Republic of Botswana

Gap Analysis on the Implementation of Commodity-Based Trade of Beef in Ngamiland, Botswana

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EXECUTIVE SUMMARY

Overview

Ngamiland District in north-western Botswana is home to an estimated 152,200 people and 317,000 privately owned cattle. It is also home to the Okavango Delta and its rich wetlands and wildlife, and lies at the heart of the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA), Africa's largest conservation and development landscape. Livestock production and wildlife-based tourism are the primary land uses. The income from tourism is an important source of foreign exchange and contributor to Botswana's GDP. However, the full potential economic benefits from livestock production are not being realised, because cattle farmers in the district are excluded from higher value beef markets due to the proximity of wildlife, particularly African buffalo that are the reservoir host of the South African Territories (SAT) serotypes of foot and mouth disease (FMD) virus. The traditional standards for international trade in livestock commodities, which require beef production areas (countries or zones) to be free from FMD, restrict market access and penalise livestock owners who share the land with wildlife. Periodic outbreaks of FMD also cause disruptions in the local market due to movement restrictions, with devastating effects on the district level economy and local livelihoods. In addition, attempts to meet international standards by creating and maintaining FMD-free zones that depend largely on extensive use of disease control fencing have had significant negative repercussions for free-ranging wildlife.

Wildlife is one of Botswana's greatest assets and the status of the district as an FMD-infected 'red zone' is unlikely to change in the near future. However, this does not mean that the district cannot produce FMD-free beef. Commodity-based trade (CBT) approaches that focus on the safety of the beef production process and the beef itself, rather than on the animal disease situation in the locality of production, are scientifically sound and effective. They are also compatible with modern animal production and trade standards, as set by the World Organisation for Animal Health (OIE). These non-geographic (i.e. non-fence based) CBT approaches to managing trade-associated risks from diseases like FMD offer potential to effectively integrate livestock and wildlife-based enterprises. Furthermore, implementing CBT in an integrated way that includes improved husbandry (herding and kraaling) and rangeland management practices would help mitigate conflict between wildlife and livestock and make cattle production more sustainable and environmentally friendly, thus lending itself to the marketing of 'wildlife friendly beef'. The successful development of this approach in Ngamiland would be a 'win-win' for sustainable and diversified land use and livelihoods.

Under the Government of Botswana's (GoB) Ministry of Agricultural Development and Food Security (MoA), the Department of Veterinary Services (DVS) has been partnering with Cornell University's AHEAD (Animal & Human Health for the Environment And Development) programme for several years now to re-look at the way in which FMD is managed in Ngamiland, with a focus on reducing trade disruptions due to outbreaks and enabling sustainable beef trade through CBT-based approaches. To assist DVS in these efforts, the collaborative project investigated the components of the beef value chain in Ngamiland with a view to facilitating adoption of a CBT approach in order to sustainably improve market access, diversify economic opportunities and enable coexistence between livestock and wildlife. While the concept has been well received at multiple levels (government, private sector, producer), sustainability of this CBT value chain approach will depend on it delivering clear financial benefits to cattle producers and other value chain actors. The potential profitability of the current production and marketing systems is hampered by a number of obstacles that need to be addressed in order to improve market access and thereby incentivise more investment in the sector and CBT approaches.

The purpose of this report is to document the results of a gap analysis performed on the components of the value chain in the production of wildlife friendly beef and provide practical recommendations to address the gaps identified. The findings and recommendations are based on extensive consultations with various stakeholder groups, workshops, fieldwork and analyses, with funding provided to Cornell University's AHEAD programme through a "Wildlife Friendly Beef" (WFB) grant from the Atkinson Center for a Sustainable Future, with additional support from The Rockefeller Foundation. Under the AHEAD umbrella, a multi-disciplinary project team, in close collaboration with DVS, undertook this work between November 2017 and July 2019. The gaps, together with practical recommendations, have been validated by relevant stakeholders and are summarised below.

Gaps and recommendations

This study, as well as a complementary market opportunities study conducted in 2017 (http://www.wcs-ahead.org/kaza/171003_rpt_final_marketopportunitiesforcbtbeef_ngamiland.pdf), revealed that a range of potential markets exist for beef produced in Ngamiland, but currently only a few of these are being accessed, namely mainly lower value local markets and at least one SADC country of equivalent FMD status that does not require certification of freedom from FMD. Potentially high value local markets are also not fully exploited, for example, the market for WFB offered by Ngamiland's tourism industry. While tourism contributes an estimated 11.5% to Botswana's GDP, with most of it focused on photographic wildlife tourism deriving from international markets, to date there are almost no linkages between the tourism industry and local producers of domestic products. This is in part a consequence of an absence of domestic production of consumer goods, but nowhere is there a greater disconnect between an industry demand for product and the local production of that product than in Ngamiland's beef sales. Opportunities also exist for developing secondary processing/value addition although investment in infrastructure and capacity building will be required. Development of niche products such as WFB salamis, sausages and biltong does, however, offer an opportunity for local entrepreneurs and artisanal industries to develop.

Other potential markets exist in countries of equivalent FMD status in and outside the SADC region. Implementing a CBT value chain approach to WFB production could enable access to markets in FMD-free countries or zones for beef commodities and products that comply with OIE Terrestrial Animal Health Code (TAHC) Article 8.8.22 (i.e. through quarantine) for beef produced in areas not free of FMD – as well as via Article 8.8.31 for beef that has been processed in such a way as to destroy the FMD virus.

Pre-slaughter quarantine functioned satisfactorily in Ngamiland prior to 2007, as no FMD outbreaks in any quarantine station (QS) or anywhere else in Ngamiland were reported. The present situation, with frequent outbreaks in the district and probable circulation of FMD virus in cattle, demands rigorous implementation of a high level of biosecurity to prevent outbreaks in the QS and provide a level of assurance that supports export certification. It's also important to note that the requirement for pre-slaughter quarantine of cattle (under TAHC Article 8.8.22) is currently resulting in a bottleneck due to a number of issues, including producers' reluctance to quarantine their animals, and the location, holding space and physical state of the existing quarantines. While progress is being made on rehabilitating the QS at Makalamabedi, having a single QS located a considerable distance from most of the main cattle-producing areas will not provide a sustainable solution for export of beef under Article 8.8.22. That said, the need for quarantine will be market-dependent and should not be imposed on producers if not required by the trade partner.

Several available options to overcome the limitations of having a single QS exist, namely to:

- identify as wide a spectrum of markets as possible that do not require quarantine;
- consider rehabilitating additional existing government QSs depending on resources and practicality (e.g. location, ease of access);
- create an enabling environment for the establishment of smaller, intensive, privately owned facilities (such as quarantine in privately managed facilities and/or quarantine-compliant feedlots); and
- conduct a feasibility study into the establishment and operation of mobile quarantines.

Accessing higher priced markets requires more than a CBT approach; compliance with international food safety standards and the offering of products of sufficient quality to satisfy consumer expectations in those markets are also essential. The gap analysis revealed that a degree of modernisation of cattle production in Ngamiland will be necessary to support a value chain that will result in a sustained demand for beef from higher priced markets.

During consultations, the implementation of Botswana's Animal Information and Traceability System (BAITS) featured as a significant constraint to producers and their ability to move their cattle to markets. The importance of cost-benefit studies to ensure that investment in a particular animal identification and traceability system is justified by the returns that it will generate has been emphasised repeatedly in the literature. While it is ideal to

have all the cattle identified according to a single system, until that system is functional throughout Ngamiland it may be necessary to accept that other systems should continue to be used, depending on the target markets.

In addition to some of the CBT-related constraints highlighted above, a range of constraints applicable to the wider beef production system in the district has also been identified. For many years, reduced market access for cattle due to FMD concerns has led to low offtake, poor cattle management, overstocking and rangeland degradation. Furthermore, the distance between production areas and abattoirs and QSs reduces participation in formal markets by many cattle farmers. This is exacerbated by the lack of a text/SMS-based marketing information system and the fact that while Ngamiland farmers have been excluded from higher value markets, there are no clear incentives for sourcing beef locally for government-run institutions in Ngamiland, rather than from the green zones. The beef market, in turn, is affected by the offtake of larger, older animals, which impacts on both quality and consistency of supply. These challenges are compounded by lengthy bans on cattle movements and closure of abattoirs during FMD outbreaks. Together, these factors have inhibited investment in the beef value chain, and potential sources of income in addition to fresh beef, such as those associated with processing marketable animal by-products, are largely untapped.

The gap analysis also found that the unequivocally high incidence of FMD events in Ngamiland cattle over the last decade provides *prima facie* evidence that the vaccination programme in Ngamiland has been insufficiently effective since 2007. Adequacy of coverage is difficult to assess due to the fact that the size of the cattle population of Ngamiland is founded on imprecise data. Other factors that may reduce vaccination efficacy are potential mismatches of vaccine strains with field viruses, and flaws in the vaccine administration process. The extent of these potential problems can to a large extent be gauged by post-vaccination monitoring. Although such exercises have been conducted periodically in Ngamiland, results have not been made available to the project team.

Given the importance and potential complexity of the issues that need to be addressed, it must be recognised that elimination of FMD from Ngamiland within the foreseeable future is virtually impossible. Improved approaches to *managing* FMD in the long term are therefore imperative and depend on a better understanding of the factors that reduce vaccination efficacy as well as the epidemiology of the disease in Ngamiland, and Botswana generally, to inform appropriate control measures and improve collaboration between DVS and farmers. It is suggested that FMD management be addressed more objectively in future because it has wide-ranging implications for the expectations of a large section of Botswana's civil society. Major challenges (gaps) meriting attention are presented in more detail below.

While a number of gaps have been identified, it may be helpful to distinguish between the challenges facing CBT implementation specifically versus the challenges facing Ngamiland's beef sector overall – with or without CBT. The tables below make that distinction.

- Table A outlines gaps specific to CBT that need to be addressed to access most markets, with a sub-section on constraints that need to be overcome to achieve access to markets in FMD-free countries or zones, e.g. through quarantine. It also identifies gaps that need to be addressed to reduce conflict between livestock production and wildlife conservation and enable potential development of a WFB brand;
- Table B outlines gaps that hinder beef production and marketing in general in Ngamiland, with or without CBT, that need to be addressed.

Within the tables, all gaps are considered important. However, further distinction is made as follows:

Gaps that are considered **absolutely critical** to address, failing which, CBT implementation is unlikely to succeed

Gaps whose corrective actions are considered **low hanging fruit** in terms of being relatively easily addressed

Table A. Constraints that hinder implementing a CBT approach along the value chain in Ngamiland.

	GAPS	RECOMMENDATIONS
FIELD	**Good animal husbandry and livestock management practices not being implemented sufficiently** *Record keeping, herding and kraaling to reduce contact with buffalo, basic health care & grazing management are inadequate, affecting farmer compliance with producer protocols for CBT implementation and overall livestock productivity (& exacerbating human-wildlife conflict).*	• Provide training & extension including farmer-to-farmer extension (e.g. beef productivity training for farmers and herdsmen through DAP), and 'train the trainer' programs for DAP staff. • Introduce skilled herding, including collective herding for smaller herds, at pilot sites to demonstrate proof of concept (Herding for Health [H4H] model). • Utilise farmers associations/farmers to identify individuals for herder training. • Ensure good working conditions & job descriptions for skilled herders. • Consider collective action to enable joint sourcing of medicines & feed supplements to be shared amongst small-scale producers - minimises wastage & enables better prices & shared transport costs. • Increase understanding of conservation agreements (see Section 3.1) as mechanisms to facilitate compliance with good husbandry and livestock management practices so that benefits offered in the agreement are based on participants' sustainable use of specific natural resources. • Share responsibility for implementation among farmers, non-governmental organisations (NGOs) that provide support & government agencies. • Consider development of legal/policy instruments that support grazing plans & related animal husbandry practices.
	Challenges surrounding BAITS are inhibiting its successful implementation in Ngamiland *Animal identification systems can ensure traceability to support disease control & comply with requirements for some markets. Several factors including equipment challenges, information inaccuracies, limited bandwidth & inadequate access to computers &/or internet in many rural areas are however hampering implementation of BAITS, leading to farmer frustration. The above issues are exacerbated by the absence of transitional arrangements that would allow farmers to move cattle that are not yet in the BAITS system to abattoirs for slaughter.*	• Capacitate DVS staff as a matter of urgency (includes technical equipment as well as training & maintenance). • Increase the number of BAITS cafes in Ngamiland to at least include pilot sites for herding programmes so as to build on existing & complementary initiatives. • Explore innovative solutions through partnerships (e.g. tech & cell phone companies) to increase internet access & connectivity within Ngamiland e.g. BTC to increase bandwidth sufficiently to enable BAITS access. • Consider allowing the use of previous identification systems (e.g. identification brand & most recent vaccination brand; manual/paper-based system) that enable cattle to be moved to abattoirs & accepted for slaughter if problems with BAITS are not resolved adequately. • Share responsibility for implementation among relevant government agencies, with support from non-state actors.
ABATTOIR	**Distance between production areas, quarantine stations & abattoirs reduces formal market participation by producers** *The concentration of abattoirs around Maun makes it difficult for producers further afield to access formal markets. Increased transport costs also prevent formal market participation for some producers.*	• Consider innovative options that offer slaughter services for the formal market further afield, for instance, mobile abattoirs linked to approved slaughter slabs. • Explore the feasibility of mobile QSs to enable compliance with the requirement of some markets for pre-slaughter quarantine.

