184	0.013	2 851	38	1 569	255	0.007
	HA3	3 203	37	1 340	220	0.000	3 421	38	1 883	305	0.000
Floodplains	HA4	4 093	37	1 712	281	0.000	4 371	38	2 406	390	0.000
	Reference	1 604	32	922	163		1 604	32	922		
	LA1	1 093	32	654	116	0.005	1 398	33	1 863	324	0.017
	LA2	1 426	32	853	151	0.155	1 823	33	2 430	423	0.288
	LA3	1 711	32	1 024	181	0.587	2 188	33	2 916	508	0.936
	LA4	2 187	32	1 308	231	0.150	2 795	33	3 727	649	0.095
	MA1	1 756	32	1 051	186	0.985	2 245	33	2 993	521	0.782
	MA2	2 291	32	1 371	242	0.082	2 929	33	3 904	680	0.050
	MA3	2 749	32	1 645	291	0.004	3 514	33	4 685	816	0.002
	MA4	3 513	32	2 102	372	0.000	4 491	33	5 987	1 042	0.000
	HA1	2 469	32	1 477	261	0.030	3 156	33	4 207	732	0.018
	HA2	3 220	32	1 927	341	0.000	4 117	33	5 488	955	0.000
	HA3	3 864	32	2 312	409	0.000	4 940	33	6 585	1 146	0.000
	HA4	4 937	32	2 955	522	0.000	6 312	33	8 415	1 465	0.000

Next page...

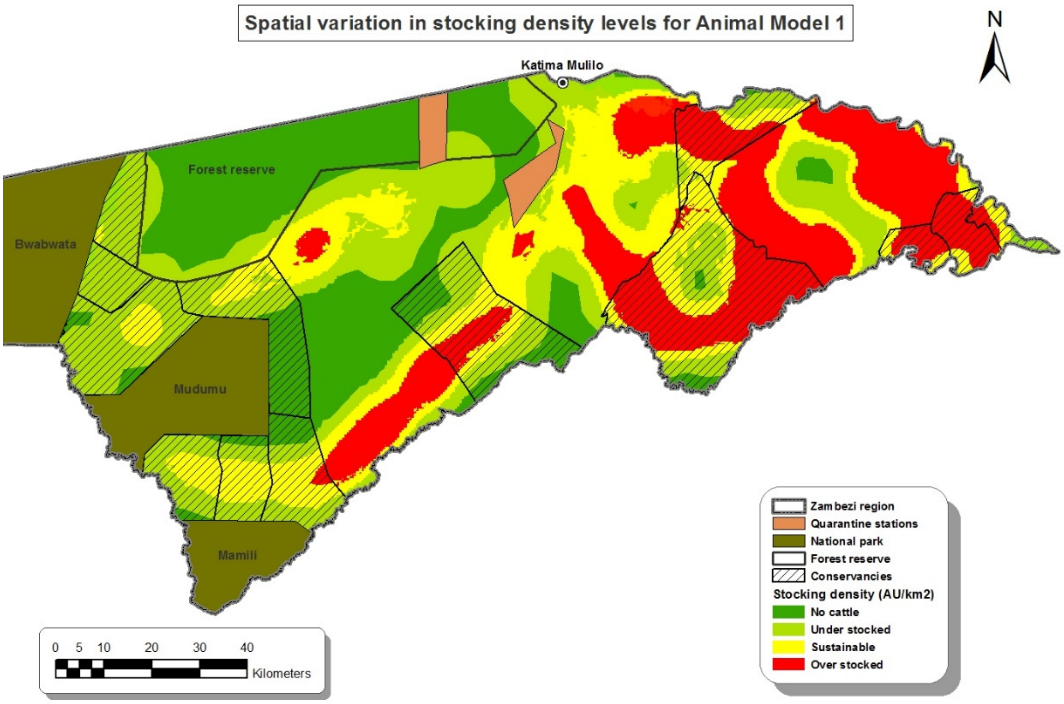
Kalahari woodlands	Reference	515	34	285	49		515	34	285	49	
	LA1	875	34	1 079	185	0.912	1 602	35	4 430	749	0.694
	LA2	1 142	34	1 408	241	0.071	2 090	35	5 778	977	**0.044**
	LA3	1 370	34	1 689	290	**0.004**	2 508	35	6 934	1 172	**0.002**
	LA4	1 750	34	2 158	370	**0.000**	3 204	35	8 860	1 498	**0.000**
	MA1	1 046	34	1 289	221	0.215	1 914	35	5 293	895	0.140
	MA2	1 364	34	1 682	288	**0.004**	2 497	35	6 904	1 167	**0.002**
	MA3	1 637	34	2 018	346	**0.000**	2 996	35	8 285	1 400	**0.000**
	MA4	2 091	34	2 579	442	**0.000**	3 829	35	10 587	1 789	**0.000**
	HA1	1 250	34	1 542	264	**0.019**	2 289	35	6 329	1 070	**0.011**
	HA2	1 631	34	2 011	345	**0.000**	2 985	35	8 255	1 395	**0.000**
	HA3	1 957	34	2 413	414	**0.000**	3 582	35	9 906	1 674	**0.000**
	HA4	2 501	34	3 083	529	**0.000**	4 578	35	12 658	2 140	**0.000**
Riverine woodland	Reference	72	30	40	7		72	30	40	7	
	LA1	74	30	65	12	0.586	74	31	64	11	0.829
	LA2	96	30	84	15	0.614	97	31	83	15	0.433
	LA3	115	30	101	18	0.254	117	31	100	18	0.164
	LA4	147	30	129	24	**0.014**	149	31	127	23	**0.008**
	MA1	94	30	82	15	0.644	95	31	81	15	0.456
	MA2	122	30	107	20	0.159	124	31	106	19	0.100
	MA3	147	30	129	23	**0.014**	148	31	127	23	**0.008**
	MA4	187	30	164	30	**0.000**	190	31	162	29	**0.000**
	HA1	120	30	105	19	0.185	121	31	103	19	0.117
	HA2	156	30	137	25	**0.003**	158	31	135	24	**0.002**
	HA3	187	30	164	30	**0.000**	189	31	162	29	**0.000**
	HA4	239	30	210	38	**0.000**	242	31	207	37	**0.000**