	GAPS	RECOMMENDATIONS
ABATTOIR	**Insufficient focus in some abattoirs on implementing Hazard Analysis and Critical Control Points (HACCP) or HACCP-like systems to increase spectrum of available markets** *For some markets, additional food safety requirements may need to be met.*	• Investigate requirements of a range of potential markets (not all markets have the same requirements as the EU). • Private abattoirs to formalise HACCP implementation by instituting the necessary documentation. • Formalise guidelines for different scenarios for batch separation of quarantined animals & those slaughtered for markets that don't require quarantine. • Increase laboratory capacity to detect food safety threats in abattoirs in Ngamiland.
FURTHER PROCESSING & VALUE ADDITION	**Range of secondary beef products is limited** *Value addition via processing beef into sausages, meat pie fillings, & other processed vacuum-packed meat cuts could be viable & would diversify the industry. However, investment in equipment and technical expertise would be required. BMC-Maun's cooking plant is no longer functional, but the potential exists for exporting processed cooked beef to regional markets such as South Africa. Cooking plants can theoretically remain open for slaughter, canning & export during FMD outbreaks & any products processed in accordance with OIE TAHC Article 8.8.31 could also be exported, with little or no market disruption.*	• Government agencies/parastatals in collaboration with private sector & NGOs to identify products & potential markets that have the capacity to generate a positive return on investment, e.g. emphasize quality products that can be marketed for best value. • Botswana Meat Commission (BMC) & private enterprises to evaluate whether to invest in the requisite heat treatment & other processing technology. • Government to re-evaluate previous processed product recommendations/ proposals put forward by private sector investors for Ngamiland.
	Potential market for WFB offered by Ngamiland's tourism industry not being realised *Markets for Ngamiland WFB and/or free range/grass fed beef are integral to a long-term sustainable business model that achieves envisioned conservation & economic goals. The tourism market in northern Botswana currently sources meat from outside Ngamiland. However, to tap this market, issues of seasonal variation in quality & supply need to be improved.*	• Initially, engage Ngamiland's tourism sector to secure commitments to support local farming communities to supply beef products such as bone-in beef for lodge staff; or products such as dried boerewors. • Over time, engage Ngamiland's tourism sector to secure commitments to support local farming communities & engage with the latter to provide the preferred type of beef for the niche market (i.e. younger, grass-fed animals tied into conservation agreements). • Draft comprehensive Production Standards for WFB for Ngamiland beef producers. • Pilot the above at a site such as Habu or Eretsha, to complement ongoing activities by NGOs in communal herding & kraaling.
MARKETS	**Entities such as Ministry of Investment, Trade & Industry and the National Strategy Office have not been co-opted adequately in the exploration of markets for CBT beef** *While DVS has traditionally played some role in securing markets for trade in beef, the successful implementation of a novel approach such as CBT will require expertise from other ministries such as trade & finance, working collaboratively with private sector to open up previously unexplored avenues for trade.*	• Actively engage as wide a spectrum of stakeholders (including other government ministries, parastatals, NGOs & private sector) with the requisite expertise & skills to identify & secure potential markets for CBT beef. • Ensure a legislatively grounded & transparent policy enabling environment for CBT.

	GAPS	RECOMMENDATIONS
FMD OUTBREAK CONTROL	**Approaches to managing FMD outbreaks are not fully aligned to CBT, causing trade disruption & affecting investor confidence** *Blanket movement restrictions associated with FMD outbreak management have sometimes been excessively long which inhibits trade unnecessarily. There is ongoing need for alignment of FMD outbreak response & protocols for implementing CBT. Although there have been positive developments in this respect, these need to be formalised in the form of a Standard Operating Procedure (SOP) & communicated transparently to relevant stakeholders.*	• DVS to finalise SOP on outbreak management to provide more detail, to safely enable trade in the event of FMD outbreaks. • DVS to communicate outbreak management SOPs to stakeholders so as to instil confidence in the enabling environment established by government for implementation of CBT [of importance to the private sector (& possible investors) & producers]. • DVS to revisit and clarify movement protocols for samples to the national reference laboratory to enable rapid diagnostic confirmation of suspected outbreaks; a satellite diagnostic lab in Maun is reportedly under development.
FENCING	**Lack of clear understanding of the state, impact, purpose & cost of the fencing inventory of Ngamiland** *A CBT approach to beef production facilitates the management of FMD associated trade risk while diminishing the need for expensive & often environmentally damaging fences. This has been embraced by the GoB, with the Directors of DVS, Wildlife & National Parks (DWNP), Animal Production (DAP), Environmental Affairs (DEA) and Lands re-establishing the National Committee on Cordon Fences. The Committee recognises the need for an audit on the state of Ngamiland's fences to inform decision making on which fences are no longer necessary or are more damaging than beneficial & should be considered for decommissioning or re-alignment.*	• Newly revived multi-sectoral fencing committee (National Committee on Cordon Fences) to provide technical, cross-sectoral advice on fencing issues. • Conduct an assessment of fences with respect to their purpose, exact length & alignment, state of repair, maintenance costs, & impact on wildlife movement (both within Ngamiland & the broader KAZA TFCA landscape). • Based on assessment, produce a strategic fencing plan that considers Ngamiland & the KAZA TFCA (i.e., the needs of the wildlife resource). • Fencing committee should oversee and drive implementation of the strategic fencing plan. • If some fences can be decommissioned or down-sized, DVS budgetary savings could be applied to key needs related to CBT implementation as outlined elsewhere in this chart.
STAKEHOLDER COORDINATION, COMMUNICATION & OUTREACH	**Insufficient understanding of CBT & the role that different stakeholders need to play in its successful implementation** *As a new approach being introduced into the country, adequate resources need to be invested into raising the level of understanding of CBT so that stakeholders appreciate potential benefits & their specific role(s) in that outcome & have realistic expectations.*	• Source & invest resources into developing a suite of communication tools to develop an understanding of CBT at the regional & national level in collaboration with non-state actors (farmer associations & NGOs). Communication tools range from radio & TV shows to fliers, road shows & workshops. • Specifically target government extension staff (DAP, DVS & DWNP) & farmers to raise their level of understanding by organising trainings/awareness raising workshops in production areas, in collaboration with NGOs/academia.
	Ground level activities amongst farmers, NGOs & government entities need to be coordinated *A number of projects are underway with selected farming communities in Ngamiland involving conservation NGOs in a bid to minimise human-wildlife conflict through improved husbandry practices and/or implement CBT practices at the producer level. These activities need to be coordinated to avoid conflicting messaging & training. Some progress has been made through the establishment of a Ngamiland Wildlife Friendly Beef Forum.*	• Use existing forums to increase collaboration & complementarity amongst the various projects. • Mandated government entities such as DAP & DWNP, and District Council officials, to play a stronger role in this coordination.

	GAPS	RECOMMENDATIONS
	CONSTRAINTS SPECIFIC TO ACCESSING MARKETS FOR CHILLED OR FROZEN BEEF IN FMD-FREE COUNTRIES OR ZONES (ADDITIONAL TO ABOVE)	
QUARANTINE	**In terms of the production of chilled or frozen beef, the requirement for pre-slaughter quarantine of cattle is currently resulting in a bottleneck due to producer reluctance to quarantine their animals** *Producers may be reluctant to quarantine cattle for a range of operational & other issues including lack of manpower to care for animals in QS, additional transport costs & failure to understand or accept the pricing system. Insufficient quarantine capacity is likely to create a further bottleneck in times of oversupply of cattle.*	• DVS to strictly limit the requirement for quarantine to cattle destined to supply chilled or frozen beef to markets that demand compliance with TAHC Article 8.8.22. • Actively seek and identify further markets that do not have a pre-slaughter quarantine requirement, either because they are FMD-infected or because their requirement is for matured, deboned beef from which visible lymphoid tissue has been removed, providing a scientifically accepted 'very safe' product. • Encourage further processing of products to comply with TAHC Article 8.8.31 to further reduce the number of cattle requiring quarantine. • Arrange with abattoirs for slaughter of quarantined and non-quarantined cattle on separate lines or days with complete cleaning and disinfection in between to minimise possible contamination. • Ensure that producers understand the costs involved in cattle transactions and, if necessary and feasible, modify the pricing system to accommodate their concerns.
	The location, holding space & physical state of existing quarantine stations are factors limiting quarantine capacity *Prior to the FMD outbreak in 2007, the government operated quarantine stations (QSs) were an essential part of the Ngamiland beef production system. Since then, there has been no significant use for the designated quarantines & they have fallen into a state of disrepair. Makalamabedi is the most accessible QS and the only one that could be rehabilitated for use within a fairly short space of time. However, the layout of Makalamabedi does not fully meet the requirements for biosecurity. Furthermore, it is clear that having a single QS located at a considerable distance from most of the main cattle-producing areas will not provide a sustainable solution for export of beef under TAHC Article 8.8.22.*	• MoA/DVS to complete the rehabilitation of Makalamabedi QS, taking into account biosecurity and stocking capacity concerns. • Consider the use of mobile fences to avoid the expense of installing additional internal fencing to achieve physical separation of cattle from different batches at all times, including at water points in adjoining paddocks. • Provide disinfection facilities, toilet facilities and office accommodation. • Consider all available options/scenarios to overcome the limitations imposed by having a single QS: ▪ identify as wide a spectrum of markets that do not require quarantine as practical; ▪ consider rehabilitating one or more of the other existing government QS depending on resources and practicality (e.g. location, ease of access); ▪ create an enabling environment for the establishment of smaller, intensive, privately owned facilities (such as quarantine in privately managed facilities & quarantine-compliant feedlots); ▪ conduct a feasibility study into the establishment & operation of mobile quarantines.

	GAPS	RECOMMENDATIONS
QUARANTINE	**Lack of a comprehensive biosecurity plan for quarantine stations** *Frequent FMD outbreaks in the district and probable circulation of FMD virus in cattle demands rigorous implementation of a high level of biosecurity to prevent outbreaks in the QS and provide a level of assurance that supports export certification.* *The current QS SOP (DVS-OCp-Doc:046) does not fully satisfy the requirements of a biosecurity plan. In addition to that document, a basic biosecurity plan needs to be developed that provides details on the day-to-day management and maintenance activities essential for the effective biosecurity of QSs. In particular, the plan needs to reconsider personnel allocation as the current allocation appears to be inadequate. Further training of the Principal Technical Officer & staff will be necessary to ensure that they understand the reasons for & the tasks essential to the running of a QS. The need for this was identified during a training session held in Maun in September 2018.* *Another major issue is potentially insufficient guarantee of the integrity of the Makalamabedi QS perimeter fence due to elephant incursions. The siting of Makalamabedi QS in Zone 3d Buffer makes impenetrable biosecurity imperative to avoid escape of cattle from Zone 2 into the EU Buffer Zone in 4a. Damage to fences due to incursion of elephants into the QS therefore needs further consideration in addition to the elephant-proof trench that is being dug along one border of the QS. Additionally, cloven-hoofed wildlife will need to be excluded from the facility on a continuous basis.*	• Appoint a dedicated group within DVS to document the minimum standards, develop a biosecurity plan, provide relevant SOPs & monitor implementation. • Develop job descriptions to enable an accurate assessment of the number of employees required to operate the QS to the necessary level of efficiency & biosecurity based on the holding capacity. • Consider expanding the professional workforce with ecorangers employed through the *Ipelegeng* job creation programme or H4H programme. • Reconsider the option of using owners of cattle in the QS & their employees for the day-to-day handling of cattle in the various camps due to possible increased risk of introducing FMD. However, if no alternative is feasible, put in place risk mitigation measures that include preventing uncontrolled access to the QS, training in basic biosecurity procedures including the use of protective clothing & disinfection, & ensure supervision by well-trained, full-time, core QS staff. • Provide more detailed training of the workforce in biosecurity principles & practice, including but not limited to detailed instruction on what to do in the case of (1) mortalities occurring within the QS, (2) the immediate set of actions should FMD be detected in the QS, & (3) actions necessary following other incidents that threaten biosecurity, e.g. elephant incursion resulting in fence breakages. • Consider further investment in strengthening the perimeter fence. • Make provision within the biosecurity plan for sufficient patrolling, maintenance & when necessary repair of fences to ensure the uninterrupted integrity of the perimeter fence.
	Lack of QS environmental management plan and inadequate grazing capacity to meet potential abattoir throughput demand *In a semi-arid environment, quarantine facilities need to be very large properties subdivided into smaller paddocks, in which grazing is efficiently managed to prevent degradation of rangeland & loss of condition by cattle during the quarantine period. Remote sensing data suggests Makalamabedi QS, on its own, will be unable to supply enough paddocks & grazing to ensure adequate separation of batches & maintenance of body condition during a 30-day holding to meet potential abattoir throughput demand.*	• Develop an appropriate Environmental Management Plan with support from animal production & rangeland scientists (e.g. from ORI/NGOs) to ensure optimal management of grazing in the QS. • Consider enhancing quarantine capacity through one or more of the scenarios described above, while also maximizing development of products & markets (including within Ngamiland itself) that don't require quarantine. • Provide rangeland management & restoration skills through appointment of ecorangers, who can also assist with animal handling & record keeping. • Consider the use of internal mobile paddocks according to a grazing plan to ensure compliance with both rangeland management & biosecurity measures whilst not compromising animal condition.

Table B. Constraints that hinder beef production and marketing in general in Ngamiland, with or without CBT.

	GAPS	RECOMMENDATIONS
FIELD	**Overstocking and overgrazing are leading to rangeland degradation** *The estimated number of cattle in Ngamiland in 2016 was 317,000, yet rangeland condition allowed for a grazing capacity of approximately half that (147,330). Overstocking & consequent overgrazing have been exacerbated by lack of opportunities to market cattle, leading to low offtake, particularly during lengthy movement bans following FMD outbreaks. Damage to rangelands also results from uncontrolled movement of cattle.*	• Based on planned grazing and pasture management trials at pilot sites, upscale to other areas in the district to counter rangeland degradation. • Appropriate and practical grazing plans with which farmers comply can significantly buffer the apparent overstocking, but that will have to be linked to capacity in professional herders and reliable market access. • Share responsibility for implementation among farmers, NGOs that provide support & government agencies/institutions (e.g. ORI).
	Low offtake consisting of primarily larger, older animals has implications for quality of beef & consistency of supply *The traditional production system results in large oxen being marketed for beef, which has implications for quality, production costs & transport. It also carries higher risk of loss of animals during drought, although it is a traditional risk mitigation strategy for communal farmers. For free-range beef to be competitive & potentially access niche markets, it should be derived from animals <2years, which could improve supply of cattle to abattoirs, reduce production & transport costs, reduce rangeland degradation & result in high quality meat, fetching higher prices at the abattoirs. It would also provide a supply of suitable animals for feedlot finishing.*	• Encourage collective herding and kraaling as a strategy for holistic risk management. • Develop a conducive environment for feedlot investment where feasible to enable animals to be finished as necessary. • Increase level of understanding among farmers on the possibilities that CBT brings, as well as the requirements to ensure the quality, consistency & quantity of beef that are critical to sustained access to desirable markets. • Encourage farmers to market younger animals & incorporate weaner production. • Through consultation and discussion at farmers' days, DAP/DVS to introduce the concept of payment for quality rather than weight alone.
	Information pertinent to appropriate management of FMD in Ngamiland, including science-based information on the efficacy of the vaccination programme, is insufficient *The incidence of FMD in cattle has increased remarkably in Botswana despite regular vaccination campaigns being conducted 2 or 3 times/year. The reason for this is unclear & probably multi-factorial. Potential contributing factors include insufficient information on the epidemiology of FMD in Ngamiland, lack of an independent assessment of post-vaccination monitoring data, and the fact that the estimated size of the cattle population is founded on imprecise data.*	• State and non-state actors to conduct further research to provide the information needed to develop appropriate control measures. A list of potential research questions is provided in Annex C. • Independent assessment of post-vaccination monitoring data is needed to determine whether the current vaccine programme is being conducted effectively or not. • Depending on the results, ▪ develop a programme to establish the reason(s) for vaccine failure, institute corrective measures & assess their effect, or ▪ seek other reasons for repeated outbreaks of FMD in Ngamiland. • Obtain reliable information on size & distribution of the cattle population. • Improve understanding of SAT-type virus behaviour in both wildlife & livestock populations generally.
	Need to strengthen plan of action to deal with the Lake Ngami cattle population *Unvaccinated, feral cattle congregated around Lake Ngami poses an unacceptable FMD risk.*	• MoA to continue engagement with farmers associations to develop a mutually agreed plan of action to deal with the Lake Ngami cattle given the risk posed for all producers. • Consider the involvement of game capture contractors in the mutually agreed plan to ensure human safety.

	GAPS	RECOMMENDATIONS
ABATTOIR	**Lack of consistent supply of cattle to meet slaughter capacity & fulfil export quotas** *Seasonal fluctuations in cattle supply are usual in areas with a marked dry season & can only be overcome by systems based on proper planned grazing with supplementary feeding, including feedlots if appropriate and feasible. Other contributory factors in Ngamiland are the siting of the abattoirs in relation to the distribution of the cattle population & traditional production systems, as well as non-quality-related pricing that favours sale of older animals. Severely delayed payments are also problematic. In order to supply sufficient cattle to enable all three abattoirs to operate at capacity a change in the demography of the cattle population over time will be necessary.*	• Consider expanding the available production systems to include sale of younger cattle, weaner production & quarantine compliant feedlots. • In consultation with stakeholders including the farmers, initiate negotiations for quality-based pricing systems based on carcass grading & ensure that farmers understand the principles & importance of consumer preferences when accessing higher value markets. • Abattoirs to pay producers in a timely manner as delays disenfranchise them, affecting their ability to invest in their production system & participate in the formal market. • Consider undertaking an assessment, in consultation with producers, into the introduction of a grading system to encourage weaner production & provide incentive through increased prices.
	Potentially unsafe disposal of waste & condemned material *The project team observed that solid waste from abattoirs was disposed of at the unprotected municipal dump. While the local council has since taken steps to manage the situation, implementing waste disposal law & forcing abattoirs to comply, this still needs to be monitored.*	• Transform as much of the solid waste as possible on site into safe products or destroy it (condemned material). • GoB/DVS to review existing legislation on meat safety to ensure that legislation relating to handling & disposal of solid waste from abattoirs clearly specifies what is necessary for safe disposal. • Monitor abattoir waste disposal to ensure compliance with waste disposal law. • Over time review waste management plans to ensure they keep up with global environmental and social trends to ensure sustainability.
FURTHER PROCESSING & VALUE ADDITION	**Use of animal by-products is limited, leading to unrealised potential for the development of associated enterprises** *The development of industries around animal by-products (currently lacking in Ngamiland) could improve income along the value chain, reduce waste being deposited in the Maun landfill & contribute towards GoB's priority of job creation & economic diversification, particularly among women & youth.*	• Engage institutes with the requisite skills & expertise such as LEA's Leather Incubation Programme & Zimbabwe's University of Science & Technology. • For leather production, emphasise use of vegetable tanning agents (versus chrome tanning agents), which are more environmentally friendly & review the Branding of Cattle Act (once BAITS is fully functional) as branding reduces leather quality. • LEA/NGOs to explore SMME development centred on leather goods, soap & other tallow-related products, either for sale to wholesale markets or for production in smaller quantities aimed at high-end tourist lodges in northern Botswana.
PACKAGING & TRANSIT	**Insufficient mechanisms exist to ensure transit issues do not disrupt trade** *The transit of beef from areas of production in Ngamiland to current export markets is not at present a challenge, but potential challenges may depend on both the product type & requirements of the country of transit.*	• GoB to put in place mechanisms to avoid potential trade disruptions in the future through a process of bi-lateral negotiations with countries of transit & protocol development.

	GAPS	RECOMMENDATIONS
MARKETS	**Government run/fed institutions in Ngamiland should be encouraged/ incentivized to increase proportion of beef that is locally sourced** *Anything that can be done to augment local sourcing of beef from within Ngamiland merits consideration.*	• GoB to revisit procedures for sourcing of beef for government run institutions in Ngamiland, (schools, prisons, military, etc.).
	Lack of SMS-based market information system inhibits producers from effectively participating in formal trade *Market information systems based on simple text messaging services (SMS) which do not require internet connectivity are commonly used elsewhere in Africa to provide real time information on market prices & alerts on market channels (e.g. buying points, closures of abattoirs, appeals for cattle, etc.). This ensures that the information reaching producers is accurate & consistent & leads to a sense of empowerment.*	• MoA/BMC to develop a simple text based (or similar) system for Ngamiland that does not require either internet connectivity or smart phone technology for ease of use & maximum coverage of producers. Information to include all relevant aspects of the beef industry such as available capacity & pricing at abattoirs; buying points; vaccination campaign dates; outbreak alerts & requisite procedures; etc.
STAKEHOLDER COORDINATION, COMMUNICATION & OUTREACH	**Inadequate understanding of how pricing is determined (live weight vs carcass weight) is leading to disputes between BMC and farmers over future pricing once quarantine is established, and reluctance to sell to abattoirs in the interim** *The determination of live weight versus carcass weight pricing involves a series of concepts (age, quality, bruising, point of sale, transport & other additional costs/risks borne by farmers) which may not be well understood by producers & therefore affect their ability to make an informed decision.*	• Arrange farmer workshops in order to address this topic specifically. • Farmers to consider investing in scales (collectively at village level) or weight bands to estimate live weight before sale. • Farmers associations to communicate more widely to farmers about how prices compare.
	Inadequate understanding of FMD & its characteristics in the region affects outbreak & farmer response *Recent capacity building workshops have highlighted the need for further efforts targeting vaccination campaign staff & farmers on the basics of FMD in the field & relevance of vaccination.*	• Vaccination campaigns offer an important opportunity to refresh the minds of both farmers & technical staff on the basics of FMD & relevance of vaccination in FMD management. Other mechanisms such as regular crush meetings, use of crush leaders & farmers associations should be utilised to disseminate information on a periodic basis as opposed to once-off trainings.
	Distrust & inadequate communication has damaged the relationship between farmers & DVS, resulting in poor compliance *The current relationship between DVS & farmers has deteriorated to the point where it is becoming a factor inhibiting the successful implementation of CBT, primarily due to a lack of trust as accusations of non-compliance run in both directions. The rebuilding of trust will take time, and will require both parties fulfilling their roles & responsibilities to the best of their abilities.*	• Farmers' associations & DVS to establish mechanisms for periodic, open, honest & transparent communication between the parties where issues & challenges are constructively discussed. • Plan interventions (beyond just consultation) related to the challenges in the beef industry in Ngamiland with the relevant stakeholders, particularly the farmers, so that there is adequate ownership & participation in the uptake of interventions.

Conclusions and way forward

The list of recommendations may seem daunting, but it is important to remember that firstly, not all actions fall under the responsibility of DVS. As identified in the report, there are a host of stakeholders relevant in the wildlife friendly beef CBT landscape. One of the most critical roles of DVS and government as a whole is to establish a truly transparent enabling environment that allows different stakeholders to identify and fulfil their particular role(s) in ensuring that the value chain functions successfully. This enabling environment must encourage and invite the participation of these stakeholders, rather than prohibit or limit such participation. As an immediate way forward, a stakeholder meeting was convened in July 2019 by the GoB in collaboration with AHEAD, with invitations to all key stakeholders (from development partners to NGOs, from farmers to academic institutions, and of course the private sector) to take responsibility for different actions to address the various gaps, individually or collaboratively, depending on their respective mandates (see Annex D).

Secondly, not all actions require monetary resources, but they do require coordination, synergy and partnerships. DVS has already established a FMD unit to be based in Maun, with an approved operational budget from Cabinet, which has been tasked with championing CBT. These functions of coordination and nurturing of partnerships ideally should be a function of this unit. Therefore, it is strongly advised that the Terms of Reference for the unit be reviewed and modified to capture and reflect the relevant recommendations of this report, and that the unit's operational plans reflect the same.

Thirdly, there are existing opportunities for synergy that could potentially be tapped into. For instance, the current focus area for the European Union's bilateral relationship with Botswana is capacity and skills development in the livestock value chain. The need for capacity development has come out strongly in our recommendations for addressing various gaps. Ngamiland also forms part of the KAZA TFCA. Engagement by DVS or the FMD Unit with the TFCA Unit in the Ministry of Environment, Natural Resources Conservation and Tourism can assist in ensuring that agreed priorities find their way into the various planning processes of KAZA, and that potential funding sources are explored.

Finally, as mentioned above, not everything can be resolved or needs to be resolved at the same time. A distinction has been made between those obstacles that threaten the entire value chain and therefore must be addressed as a matter of urgency, and those that offer "low-hanging fruit" in terms of being relatively easily addressed.

The implementation of a CBT value chain approach to support the production of WFB carries with it the potential for marrying the distinct competitive advantage of Ngamiland's wildlife-based economy with the needs of local communities to improve their food security and livelihoods through the age-old tradition of livestock rearing. Therefore, the work at hand is not just about improving and increasing agricultural output, but is also about securing the natural resource base and restoring and maintaining ecosystem health. The current pilot project at Habu village (as described in Section 12 of the report) exemplifies how communities can achieve this by sustainably benefiting from the natural resource base, rather than only bearing the cost of living adjacent to wildlife. In Habu, the community's decisions to move their cattle further away from the delta and adopt better husbandry practices whilst establishing wildlife-based enterprises serve to demonstrate the inherent value that most of Ngamiland's population places on wildlife and wild habitats. It is only years of hardship and a dearth of solutions to very real conflicts arising at the livestock-wildlife interface that have contributed to a negative attitude towards wildlife.

The GoB has committed to implementing CBT approaches to beef trade in Ngamiland. It is hoped that the recommendations in this report provide a platform to help guide such efforts, in collaboration with a host of other key stakeholders, in order to sustainably improve market access for Ngamiland farmers, diversify economic opportunities, enhance system resilience and enable greater coexistence between the livestock and wildlife sectors.