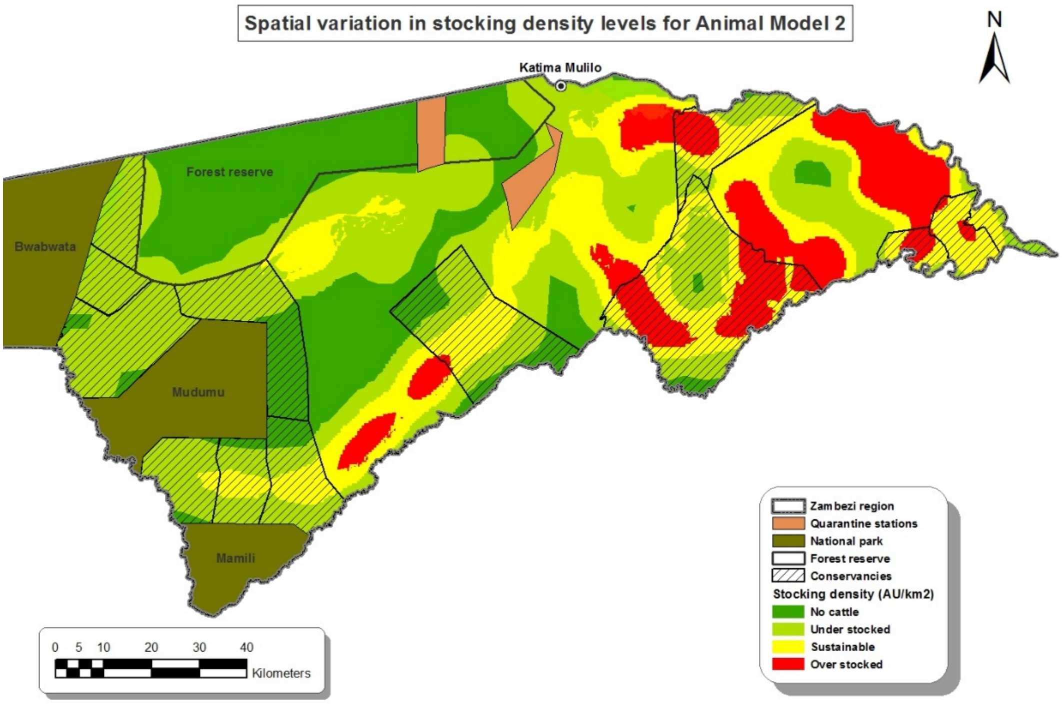
Notes:

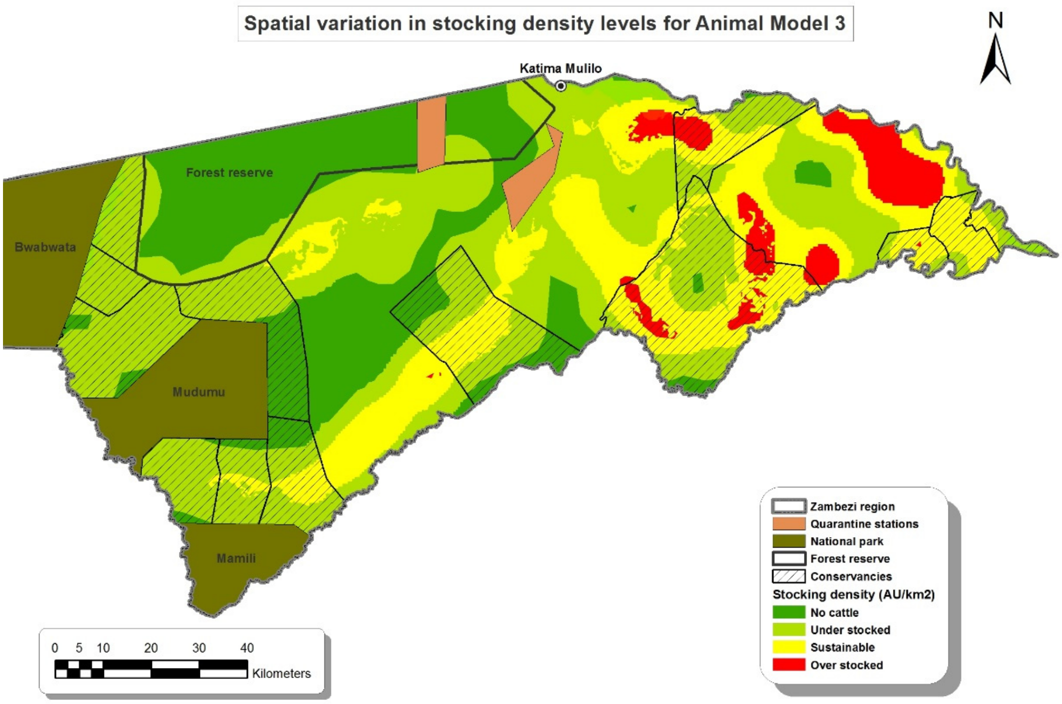
- *P-value significant at the 5% significance level (95%) confidence interval. All significant P-values in* **bold**
- *Test used to compare means: Related-Samples Wilcoxon Signed Rank Test*

APPENDIX 9

The spatial distribution of cattle that are either under, over or sustainably stocked across vegetation types in the ZR, using Animal Model A1-3 at the mean biomass production levels over 8 months