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ABBREVIATIONS AND ACRONYMS

AHCOF	Ad Hoc Committee on Fences
AHEAD	Animal & Human Health for the Environment And Development, Cornell University
BAITS	Botswana Animal Information and Traceability System
BMC	Botswana Meat Commission
BSE	Bovine spongiform encephalopathy
BTC	Botswana Telecommunications Corporation
BVI	Botswana Vaccine Institute
CBPP	Contagious bovine pleuropneumonia
CBT	Commodity-based trade
CDM	Cold dressed mass
CLAWS	Communities Living Among Wildlife Sustainably
DAP	Department of Animal Production
DEA	Department of Environmental Affairs
DRC	Democratic Republic of Congo
DVS	Department of Veterinary Services
DWNP	Department of Wildlife and National Parks
EIA	Environmental impact assessment
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FMD	Foot and mouth disease
GDP	Gross domestic product
GoB	Government of Botswana
GPS	Global positioning system
H4H	Herding for Health
HACCP	Hazard analysis and critical control points
KAZA TFCA	Kavango Zambezi Transfrontier Conservation Area
LITS	Livestock Identification and Trace-back System
LSU	Large stock unit
MBM	Meat and bone meal
MoA	Ministry of Agricultural Development and Food Security
NGO	Non-governmental organisation
NSO	National Strategy Office
OIE	World Organisation for Animal Health
QS	Quarantine station
SADC	Southern African Development Community
SAT	South African Territories (serotypes of FMD viruses)
SGS	formerly Société Générale de Surveillance (General Society of Surveillance)
SMME	Small, micro, and medium enterprises
SOP	Standard operating procedure
TAHC	Terrestrial Animal Health Code (of the OIE)
TFCA	Transfrontier conservation area
UNESCO	United Nations Educational, Scientific and Cultural Organization
WFB	Wildlife friendly beef
WildCRU	Wildlife Conservation Research Unit, University of Oxford
WDA	Wildlife dispersal area (of KAZA)
WTO	World Trade Organisation

1. INTRODUCTION

1.1 Background to the report

Ngamiland (North West District) in north-west Botswana is home to more than 152,200 people (Statistics Botswana, 2014) and approximately 317,000 privately owned cattle (DVS FMD vaccination data, 2016, unpublished report). It is also home to the Okavango Delta and its rich wetlands and wildlife, and lies at the heart of the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA) – Africa's largest conservation and development landscape.

Figure 1. Ngamiland (North West District), Botswana. Source: adapted from Google Maps.

Livestock production and wildlife-based tourism are the primary land uses in Ngamiland. However, cattle farmers in the district are excluded from higher value markets for the beef that they produce due to the proximity of wildlife, particularly African buffalo (*Syncerus caffer*) that are the reservoir host of the southern African serotypes of foot and mouth disease (FMD) virus. Standards for international trade in livestock commodities have historically required that beef production areas (countries or zones) be free from FMD. This situation restricts market access and penalizes livestock owners who share the land with wildlife. Periodic outbreaks of FMD also cause disruptions in the local market with devastating effects on the district level economy and local livelihoods. In addition, attempts to meet international standards related to the required "freedom from disease" under currently applied policies for addressing FMD have had significant negative repercussions for free-ranging wildlife, largely related to disease control fencing.

Wildlife is one of Botswana's greatest assets and the status of the district as an FMD-infected 'red zone' is unlikely to change in the near future, but this does not mean that the district cannot produce FMD-free beef. Scientifically sound and effective non-geographic (i.e. non-fence based) approaches to managing trade-associated risks from diseases like FMD now exist. Commodity-based trade (CBT) approaches focus on the safety of the beef production process and the beef itself, rather than on the animal disease situation in the locality of production. The CBT approach offers potential to effectively integrate livestock and wildlife-based enterprises while being compatible with modern animal production and trade standards, as set by the World Organisation for Animal Health (OIE). Furthermore, implementing CBT in an integrated way that includes husbandry (herding and kraaling) and rangeland management practices would help mitigate conflict between wildlife and livestock, and lends itself to branding and marketing of 'wildlife friendly beef'. Thus, the successful development of this approach in Ngamiland would be a 'win-win' for sustainable and diversified land use and livelihoods.

1.2 Report structure

This report offers an analysis of the situation in Ngamiland relevant to the production and marketing of FMD-free, wildlife friendly beef through CBT in order to identify key gaps that could affect successful implementation of this approach.

Specifically, the project investigated the components of the beef value chain in Ngamiland with a view to facilitating adoption of a CBT approach in order to:

1. Facilitate improved and sustained market opportunities for red zone farmers;
2. Facilitate economic diversification;
3. Enable coexistence between livestock and wildlife.

Section 2 lays the context of the analysis. The current Ngamiland situation is reviewed with respect to the districts' biophysical and socioeconomic characteristics, the threats and conflicts between livestock and wildlife and the importance of both as contributors to the Ngamiland economy. It also provides an overview of CBT, together with an outline of existing market channels and options for Ngamiland beef market access. The range of stakeholders, from local to international, that have a role to play in the successful implementation of CBT are also identified and described, as is the legal and policy framework.

The sections that follow provide more detail on the key sections of the beef value chain in Ngamiland. Section 3 covers the primary production system and the issues relating to reducing the risk of FMD outbreaks, improving the productivity of farmers and the quantity and quality of beef produced, and increasing the compatibility of wildlife conservation and livestock production. Specific issues addressed are better livestock management, including mitigation of conflict with wildlife and reduction of contact through herding and kraaling of animals as well as better rangeland management; implementation of the national animal identification and traceability system; vaccination best practices; and producer protocols and conservation agreements to support full buy-in and participation by stakeholders.

The next sequential links in the value chain, namely transport, quarantine, abattoirs (including risk reduction during the slaughter process), further processing and product diversification, and packaging and transit are addressed in specific sections (Sections 4-8) in the context of the Ngamiland situation, followed by a section on monitoring, compliance and certification (Section 9).

Sections 10 and 11 cover the supporting activities of FMD outbreak control, and stakeholder coordination, communication and outreach. Section 12 describes the proposed pilot project at Habu village that should provide proof of concept, and the report ends with gaps and recommendations in Section 13 and conclusions in Section 14.

1.3 Approach and methodology

This section outlines the approach and methodology used to conduct the gap analysis, including the stakeholder consultation process.

The Wildlife Friendly Beef (WFB) project team that contributed to the compilation of this report represent a range of professional expertise including animal health experts, FMD virologists, veterinarians, ecologists and conservationists, farmers, food safety specialists, and industry (livestock) specialists/private sector representatives. Information was sourced for the report from a combination of desktop research, direct communication and consultations with various stakeholder groups (written and verbal), workshops and site visits.

- An inception workshop held in Maun in November 2017, in collaboration with the Department of Veterinary Services (DVS), was attended by approximately 80 participants including technical experts from both the wildlife and livestock sectors, farmers and farmers associations, representatives from the private sector, civil society organisations and various government entities

(http://www.wcs-ahead.org/dvs_ahead_maun_workshop_2017/dvs_ahead_maun_workshop_2017.html);

- Three (3) capacity building workshops were held with DVS (and the Department of Animal Production [DAP] and Department of Wildlife and National Parks [DWNP]) staff in 2018 (see Section 11);
- Over 20 villages in Ngamiland were targeted for a series of half-day awareness raising workshops, attended by farmers, community members (including leadership) and Ministry of Agricultural Development and Food Security (MoA) extension staff (see Section 11);
- Site visits were paid to each of the abattoirs and quarantine stations in Ngamiland;
  Meetings with different stakeholders including conservation non-governmental organisations (NGOs), private sector representatives and government entities were held at various points through the course of 2018, individually and collectively, on various aspects of the value chain; and
- A stakeholder validation workshop held in Maun in July 2019, in collaboration with DVS, was attended by more than 100 participants including traditional authorities, farmers and farmers associations, representatives from the private sector (wildlife tourism & livestock), civil society organisations, academia and various government entities. Participants thoroughly reviewed and evaluated the gaps and recommendations highlighted in this report. Suggested modifications were discussed in plenary sessions and agreed submissions were incorporated directly into this final report. Participants also began to identify, through a participatory process, where and how stakeholders might play roles in filling the gaps (see Annex D).

2. CONTEXT LAYING

2.1 Biophysical and socioeconomic characteristics of Ngamiland

Ngamiland District covers an area of approximately 110,000 km^2 in north-western Botswana. Although more humid than the southern part of the country, it is nevertheless semi-arid, receiving mean annual rainfall of around 500 mm per year. Rainfall is strongly seasonal, and drought is common. The terrain is flat to undulating and dominated by Kalahari sand-derived soils. Conditions are marginal for rain-fed crop production, and most land produces income through livestock production and wildlife use.

The district is home to the Okavango Delta, a UNESCO World Heritage Site, and one of Africa's most highly prized wildlife tourism destinations. It supports a diversity of habitats, from perennial swamps and wetlands around the delta to semi-arid grasslands and *Acacia* scrubland in the south and west. In the north, wedged between the Okavango and the Linyanti swamps, extensive *Mopane* woodland and open grassland occur. Ngamiland also lies in the heart of the KAZA TFCA, Africa's largest conservation and development landscape covering an area of ~520,000 km^2 across five nations (Angola, Botswana, Namibia, Zambia, Zimbabwe). KAZA is home to over 2.5 million people and a large and diverse array of wildlife species, including the world's largest contiguous population of African elephants (*Loxodonta africana*) (~250,000). Recognised by a five-nation Treaty in 2011, KAZA represents an ambitious commitment to conserve biodiversity at an ecosystem scale and is underpinned by hopes that tourism will help drive sustainable rural economic development.

Over 35% of the district is protected State Land. The remainder is communal or Tribal Land, managed by the Tawana Land Board, and primarily zoned for pastoral, arable or residential use. Here households practise dryland (rainfed) or *molapo* (flood recession) subsistence crop production (primarily maize, sorghum, beans and millet), and mixed herd pastoralism (cattle mainly). Households also make use of veld products such as fuel wood, poles, reeds, thatching grass, wild fruits and medicinal plants. More locally, small-scale fishing is important. Tribal Land also includes blocks of fenced ranches in the south (Hainaveld) that were zoned for commercial ranch development under the 1975 Tribal Grazing Land Policy and subsequent National Policy on Agricultural Development in 1991. Successive phases of ranch allocation have steadily increased the number of ranches over time, although quite how many have been allocated, occupied and operated is unknown (ESFA, 2016). State Land comprises mostly National Parks (Nxai Pan, northern part of

Makgadikgadi), Game Reserves (Moremi) and 29 Wildlife Management Areas, some of which are operated as tourism concession areas. Many Wildlife Management Areas form buffer zones between protected areas and human settlement; however, the overlap of land uses and proximity of human settlements to wildlife often leads to conflict between wildlife and people/their livestock.

Wildlife in the district is typically concentrated in and around the Okavango Delta (including Moremi Game Reserve), and the Linyanti system (Figure 2). Here species such as elephant, buffalo, hippopotamus (*Hippopotamus amphibius*), giraffe (*Giraffe camelopardalis*), lion (*Panthera leo*), and leopard (*Panthera pardus*) occur with many species of plains game including sable antelope (*Hippotragus niger*), roan antelope (*Hippotragus equinus*), tsessebe (*Damaliscus lunatus*) and specialised wetland species such as sitatunga (*Tragelaphus spekei*) and lechwe (*Kobus leche*). An estimated 31,500 buffalo occur in the Okavango Delta. Aerial survey data indicate, however, that their numbers have declined within Moremi Game Reserve but increased in the surrounding Wildlife Management Areas – those areas closest to livestock (Chase, 2011). Survey results also indicate a growing elephant population, with Ngamiland supporting 61% of Botswana's population (Chase et al., 2015). In the sandveld habitats away from water, wildlife densities and diversity are lower, and most large charismatic species are rare (Barnes et al., 2003).

The livestock population comprises an estimated 317,000 cattle (DVS FMD vaccination data, 2016, unpublished report), along with over 100,000 small stock (goats and sheep). Cattle provide milk, meat, manure, draught power, and a source of income in times of need. Milk production has been shown to play a crucial role in nutrition, particularly of children under five years of age, in Ngamiland. The eradication of the entire population of 320,000 cattle to prevent the spread of contagious bovine pleuropneumonia (CBPP) in April 1996 to February 1997 resulted in a marked increase in malnutrition in children under five (Boonstra et al., 2001). Cattle are also important for ceremonies (weddings and funerals) and to pay *lobola* (bride price). Livestock rearing is, however, limited by water, and the distribution of cattle typically follows the availability of fresh water sources. As such, cattle density is highest along the western delta and lowest along the western border with Namibia (Figure 2). The main livestock rearing areas are Maun/Shorobe, Toteng/Sehithwa/Tsau, Nokaneng/Gumare, Shakawe, and Seronga.

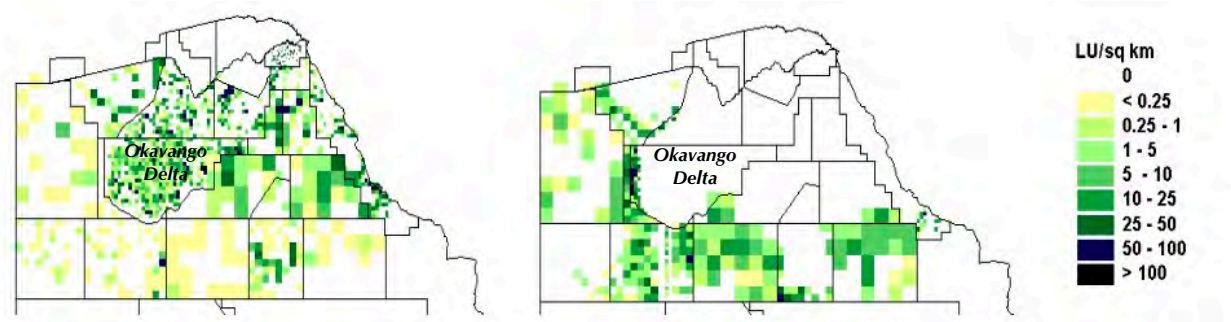

Figure 2. Wildlife (left) and cattle (right) distributions across northern Botswana. Source: 2013 DWNP dry season aerial survey results.