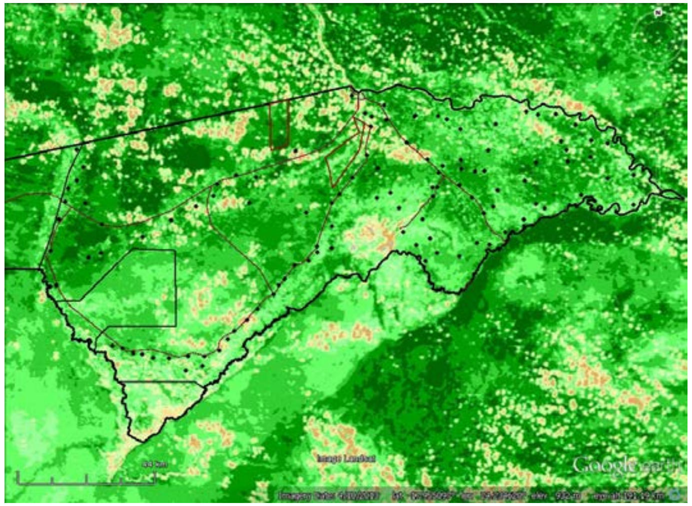




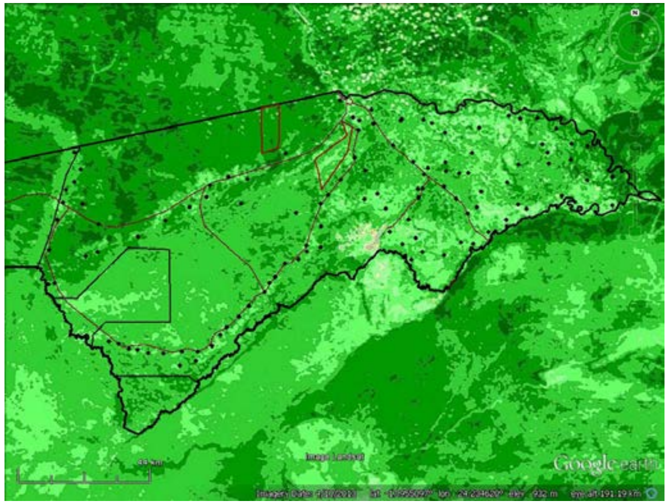

Spatial variation in stocking density levels for Animal Model 3
N
Katima Mulilo
Forest reserve
Bwabwata
Mudumu
Mamili
0 5 10 20 30 40
Kilometers
Zambezi region
Quarantine stations
National park
Forest reserve
Conservancies
Stocking density (AU/km2)
No cattle
Under stocked
Sustainable
Over stocked

APPENDIX 10

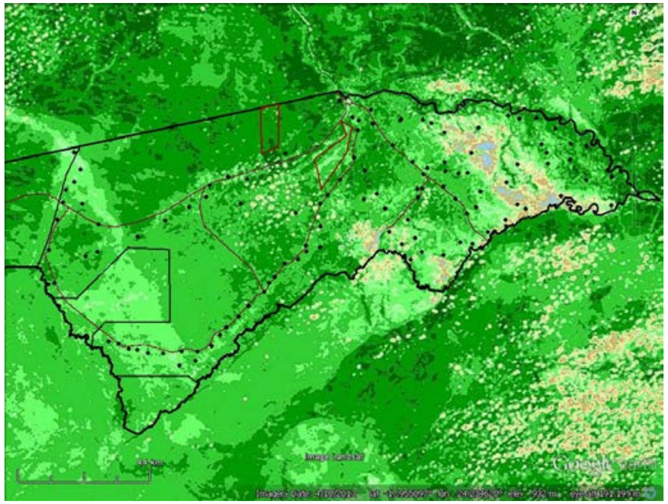
Variation in NDVI[29] in the Zambezi Region- 2011