Most residents live in rural settlements along the margins of the Okavango Delta and the Panhandle. Other areas are more sparsely populated. As of 2011, the population of the district was 152,284 of which 60,263 resided in the administrative hub of Maun (Statistics Botswana, 2014). Despite its vast rangelands and wildlife resources, Ngamiland is the second poorest district in the country (47.3% poverty incidence according to 2009/10 Botswana Core Welfare Indicator Survey - CSO, 2009), with poverty rates in the western Okavango standing at 50-60% (CSO, 2008).

2.2 Main economic drivers

Ngamiland's economy hinges on its extensive rangelands, which support large wildlife populations (and in turn tourist revenue), and livestock. The main economic activities are agriculture, tourism, government, and wholesale/retail trade.

At the macroeconomic level, agriculture, driven by the livestock sector and beef exports, only accounts for 2-3% of Gross Domestic Product (GDP) – down from 40% in the 1960s, in part due to the increasing importance of mining. Despite its small contribution to GDP, traditional livestock farming remains central to rural economic activity in the district and is an important source of income at the household level. According to the 2011 Population and Housing Census, 31% of the 35,555 households in the district received income from agricultural activities (Statistics Botswana, 2014). Assuming an average size of roughly four people per household, farming provides a livelihood to about 44,000 people. However, repeated closure of the abattoirs due to FMD outbreaks and the district's classification as an FMD-infected zone have negatively affected livelihoods, representing a major challenge for livestock production in the area.

While the relative importance of the agricultural sector has declined, that of wildlife-based tourism has steadily increased. At the national level, travel/tourism is now Botswana's second largest income earner after diamond mining, contributing 11.5% of GDP in 2017, and directly supporting 26,000 jobs nationally (2.6% of total employment – WTTC, 2018). Ngamiland is one of the country's top tourist destinations, attracting large numbers of foreign visitors to the Okavango Delta, Moremi Game Reserve, and Tsodilo Hills (a key cultural site and second UNESCO World Heritage Site). As a result, numerous tourism enterprises, including hotels/lodges and safari camps occur across the district. Most are privately operated, but some community-based initiatives have been developed through community-based natural resource management programmes.

Tourism is the largest formal sector employer and largest source of the district's revenue (North West District Council, 2017). That said, while income generated from wildlife-based tourism is a significant contributor to national GDP, it is unlikely to support the envisioned socioeconomic development at the local level on its own. Foreign dominated ownership of tourism facilities, discrepancies between citizen and non-citizen employee salaries (with the former being paid considerably less), limited tourism products and leakage of tourism revenue out of the country are challenges that continue to face the industry (Mbaiwa, 2003, 2017; Stone et al., 2017). It is thus likely that a combination rather than separation of wildlife and livestock-based economic development initiatives will diversify livelihood options for marginalised communities, improving prospects for resilience. (Thomson et al., 2013b).

Besides agriculture and tourism, other important sectors include central and local government. There are also numerous wholesale and retail entities that service both the tourism industry and local domestic market. The only significant manufacturing activity comes from the existing abattoirs (i.e. Botswana Meat Commission [BMC]-Maun, Ngamiland Abattoir and Batawana Beef), all of which currently export beef to the Democratic Republic of Congo (DRC) and service the local retail market. Mining along the Kalahari Copper Belt has provided employment in the past, but unfavourable global commodity prices resulted in closure of the Bosetso Mine in 2014, with people losing their jobs. This leaves livestock production and wildlife-based tourism as the main income generators in the district.

2.3 Challenges for realising the potential of livestock production and wildlife-based tourism

2.3.1 Threats and conflict at the livestock-wildlife-human interface

Despite the importance of both livestock and wildlife-based tourism to the economy, both of which rely on a healthy rangeland, the integrity of the natural resource base in the district has been declining steadily over several decades. In addition, human-wildlife conflict is increasing.

Concerns over overgrazing and the threat it posed to the environment at both the district and national level led to the introduction of the Tribal Grazing Lands Policy in 1975 (followed by the National Policy on Agricultural Development in 1991), which sought to relieve pressure on communal grazing areas by moving large herds to commercial, fenced ranches under 50-year leases. At the time it was believed that better grazing management and increased beef production could be attained if farmers had an incentive to gain control over grazing areas, exclude others by fencing their land, and thereby obtain direct benefits through investments and production of quality beef (Basupi et al., 2017). However, the policy was never enforced,

and non-compliance (large cattle owners both gained exclusive use of commercial areas and continued to use the communal area) simply contracted the grazing land available to small-scale communal livestock farmers, leading to increased overgrazing (Frimpong, 1995; Rohde et al., 2006).

Grazing pressure has been compounded by a lack of market outlets for Ngamiland cattle. As an FMD-endemic area, Ngamiland is prone to frequent outbreaks of FMD. An FMD outbreak near Habu in 2007 resulted in the whole of Ngamiland being closed for the movement and sale of cattle or beef from the region for seven years until 2014 when the BMC-Maun abattoir re-opened with limited production capacity. During these seven years, there was virtually no commercial slaughter of cattle and no serviceable market for animal sales for Ngamiland's cattle farmers. Consequently, the regional cattle herd continued to grow in number, with no investment by, nor incentives for, farmers to manage stock quality or cattle ranging. By 2017, the regional herd (317,000 head) consisted of cattle primarily of low quality and in poor condition – with a proportion of these completely unmanaged and feral, and never vaccinated, including a population of between 15,000 and 20,000 around Lake Ngami.

Human-wildlife conflict is also increasing and poses a significant threat to both people's livelihoods and wildlife. Elephant numbers have quadrupled since 1990. In addition, elephants are expanding the spatial area they now cover, resulting in unprecedented levels of human-wildlife conflict and infrastructure damage. Crop destruction (particularly by a growing elephant population), livestock predation by wild carnivores, competition for grazing and water, and animal diseases involving wildlife and the resulting trade impacts (especially in the case of FMD) are all leading to increases in human-wildlife conflict in the district. Furthermore, the lack of market access and the resulting economic hardships to communal farmers has led to growing antagonism towards wildlife. On the other hand, disease control fencing poses a significant threat to long-term wildlife population viability and is described below.

2.3.2 The use of fences as part of disease control policy

Botswana, along with other southern African countries, has employed fencing to control animal disease. Over 50 years ago, European Union (EU) treaties provided preferential market access agreements to southern African countries, aimed at promoting economic development. The commercial livestock sector, in particular, was a major benefactor of these agreements, with participating countries receiving lucrative returns for exported livestock products to recipient EU markets (Taylor, 2012; Barnes, 2013).

The control measures to enable engagement in these trade agreements included eradication of targeted wildlife species in some areas followed by the establishment of FMD-free livestock export zones and adjacent FMD surveillance areas through the construction of thousands of kilometres of wildlife-proof fencing aimed at separating wildlife from livestock. This resulted in significant negative consequences for wildlife populations and their associated dispersal or movement routes (Cumming et al., 2015; Perkins, 2010; R. Taylor, 2010, unpublished report). Furthermore, many traditional agro-pastoral livestock producers were not beneficiaries of these agreements, because they were located outside veterinary cordon fenced zones in FMD-endemic areas like Ngamiland.

In Botswana, more than 10,000 km of fencing (including border fences) has been constructed over the years for animal disease control purposes in order to protect the cattle industry. The first FMD fences were constructed in 1954/55 and in 1958 to separate buffalo populations in the higher rainfall areas in the north of the country from livestock populations in the drier regions to the south (Perkins, 2010). Further waves of fence construction took place in the 1980s and 1990s, including the buffalo fences surrounding the Okavango Delta. In addition, the 1995 CBPP outbreak in cattle in the extreme north-west of Ngamiland precipitated emergency construction of three east-west control fences as well as the Caprivi Border fence to try to limit the spread through cattle movement. Despite these control measures, the disease quickly spread, and the district's entire cattle population was culled to prevent further spread to the export zone.[1] Following

[1] CBPP has no wildlife reservoir. Unlike FMD in southern Africa, it can cause high mortality in naïve cattle populations.

this, the Government of Botswana (GoB) extended the Northern Buffalo fence (1996/1997) to join the newly upgraded Caprivi Border fence (Albertson, 2010; Gadd, 2012).

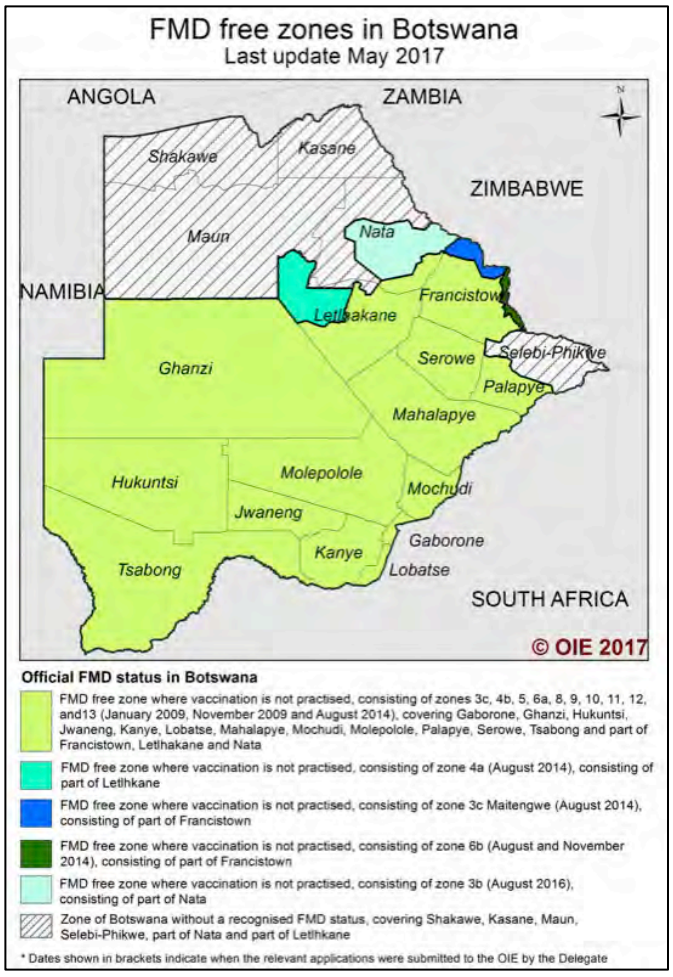

Figure 3. FMD-free zones in Botswana. Source: OIE, 2017.

Today, in order to meet international trade standards related to FMD set by the OIE, Botswana is divided into a number of veterinary zones containing livestock of different FMD health status (Figure 3). The FMD-free zones, or green zones, are located in the south while the FMD-infected zones, or red zones (grey-shaded in Figure 3), are located primarily in the north. Beef produced within the FMD-free zones can be sold for export to premium markets, while markets for beef in the red zones are currently limited.

DVS also maintains additional fences in the north, particularly within Ngamiland, to control the movement of cattle within zones. Thus, Ngamiland (Zone 2) is further divided into six sub-zones (2a-f – Figure 4). Sub-zones 2a-2d are FMD-infected zones with vaccination and sub-zones 2e and 2f are considered buffer zones. Vaccination was discontinued in sub-zone 2e in 2014 and DVS anticipates doing the same in 2f at a later date.

All the above fences were built without assessment of the impacts on wildlife populations. Whilst meeting the requirements of the commercial beef industry in the south of the country, the fences have contributed to the collapse of populations of wild ungulates by interfering with their seasonal movements and blocking access to water in dry years (Cumming et al., 2015; Gadd, 2012; Osofsky et al., 2008). The negative impacts of fences on wildlife can, in some cases, be reversed once the physical barrier is removed. More details are provided in Annex A.

DVS recently noted a number of challenges to maintaining fences in Ngamiland including: (i) lack of resources, especially transport, (ii) increased fence breakages by elephants and people, (iii) reduced accessibility due to flooding around the delta, and (iv) theft of fencing materials, especially gum poles. This has resulted in increased buffalo incursions (DVS, unpublished status report, 2017). As a result, today some of the fences are in a state of disrepair and therefore do not adequately serve their intended purpose.

Accurate estimates of the costs of fence maintenance are often difficult to obtain because disaggregated government budgets are unavailable in the public domain (Thomson et al., 2013a), but estimates suggest costs as high as P47,000 per km (see Annex A for more details). Preliminary observations by research groups indicate extensive elephant breakages, and with the expanding elephant population, this is likely to remain a persistent challenge. Indications of the extent of elephant breakages could mean an annual bill of fences maintenance in Ngamiland exceeding P20 million. Any reduction in the number of fences needing to be maintained would therefore be a cost saving to the treasury; and materials salvaged where fences are decommissioned could further offset maintenance costs elsewhere.

The Directors of DVS, DWNP, DAP, Department of Environmental Affairs (DEA) and Department of Lands are currently in the process of reconstituting and reviving the "Ad Hoc Committee on Fences" (AHCOF), a committee that was established in 1997 to provide technical advice on fences but only functioned until mid-1998 (see Annex A). Part of the role of this committee would be to review the functions of the various fences and weigh these against the ecosystem costs such as loss of habitat connectivity and wildlife migration routes. Those fences that are believed to play a valuable role in the management of disease risk from a livestock perspective must be identified and confirmed as essential. However, the advent of innovations such as CBT, when applied to beef, offer alternatives to the traditional geographic-based approach to FMD-risk management that has been so reliant on fences.