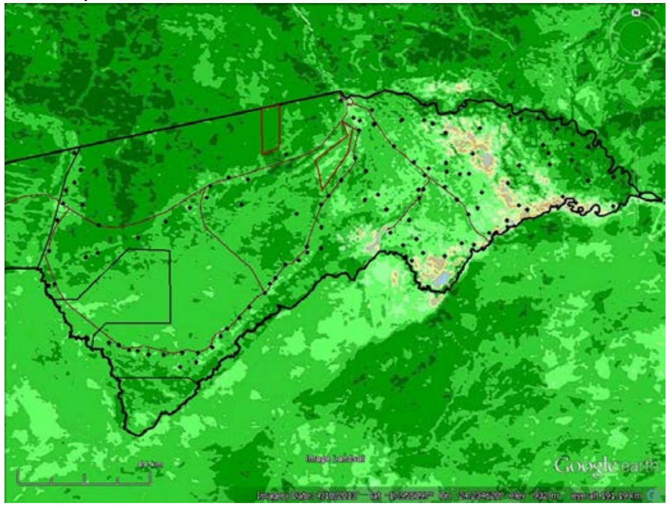
January



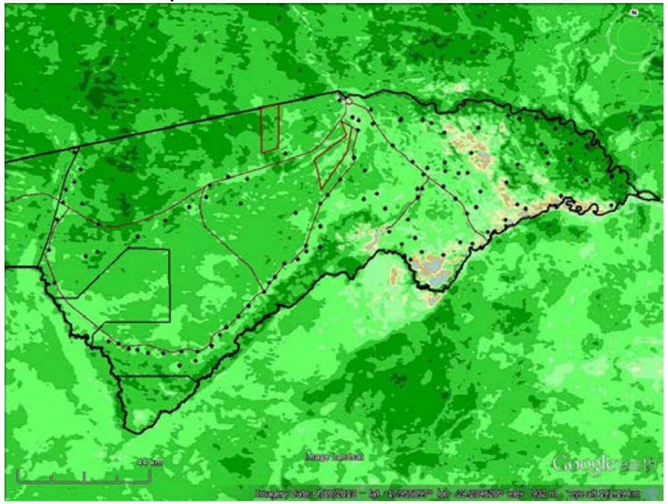
February



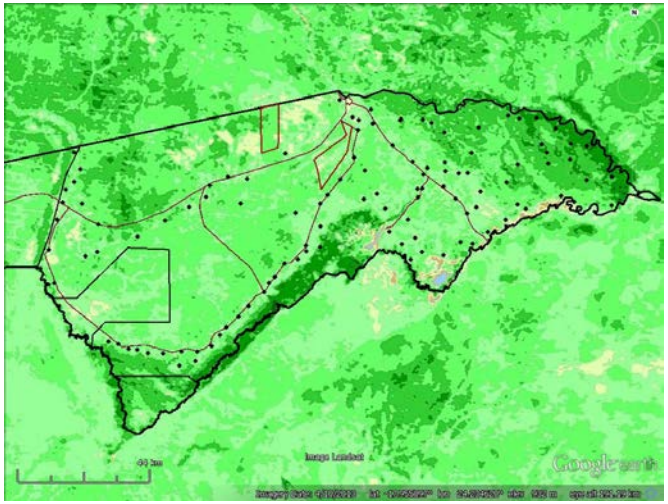
March



April



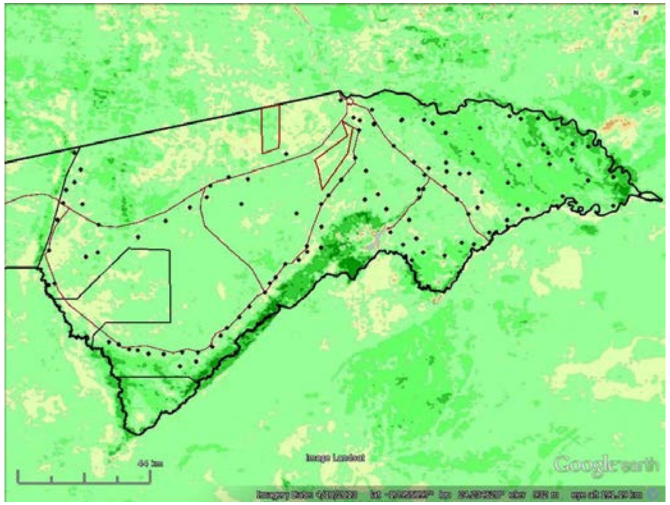
May

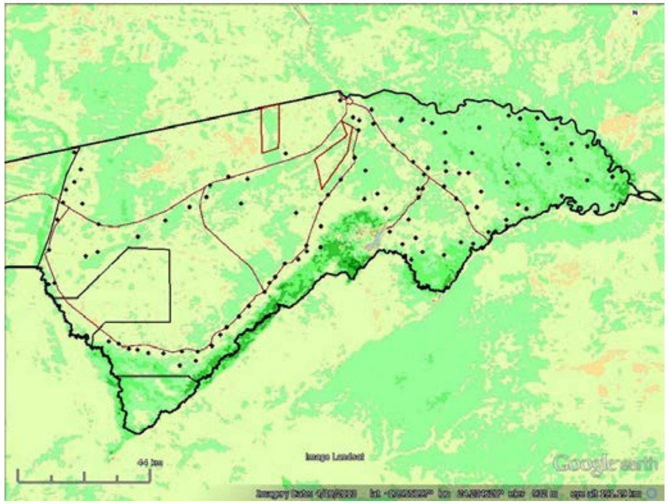


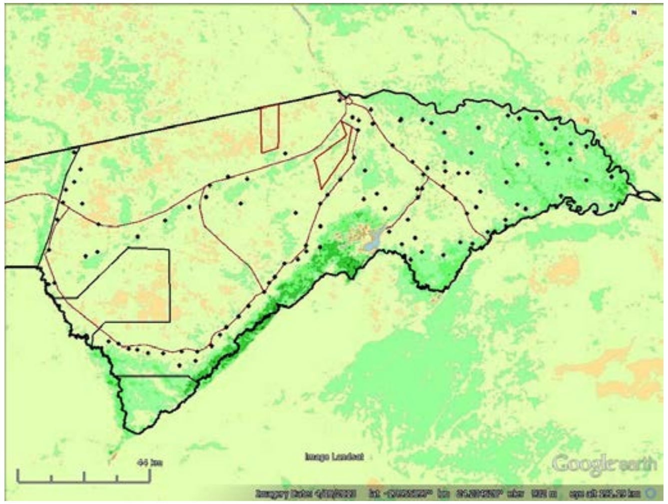