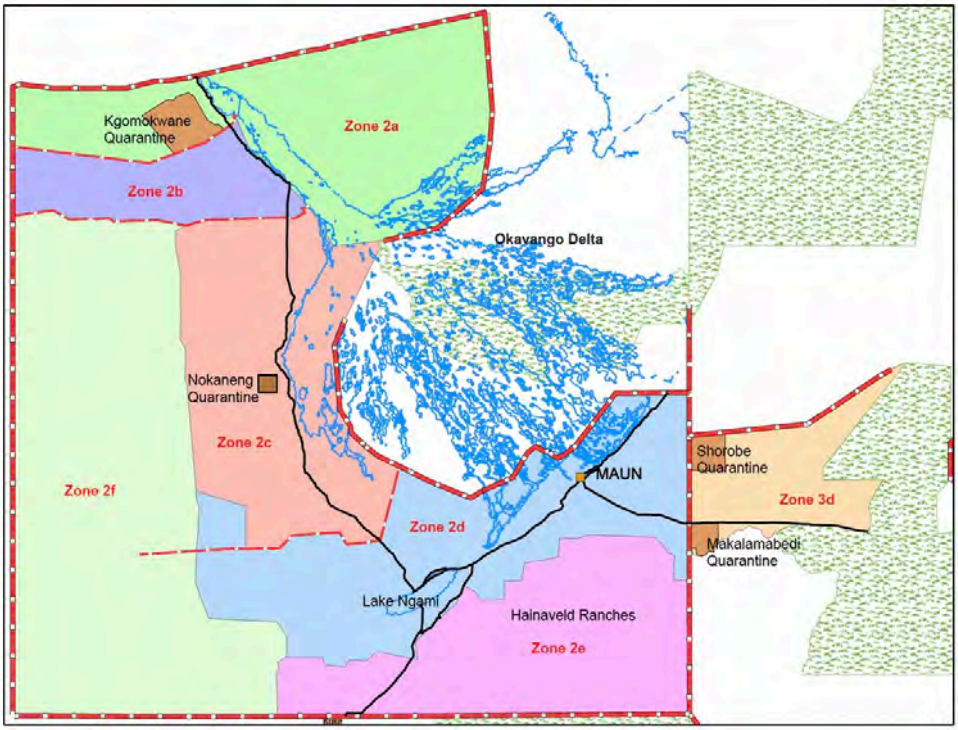

Figure 4. Ngamiland indicating FMD sub-zones, veterinary fences (red dotted lines) and quarantine stations. Source: adapted from DVS, 2018.

2.4 Commodity-based trade as an alternative way to ensure FMD-free beef

Non-geographic approaches to managing trade-associated risks posed by diseases like FMD are referred to generically as 'commodity-based trade' (CBT). CBT approaches focus on product safety achieved by specific risk mitigation steps throughout the production process (Thomson et al., 2009). They are designed to ensure that traded animal commodities will not transmit specified pathogens that cause animal or human diseases, irrespective of the disease status of the area of production. The underlying principle is that geographic freedom from transboundary animal diseases is not the only way to manage the risk associated with animal commodity trade. Instead, the focus is on the safety of the commodity itself.

CBT was proposed as an alternative to the existing geographically-based standards for trade in livestock commodities because the latter are not uniformly achievable in all livestock-producing areas. The concept was developed with a focus on areas where FMD is endemic due to the presence of infected buffalo (Thomson et al., 2004). Interestingly, the realities of wildlife-associated pathogens (e.g. avian influenza) that may affect trade of products from food-producing animals is likely to make CBT a necessary rather than an alternative requirement for sanitary safety.

Like all other trade standards, CBT is not a system for managing diseases like FMD. It is a system for managing the risk of a pathogen being present in a commodity destined for trade. Relying on commodity safety rather than geographic absence of disease in the locality of production can potentially provide a greater level of sanitary protection. Delay in detection of an outbreak of a disease in an area that is believed to be free of it has resulted in unintentional export of infected animals or commodities to other areas that were free of the disease. CBT, however, needs to be underpinned by systems for managing diseases, because measures like effective vaccination programmes contribute importantly to managing the risk of infection in the animals from which commodities are derived.

In recent years the OIE (the standard-setting body mandated by the World Trade Organization in this respect) has developed some non-geographic standards based on risk mitigation measures to enable trade from areas not free of FMD. Options include:

- Processing to inactivate any FMD virus that could potentially be present. This commonly involves various types of heat treatment but other processes are also available. The OIE provides standards for inactivation of the FMD virus (Terrestrial Animal Health Code [TAHC], Article 8.8.31).

- Establishment of compartments free from FMD. This is most suitable for intensive production systems like the dairy, pig and poultry industries. However, a major obstacle to using compartmentalisation for managing FMD in endemic locations is that vaccination is expressly prohibited (TAHC Article 8.8.4, clause 2 c).

- Management of FMD risk along the value chain. Applying a series of risk mitigation measures along the livestock value chain to reduce the risk of animal infections contaminating the final product (FAO, 2011) is increasingly accepted as the most reliable way for ensuring the safety of the final product in terms of both animal diseases and food safety (Thomson et al., 2013b). It forms the basis of the most recently added OIE standard for trade in chilled and frozen beef from areas not free of FMD, which now includes incorporation of quarantine systems into risk management (TAHC, Article 8.8.22).

  It has been known for many decades that matured, deboned beef from which visible lymph nodes have been removed does not contain transmissible quantities of FMD virus because the low pH (<6) of striated muscle attained during the maturation process inactivates FMD virus. In a qualitative risk assessment carried out on behalf of the OIE it was determined that the FMD risk posed by such beef is 'very low' and that the risk can be further reduced to 'negligible' status (the lowest possible risk status) by the application of additional mitigation measures applied along the value chain (Paton et al., 2010).

  Thus, the value chain system involves step-wise application of specific FMD risk management measures at all stages of production, e.g. vaccination of cattle, minimising cattle-wildlife contact, deboning and removal of lymph nodes from the beef, testing the pH of matured beef (Figure 5). Using this approach, sequential barriers against the presence of FMD virus can be created to ensure a safe product (i.e. CBT). To enable auditing and certification of the system, the process known as HACCP (Hazard Analysis and Critical Control Points), universally used for food safety assurance, is applied to the beef value chain to support integration of animal disease risk reduction and food safety assurance for livestock commodities and thus improve market access (Thomson et al., 2013b).

Guidelines have been developed to enable business enterprises to evaluate the options that are available for exporting beef from areas that are not free of FMD (Thomson et al., 2018). More details are available online (http://www.wcs-ahead.org/kaza/181114-guidelines-for-implementing-cbt-final.pdf), and specific options for Ngamiland are discussed in Section 2.4.2.

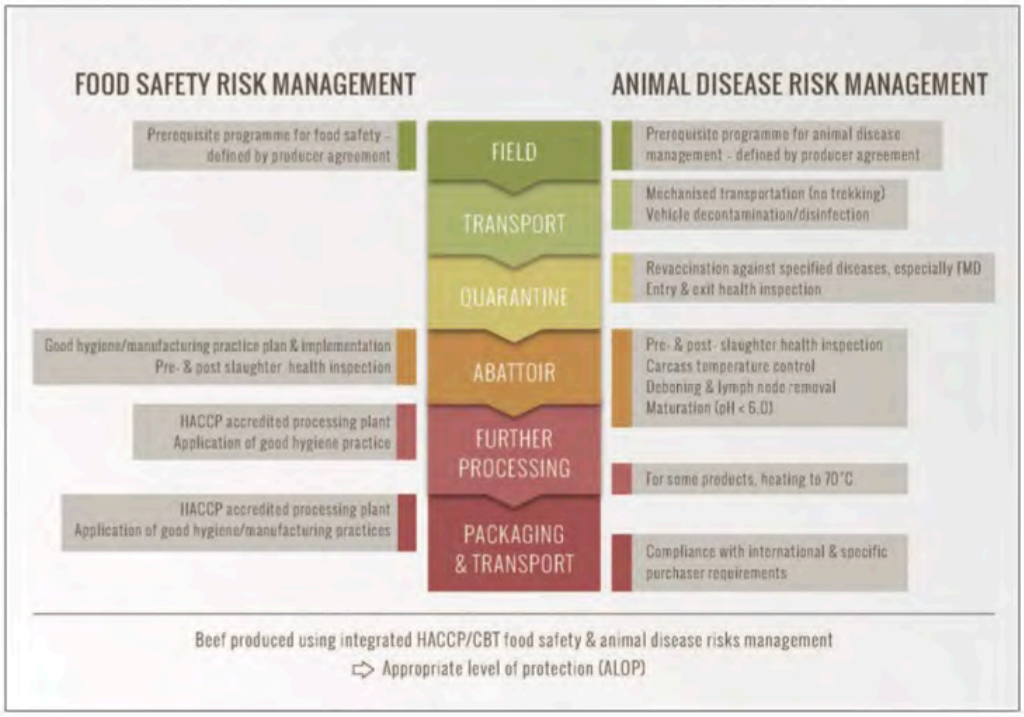

Figure 5. Parallel application of food safety and animal disease risk management measures along a value chain for beef production (Thomson, et al., 2018).

Wildlife friendly beef

Risk mitigation along the value chain and the application of a CBT approach has the potential to revive the beef sector in Ngamiland. However, this needs to be underpinned by efforts that recognise and optimise the competitive advantage of the district, i.e. its wildlife and rangelands. Implementing CBT in an integrated way that includes risk-appropriate husbandry practices (herding, planned grazing and kraaling) would reduce not only the risk of FMD transmission but also the antagonism towards wildlife (predators in particular) by Ngamiland's traditional cattle farmers. In turn, this unlocks the potential to brand and market 'wildlife friendly beef' to, for example, Ngamiland's high-end tourism lodges, thereby contributing to local livelihoods. While there is no specific model for wildlife friendly product development, the production of WFB in this report refers to beef produced utilising production techniques primarily at the farm level which contribute to the health of the rangeland, minimise conflict with wildlife, and improve the livelihoods of communities who coexist with wildlife. This is discussed in more detail in Section 3.1 (Producer protocols, animal husbandry and rangeland management) and Section 7.3 (Wildlife friendly brand development).

2.4.1 Existing marketing channels for Ngamiland beef

It is estimated that approximately 80% of the cattle in Ngamiland are owned by smallholder communal farmers and the remainder by commercial farmers, located primarily in the Hainaveld (sub-zone 2e). Offtake is low (< 8%), with producers preferentially selling older animals, i.e. a traditional oxen production system versus modern weaner production system (Statistics Botswana, 2018). Cattle are marketed through various channels, both formal and informal.

Formal market channels include BMC, private commercial abattoirs, and butcheries. The butchery channel includes local butcheries and those located in larger villages such as Gumare, as well as in Maun. This is not the preferred market channel as prices paid at local butcheries are sometimes 50% lower (P10/kg) than would be paid by BMC-Maun (P19.50/kg). However, the transaction costs of getting cattle to market often dictate which channel is utilised. For example, while BMC-Maun typically pays the best prices for cattle,

producers may choose markets such as local village butcheries due to close proximity, lower transport costs, and the possibility of price negotiations and immediate payment, particularly in cases of emergencies when farmers need access to cash.

Agents or "millers" are an essential link between the private commercial abattoirs and the producer. Agents will market cattle on behalf of a village or an area and the full service will include: booking space at an abattoir; negotiating the price (and commission); organising the cattle at a loading point; ensuring the cattle have identification; checking vaccination records; organising movement permits from DVS; organising transport and negotiating the price; checking the cattle during slaughter; picking up the payment and deducting transport costs and commissions.

The individual producer can deliver cattle to the two private commercial abattoirs by activating the above system handled by the agents on a personal basis. The situation at BMC varies. Most of the time BMC sets quotas for delivery to the abattoir. Under this scenario, individual farmers are not permitted to sell their cattle directly to BMC; however, BMC does allow farmers in the commercial Hainaveld area to apply for a quota. For farmers in other areas BMC sets quotas by village/area on a rotating buying schedule. The quotas are communicated through *Kgotla* meetings, with the quota divided up between families in advance. During times of oversupply, queueing is likely, with buying occurring at any one village roughly once per year. BMC buyers will also periodically and on a rotational basis set up buying points in villages or towns. Cattle are then transported to the abattoir for slaughter, and transport costs deducted prior to distribution of funds. Finally, during periods of undersupply, BMC will do away with its quota system, and instead accept direct sales to its Maun abattoir – in which case farmers can approach BMC directly and arrange a delivery date.

Service slaughter for the local market (where an individual/agent delivers cattle to the abattoir and takes the carcass and fifth quarter with them) is provided by both private commercial abattoirs. Fifth quarter sales (i.e. the remaining animal carcass not used in meat production, comprised of the organs, fat, bone etc.) are used at all three abattoirs, with BMC actually opening an abattoir shop on the premises.

In recent years, Ngamiland beef has been exported to other parts of Botswana, as well as the DRC, Mozambique, Kuwait and Vietnam. As of October 2017, however, all beef destined for the green zones and other high-end markets (which would not include the above countries) is required to undergo quarantine, maturation and deboning (Ministry of Agricultural Development and Food Security press release, dated 24 October 2017). Currently, this is being circumvented by the search for markets that do not require quarantine and offer a market for bone-in meat. DRC is one such market that all three abattoirs are targeting. A point of concern is that the DRC market may at some point reach saturation if all abattoirs reach capacity.

Informal cattle marketing at village level includes private sales to individuals for household consumption and ceremonies such as funerals and weddings, to pay *lobola*, or to other farmers as breeding stock. Cattle are further sold at village level for food utilised in local schools and hospitals. In some places this is informal on private treaty basis, while in other larger villages this is done on a registration basis. Pricing is based on an informal price per head and there is no weighing to determine the price on either a live weight or cold dressed mass (CDM) basis. Livestock slaughter for sale (e.g. to local butcheries) is mandated by public health regulations to occur at registered facilities (slaughter slabs or abattoirs); however, many villages lack such facilities, and so this regulation is rarely enforced – instead slaughter takes place under a tree.

2.4.2 Market opportunities offered by CBT

A CBT market opportunities analysis for Ngamiland beef, completed in 2017, determined that FMD should not be a barrier to trading with lucrative markets (Bing et al., 2017 - http://www.wcs-ahead.org/kaza/171003_rpt_final_marketopportunitiesforcbtbeef_ngamiland.pdf). While exporting beef from areas like Ngamiland that are not free of FMD has been a challenge, this has not been the case for India. India is now the largest exporter of beef (known as carabeef) by volume in the world, with annual exports of approximately 2 million tonnes to its trading partners in the Middle East, Africa and Southeast Asia. This is possible even though India is not free of FMD and has no FMD-free zones.

Through a CBT/value chain approach, South Africa may become available as a market for Ngamiland beef again once vaccination rates above 75% are achieved. Under the OIE's TAHC, marketing opportunities to countries with FMD equivalence to Botswana should also be possible, which may allow access to many middle and far eastern markets. Another potential market is the tourism industry in northern Botswana, which currently imports most of its beef from the south (i.e. the FMD-free green zones), rather than sourcing locally. The only issues for locally sourced meat marketed within the FMD-infected zone could be quality and consistency of supply.

The 2018 *Guidelines* described above are intended to assist beef producing enterprises that wish to assess their options for accessing regional and international markets. The option chosen (there may be more than one) depends on the requirements of the target market as well as the capacity of the exporter (Figure 6). For Ngamiland, three practical options currently exist – the latter two being based on CBT principles: (i) exporting to countries or zones with equivalent FMD status, (ii) processing such as heating and canning to inactive the FMD virus, and (iii) complying with requirements of OIE TAHC Article 8.8.22, with quarantine.

Based on this, a summary of the key requirements for export of beef from Ngamiland is provided in Table 1 below. It should be noted, however, that the following requirements per relevant OIE standards are in place in Ngamiland, and are therefore not repeated in the table:

- FMD is a notifiable disease and an official control programme that includes surveillance and routine vaccination is in place.
- Beef for export to other zones or countries is derived from animals slaughtered in an approved abattoir with ante- and post-mortem inspection.
- Cleaned and disinfected motorised transport is used to bring cattle for slaughter to the abattoir.

While the *Guidelines* do include the option of FMD-free compartments (OIE TAHC Article 8.8.4), this option is not included here because compartments in Ngamiland (and other FMD-endemic areas) cannot comply because FMD-vaccinated animals/FMD vaccination are excluded from compartments under the current OIE standard. Nevertheless, it is also important to note that countries can legitimately negotiate bilateral agreements that differ from OIE standards with willing partners. Finally, this table does not address the export of live animals.

Table 1. Summary of options and key requirements for export of beef from Ngamiland.

Commodity/product	Target market	30-day official cattle quarantine	Standard or justification
Canned meat	All markets	No	OIE TAHC Article 8.8.31. Article provides details of temperatures, pressures and degree of desiccation required.
Meat that has been thoroughly cooked			
Salted/dried (break-dry) meat			
Bone-in beef (carcasses, half carcasses, quarters, cuts); deboned beef and processed products to client's preference	Countries/zones not free of FMD (i.e. same or lower status)	No	OIE TAHC Chapter 5.3 as related to World Trade Organisation Sanitary and Phytosanitary Agreement (equivalence); client requirements by agreement
Matured (pH <6), deboned beef, visible lymph nodes removed	FMD-free countries/zones	Yes[2]	OIE TAHC Article 8.8.22
Any other commodities	FMD-free countries/zones	Yes[2]	Export of commodities that are not covered by an existing standard would be subject to negotiation between trading partners

[2] Because it is not feasible to certify absence of infection within a 10 km radius over the past 30 days in Ngamiland due to the presence of wildlife.

[1] *FMD-free compartments are not achievable where FMD vaccination is practiced as FMD-vaccinated animals / FMD vaccination are excluded from compartments under the current OIE standard. In addition, the presence of free-ranging wildlife makes demonstrating that "no case of FMD has occurred within a 10 km radius of the compartment during the past 3 months" essentially impossible.*

Figure 6. Decision tree for beef business enterprises located in areas not recognised internationally as free from FMD without vaccination (Thomson et al., 2018).

2.4.3 Stakeholder mapping

Many stakeholders, from local to international, have roles to play in the successful implementation of CBT, necessitating increased multidisciplinary dialogue so as to achieve a more holistic, inclusive and integrated approach to a complex and dynamic set of challenges. A stakeholder is defined as any individual, community group or organisation with an interest in the outcome of a programme or project, either as a result of being affected by it positively or negatively, or by being able to influence the activity in a positive or negative manner. Table 2 below outlines the range of currently known stakeholders active and/or relevant in the realm of CBT implementation in Ngamiland. Figure 7 goes further to distinguish between key, primary, and secondary stakeholders as per the definition below:

- **Key stakeholder** – those who can significantly influence or are important to the success of an activity
- **Primary stakeholder** – those individuals or groups who are directly affected by an activity, either as beneficiaries (positively impacted) or those adversely impacted
- **Secondary stakeholder** – all other individuals or institutions with a stake, interest or intermediary role in the activity or who are indirectly affected (positively or negatively) by an activity

Section 11 addresses the need for collaboration, cooperation and coordination between these groups.

Table 2. List of stakeholders in implementation of CBT in Ngamiland and their corresponding role or interest in the process.

Stakeholder	Role/Interest
Farmers & Farmer Associations/Committees	
Cattle producers	Livestock production, compliance with national legislation, compliance with protocols (prerequisite programme) to achieve Good Agricultural Practices and mitigate the risk of FMD during primary production
Hainaveld Farmers Association	Provide support to farmers for sourcing information and advice including market information, promote collaboration amongst their members, enable collective lobbying by the farmers, identify training opportunities, enable farmers to establish savings and insurance schemes and so forth
Nhabe Agricultural Management Association	
North West Integrated Farmers Association	
Joint Ngamiland Farmers Association	
Government	
Dept. of Veterinary Services	Animal health and disease risk management along the value chain; FMD outbreak response; market identification & agreements; quarantine management &/or oversight; veterinary fencing
Dept. of Wildlife and National Parks	Management of wildlife resources & their habitats; human-wildlife conflict mitigation; community based natural-resource management; fencing
Dept. of Animal Production	Animal husbandry; marketing; demarcation and development of farms
Dept. of Environmental Affairs	Environmental policy, programme and legislation development; oversees environmental impact assessments (EIAs) of projects & infrastructure (fences)
Dept. of Town and Regional Planning	Management of urban & rural growth
Dept. of Lands	Oversee administration of state land
Ngamiland District Council	Local level implementation of development programmes & provision of basic services
Tawana Land Board	Allocation & management of tribal land in Ngamiland
Dept. of Agricultural Business Promotion	Market identification, negotiations & access
Livestock Advisory Centres	Sale of livestock inputs (feeds, medicines, dips, vaccines, husbandry equipment) under auspices of Botswana Agricultural Marketing Board; four centres in Ngamiland

Stakeholder	Role/Interest
National Strategy Office (NSO)	Lead national strategy development by promoting strategic thinking; catalyse effective policy making & implementation. Responsible for Beef Competitiveness Reinforcement Initiative (including promoting grass-fed beef).
Local level institutions	
Traditional institutions	These include the *kgotla*, chieftaincy and wards. Communication of BMC quotas occurs through the *kgotla*. Participate in decisions related to land use, allocation & zoning. As important links between communities & government authorities, these institutions are critical entry points for any development process.
Village Development Committees	Responsible for implementing development programmes in villages & report to the *kgotla*. Can bear influence on livestock production.
Habu Elephant Development Trust	Community based natural resource management; livelihood development
Nxaraga Development Trust	
National	
Academic institutions	Applied research, capacity building and collaborators on specific projects. Such institutes include Botswana University of Agriculture and Natural Resources, and University of Botswana (including Okavango Research Institute - ORI)
Botswana Meat Commission	Parastatal abattoir in Ngamiland; quotas/market access; quarantine management in Ngamiland
Botswana Vaccine Institute (BVI)	FMD vaccine development; support field investigations of FMD outbreaks; OIE reference lab
Regional/Continental	
Southern African Development Community (SADC - Member States & Secretariat)	Regional integration; regional policy frameworks; guidelines development; consumers of CBT products
Neighbouring country veterinary services	Transit of CBT products to consumer countries and/or consumer/importers of CBT products
KAZA TFCA (Partner States & Secretariat)	Management of shared natural & cultural resources; securing transboundary wildlife dispersal areas; community development; promotion of enabling environment for public-private-community partnerships, private investment & regional economic integration; sharing experiences & pooling resources & expertise across borders; facilitate harmonisation of relevant legislation, policies & practices (including as related to transboundary animal diseases)
Regional/continental importing countries	Consumers of CBT products
International	
World Organisation for Animal Health (OIE)	Science-based, international standards for animal health, welfare & veterinary public health; toolkit development
Food & Agriculture Organisation (FAO)	Policy advice; strategy development; capacity development; technical support; trade & food standards
World Trade Organisation (WTO)	Market access; trade & food standards
International importing countries	Consumers of CBT products
Private sector	
Batawana Beef	Private abattoir in Ngamiland
Ngamiland Abattoir	Private abattoir in Ngamiland
Tourism operators (e.g. Wilderness Safaris)	High-end tourism; possible consumers of CBT-related wildlife friendly beef products
Botswana Beef	Large scale suppliers of beef & beef products – export outside of BW as well
Beef Boys	Large scale suppliers of beef & beef products within Ngamiland
Local butcheries	Local suppliers of beef within Ngamiland
Supply chain processors	Various types of processors along the value chain
Buying agents	Direct purchase from producers
Transporters	Transport of animals from producer to abattoir/quarantine/butchery
Marketing agents	Marketing of CBT products

Stakeholder	Role/Interest
Private veterinarians	Animal health care providers – could be sub-contracted by DVS to perform certain functions
Consumers – in district, in country & beyond	Provide a market for the beef
Non-governmental organisations (NGO) & projects	
Animal & Human Health for the Environment And Development (AHEAD, Cornell University)	Technical support on CBT & FMD management; capacity-building in CBT approach; cross-sectoral dialogue
Botswana Predator Conservation Trust	Conservation; research; training in farming techniques to reduce farmer-carnivore conflict
Communities Living Among Wildlife Sustainably (CLAWS)	Conservation; research; training in farming techniques to reduce farmer-carnivore conflict
Ecoexist	Conservation; research; support land-use planning; human-elephant conflict mitigation; micro-enterprise development
Great Plains Foundation	Conservation; collaboration among CBT stakeholders
Herding for Health Programme (H4H)	Sustainable rangeland & livestock management through CBT, green jobs, conservation agreements & social enterprise development. Pilot site in Habu village, jointly implemented through Conservation International & Peace Parks Foundation.
Promoting Sustainable Livelihoods in TFCAs (ProSuLi)	Multi-stakeholder dialogue for local development in the context of conservation, communal herding and training, grazeland management. Jointly implemented in Botswana by CIRAD (agricultural research for development, France) and ORI with support to CLAWS.
Wildlife Conservation Research Unit (WildCRU, University of Oxford)	Conservation; research; training in farming techniques to reduce farmer-carnivore conflict

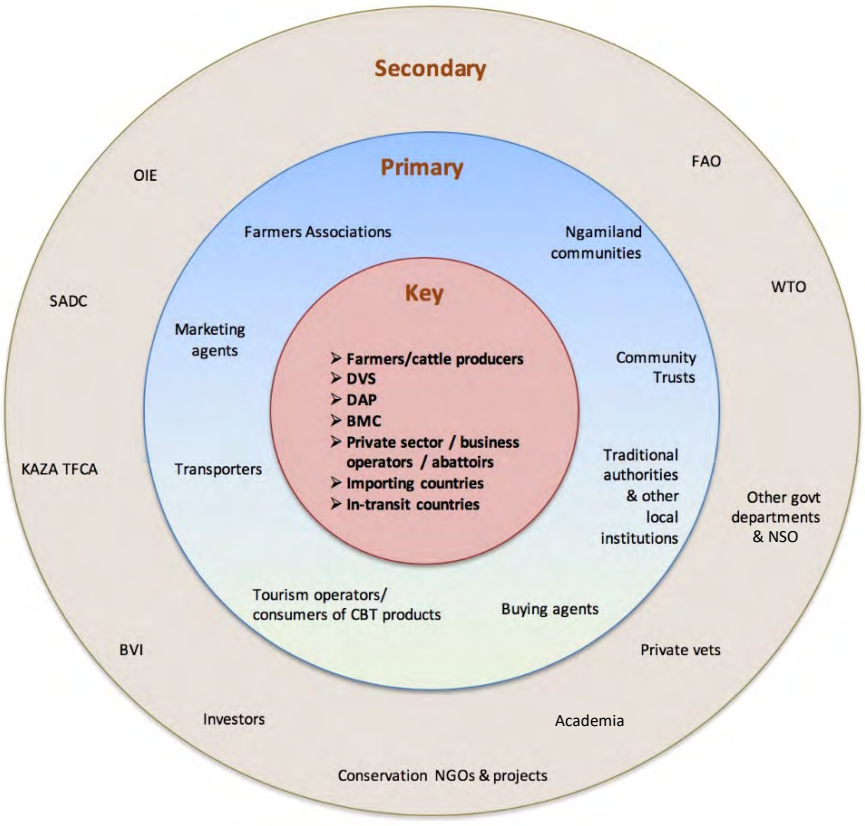

Figure 7. Key, primary and secondary stakeholders in implementation of CBT in Ngamiland.