June

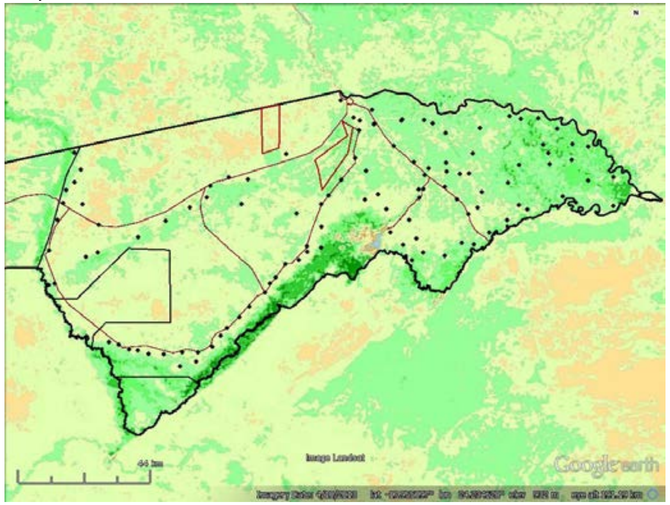
[29] NDVI Imagery: adapted in Google Earth. Imagery Source: Terra NDVI 250m, MODIS Rapid Response, NASA Goddard Flight Center, https://earthdata.nasa.gov

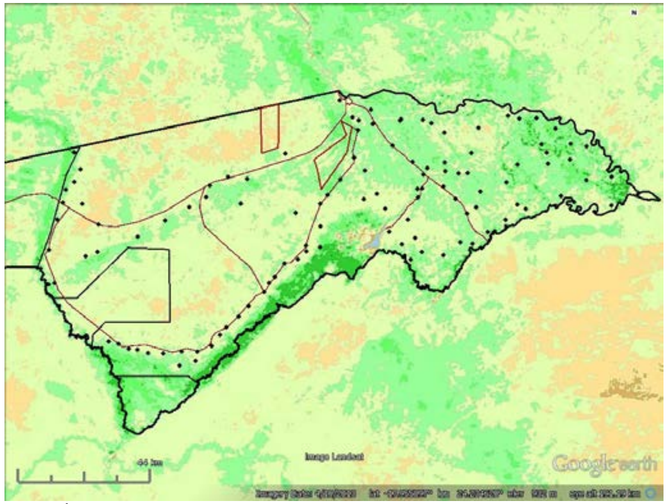
Appendix 10 continues...

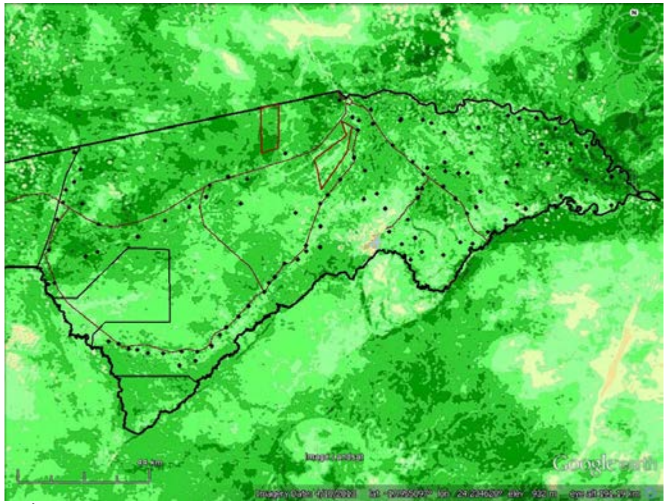

July


August


September

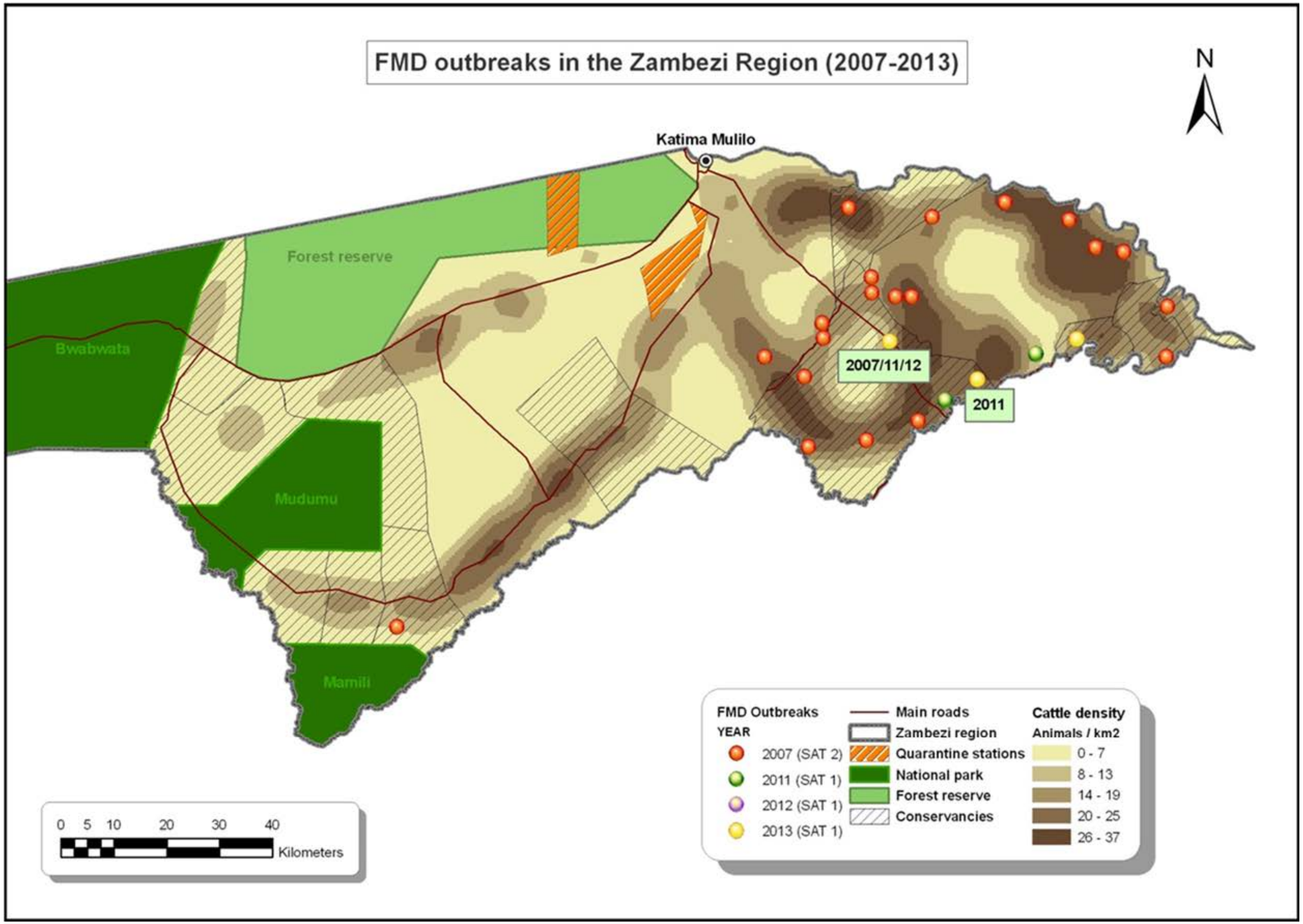

October


November

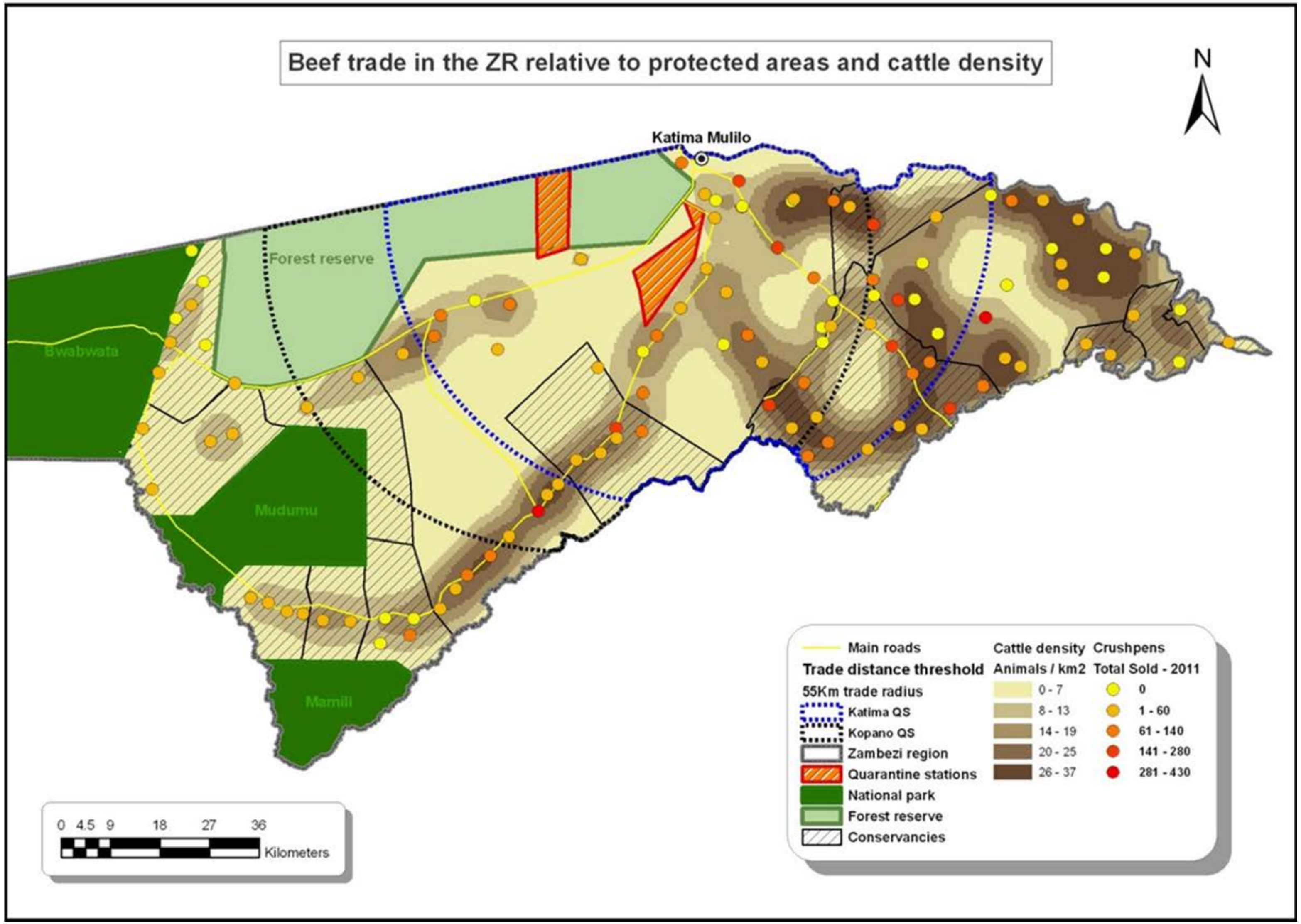

December

APPENDIX 11

Map indicating the FMD outbreaks in the ZR between 2007 and 2013 (WAHIS, OIE)



A figure indicating the concentric circles around each of the two QCs which represent the market range of the ZR



APPENDIX 13

Article 8.8.22

Terrestrial Animal Health Code, OIE [30]

Recommendations for importation from FMD infected countries or zones, where an official control programme for FMD, involving compulsory systematic vaccination of cattle, exists

For fresh meat from cattle and buffalo (*Bubalus bubalis*), excluding feet, head and viscera

Veterinary authorities should require the presentation of an international veterinary certificate attesting that the entire consignment of meat:

1. Comes from animals which:
   a. have remained, for at least three months prior to slaughter, in a zone of the exporting country where cattle and water buffaloes are regularly vaccinated against FMD and where an official control programme is in operation;
   b. have been vaccinated at least twice with the last vaccination not more than six months, unless protective immunity has been demonstrated for more than six months, and not less than one month prior to slaughter;
   c. were kept for the past 30 days in an establishment, and that FMD has not occurred within a 10 kilometre radius of the establishment during that period, or the establishment is a quarantine station;
   d. have been transported, in a vehicle which was cleansed and disinfected before the cattle and water buffaloes were loaded, directly from the establishment of origin or quarantine station to the approved slaughterhouse/abattoir without coming into contact with other animals which do not fulfil the required conditions for export;
   e. have been slaughtered in an approved slaughterhouse/abattoir:
      i) which is officially designated for export;
      ii) in which no FMD has been detected during the period between the last disinfection carried out before slaughter and the shipment for export has been dispatched;
   f. have been subjected to ante- and post-mortem inspections for FMD with favourable results within 24 hours before and after slaughter;

2. Comes from deboned carcasses:
   a. from which major lymphatic nodes have been removed;
   b. which, prior to deboning, have been submitted to maturation at a temperature greater than + 2°C for a minimum period of 24 hours following slaughter and in which the pH value was less than 6.0 when tested in the middle of both the longissimus dorsi muscle.

[30] http://www.oie.int/index.php?id=169&L=0&htmfile=chapitre_fmd.htm – accessed 30 January 2016

APPENDIX 14

A few pictures from days spent at the Africa Centre for Holistic Management, Dibangombe, Victoria Falls, Zimbabwe. March 2015

Top: Village action cycle used by villagers to train others. **Bottom**: Loose bunching by herders

Top: Herders' own grazing area map. **Bottom**: Herders fended of lion to save this heifer. Note the swelling from bite wounds to the throat.