2.4.4. Policy and legislative framework

Several policies and legislation, from the perspective of both the livestock and wildlife sectors, have an influence on the successful implementation of CBT and the production of WFB in Ngamiland. An illustrative list is shown below in Table 3.

Table 3. Policy and legislative framework (illustrative).

Authority	Policy and Legislative Framework
Ministry of Agricultural Development and Food Security	Botswana Meat Commission Act of 1965
	Agricultural Resources Conservation Act of 1972 (as amended)
	National Policy on Agricultural Development of 1991
Department of Veterinary Services	Control of Livestock Industry Act of 1941
	Branding of Cattle Act of 1962
	Livestock and Meat Industries Act 32 of 1962
	Matimela Act 25 of 1965
	Diseases of Animals Act of 1977 and fencing policies
	Livestock Improvement Act of 2009
Botswana Police Service	Cruelty to Animals Act of 1936
Ministry of Environment, Natural Resources Conservation, Wildlife and Tourism	Community Based Natural Resources Management Policy of 2007
Department of Environmental Affairs	Environmental Assessment Act of 2011
Department of Tourism	Tourism Act of 1992 and 2009
	Tourism Policy of 1990 (under review)
Department of Wildlife and National Parks	Wildlife Conservation and National Parks Act of 1992
	Wildlife Conservation Policy of 1986
Ministry of Finance and Development Planning	National Development Plan 11
Ministry of Local Government and Rural Development	North West District Development Plan (DDP) 8
	National Policy on Agricultural Development of 1991
Department of Lands	Tribal Land Acts of 1969 and 1993
	Tribal Grazing Land Policy of 1975
	National Policy of Land Tenure of 1985

The enabling environment for CBT in Botswana seems to be largely in place, in terms of the existing legislative framework. An AHEAD regional analysis ("Animal Health Policy, Legislation and Trade in Beef in the Five Participating States of the Kavango Zambezi Transfrontier Conservation Area (KAZA TFCA)") is also a helpful source of information (Thomson and Penrith, 2011).

A central function of government is to provide an enabling environment (comprised of laws, policies, practices and attitudes) that support, in this case, a value chain approach, from production in the field to a minimization of unnecessary barriers so that the private sector can invest in the local economy. While the legislation above offers a strong foundation from which CBT can be implemented, further development of Standard Operating Procedures (SOPs) and practices may be required, particularly since DVS has considerable regulatory authority. In general, while a supporting policy and legislative framework may be available, implementation and enforcement are not always adequate. Moreover, consistency and transparency go a long way toward instilling confidence among stakeholders, including investors.

3. FIELD

An integrated CBT and food safety approach. focused on the efficient management of animal disease risk and food safety along the value chain, starts at the field level. Depending on the value chain, field-focused producer protocol prerequisites could include, for example:

- record keeping to reduce the possibility of undesirable farming practices,

- herding, grazing and kraaling strategies that avoid buffalo contact as much as possible,
- animal identification and traceability to improve movement and disease control and comply with some importer requirements, and
- compliance with an official vaccination programme to achieve herd immunity and prevent the circulation of FMD virus in the cattle population (a requirement of OIE TAHC Article 8.8.22).

Together, these actions are aimed at providing beef that is safe for human consumption and from animal diseases – FMD particularly – *as well* as improving product quality and quantity so that the beef can be potentially competitive in most markets. A producer protocol, as part of any prerequisite programme, helps promote good husbandry practices to improve the quality of animals presented for slaughter while mitigating the risks of FMD.

Furthermore, within Ngamiland, it is essential to integrate the needs of both the wildlife and livestock sectors, as both could greatly increase livelihood opportunities for communities while concomitantly increasing community resilience to the shocks of drought/climate change. Some of the prerequisite approaches listed above allow for improved rangeland management (through planned grazing and herding), while minimising predator-livestock conflict. Several NGOs are currently working with communities in Ngamiland to develop herding and kraaling programmes that reduce human-wildlife conflict while enabling farmers to address many of these prerequisites.

Considerations at the field level in Ngamiland are discussed below.

3.1 Producer protocols, animal husbandry and rangeland management practices

3.1.1 Producer protocols

In order to comply with the minimum requirements for animal disease risk management and food safety as well as product quality at the site of production, several actions that a beef producer should be able to apply are proposed within the *Guidelines on Commodity-Based Trade Approaches for Managing Foot and Mouth Disease Risk in Southern Africa* (Thomson et al., 2018). Most of these activities were actions included in a producer protocol piloted in Namibia's Zambezi Region during an associated study in 2013 (Thomson et al., 2013b). The components of the protocol were (i) record-keeping, (ii) animal identification, (iii) vaccination against FMD, (iv) treatment against external and internal parasites, (v) herding and kraaling to prevent buffalo contact, (vi) grazing and pasture management, and (vii) disease reporting. While several of the requirements were services provided by Namibia's DVS (FMD vaccination and animal identification), all farmers experienced challenges in complying (J. van Rooyen, 2014, unpublished report).

The biggest constraint was in keeping records, most notably due to a lack of skills and tools, followed by herding and avoidance of contact with buffalo. Specifically, a lack of skilled and reliable herdsmen, and broader compliance with the requirement for full-time herding, especially for smaller farmers due to the costs associated with this practice, were problematic. Many farmers also indicated that they did not have a grazing strategy (van Rooyen, 2017). Similar challenges exist in Ngamiland. The Zambezi Region project highlighted that without clear benefits from a functional market, adoption of producer protocols would be very slow. Starting with the minimum requirements and then progressively implementing additional requirements was thus recommended. Extensive support services are also critical, and the process should be implemented as a shared responsibility among farmers, support organisations and government agencies.

The ability of farmers to cooperate in some form of organised collective action has, however, been shown to significantly improve their ability to manage risk, facilitate market engagement and comply with food safety/market standards. In 2018, the H4H programme began working to facilitate these steps in target communities in Ngamiland where, through the necessary stakeholder engagement, best husbandry practices can be tailored, farmers can be sensitised and (most importantly) an incentive framework for farmer participation can be developed. Deployment of skilled herders (see Section 3.1.3) becomes part of the

incentive framework because they help mitigate the major risks that producers and the market face, improve product quality through improved rangeland management, improve animal health and welfare and contribute to a sustainable production system. This all helps better define community expectations and the ingredients of good governance.

3.1.2 Conservation agreements

It is essential that improved market access through CBT provides incentives to implement best practices. This is even more important in areas where unlocking the economic opportunities presented by both the wildlife and livestock economies is paramount for prosperity and environmental sustainability. However, there is a risk that success in improving market access for beef produced in Ngamiland could come at a counterproductive cost to conservation efforts. In order to mitigate this risk, programmes such as H4H use a conservation agreement, a mechanism developed to balance and enable self-regulation of the interests of communal producers and conservationists/rural development practitioners. A conservation agreement is a *negotiated exchange of benefits in return for changes in resource use, depending on verified performance*.

Conservation agreements are used very successfully in the primary production of, for example coffee, beef, fish etc. in ways that align very well with compliance with Good Agricultural Practices. In fact, assistance with compliance with Good Agricultural Practices for a particular market can become part of the benefits offered in a conservation agreement if producers agree to use a particular resource, such as natural grazing or water for irrigation, sustainably. Similarly, a price premium can form part of the negotiated benefit package if producers refrain from using lethal predator control measures. The conservation agreement is therefore combined with other producer agreements and ultimately becomes part of the incentive package negotiated between producers and buyers who are looking to supply a particular niche market. Conservation agreements are set up by following five steps of negotiation with producers. This culminates in a joint compliance framework with monitoring capacity and systems in place at the producer and market levels. This process was developed to enable successful outcomes particularly when it comes to under-served communities such as those in Ngamiland. It is not a system where the market dictates the standard without any mechanism in place to facilitate compliance with it. Thus, where applicable, conservation agreements could be used to support compliance with prerequisite programmes for CBT.

3.1.3 Herding and kraaling

In communal farming systems like those in Ngamiland, there has been so little incentive for full-time herding that cattle generally move unattended, with major consequences for effective animal and rangeland management, disease control and wildlife-livestock conflict management. Of a survey of over 100 farmers in Ngamiland, conducted as part of a market opportunities assessment for CBT beef from Ngamiland in 2017, the vast majority of farmers reported that they never herd their animals, and only 15% reported herding most of the time. Furthermore, about half of all farmers reported that they never or only occasionally kraal their cattle at night (Bing et al., 2017; M. Masedi, 2017, unpublished report).

Recently, however, it has been shown that the practices of herding and kraaling in communal farming systems at the wildlife-livestock interface by skilled herders can play a vital role in enabling farmers to comply with and participate in a CBT/HACCP approach to risk mitigation implemented along the beef value chain to achieve a safe product. This section provides an overview of the role herding and kraaling can play to ensure that market access brought about by CBT has positive outcomes for wildlife conservation, sustainable land use and overall rural development.

Skilled herders

A herder permanently tending livestock can greatly improve the safety, health and productivity of the herd. In order to do this as well as facilitate compliance with trade standards at the farmer level, a herder must possess the right skills. The required range of skills is broad but based on basic principles that can be mastered by an adult with rudimentary literacy. The objective with upskilling herders is to create a demand

and career path for herding as a profession. At the very least, professional herders deployed at the wildlife-livestock interface should have basic training in: primary animal health care and disease reporting; planned grazing; record keeping, monitoring and evaluation; wildlife avoidance; low-stress animal handling; tracking; and community communication/mobilisation. With these skills and the ability to look for and record the right signs and parameters relevant to rangeland health, animal health and wildlife contact, herders will be able to fill a crucial gap between strained government extension services and community needs in the livestock sector.

Collective herding

Most livestock owners in communal farming systems cannot afford to hire professional herders. Typically, only the largest farmers, who make up a small proportion of cattle owners in a village, can afford a full-time herder, and even then the hired herder is usually unskilled and often foreign labour desperate to do the job at the low wage offered. Farmers without resources and/or with small herds of 5 – 15 cattle have no alternative other than to either herd the cattle themselves or let cattle graze unattended, only to be gathered in the late afternoon by family members, mostly young boys after school. Combining cattle into one or several larger herds at village level with collective herding by a few skilled herders can give smaller farmers access to the benefits of a herder with critical skills at an affordable cost, one that may even be subsidized by government job creation programs, for example.

One of the most important attributes of combined herding is that effective rangeland management can be achieved. For example, proven rotational grazing methods that mimic the behaviour of wild ungulates, which intensively graze an area and then move on, allow for regeneration of palatable native vegetation. In addition, better management of livestock-wildlife contact, herd health and animal records can be realised. Similarly, combined kraaling, particularly through specially designed predator-proof bomas, mitigates the risk of theft and predation. Strategic *mobile kraaling*[3] offers an additional advantage in terms of restoration of eroded rangelands and improved crop farming.

One of the most important challenges faced by the livestock sector in Ngamiland is the level of uncontrolled animal movement throughout the region, which severely constrains FMD risk management efforts by veterinary authorities. This situation increases the risk of livestock contact with wildlife as well as reduces the efficacy of FMD vaccination campaigns, with stray cattle much less likely to have been vaccinated. Farmers are often unable to round up all of their cattle to present them for vaccination, leading to inadequate herd immunity (see Section 3.4). Furthermore, only cattle with proof of vaccination are accepted for slaughter at the Maun abattoirs.

Collective herding by skilled herders provides a very practical solution to the challenges of uncontrolled animal movement, which can be eliminated if all farmers participate. The latest pasture mapping and herd tracking technologies, along with individually identified animals, allow skilled herders to provide auditable evidence of animal origin and current location. One of the duties of the herders is to report evidence, tracks or otherwise, of unattended cattle or non-compliant grazing that may pose a disease risk. Animals graze according to a pre-planned grazing system and at any given time a herd's location is known or traceable. Evidence of cattle outside the plan immediately indicates an uncontrolled movement that can be followed up if necessary. Legislation exists in Botswana for dealing with stray animals (Matimela Act, Government of Botswana).

A major role of skilled herders is to avoid contact during the day in rangelands/at water holes with any wildlife or cattle that may pose a disease risk. This is done through actively herding livestock away from a buffalo herd encountered or by avoiding a time of day or an area such as a specific grazing area or watering hole that buffalo or feral cattle may favour. The grazing plan makes provision for such areas, which are

[3] Mobile kraals, constructed with plastic sheeting, are enclosures used to protect livestock from predators at night. Siting them in fallow crop fields also improves soil fertility and crop yields; and, their light-weight design means they can be strategically moved to new fields every 1-2 weeks.

spatially managed by the use of specially developed applications on GPS-enabled handheld devices. Professional herders are trained in tracking and they are sourced from local communities who generally know the seasonal preferences of local wildlife and the locations where stray cattle congregate. Effective and active avoidance of buffalo and stray cattle through full control over cattle herds in the rangeland should significantly reduce the risk of disease transmission.

Successful implementation of CBT to improve market access also requires compliance with a series of risk mitigation measures that include vaccination and good animal husbandry practices at the producer level, which is highly dependent on good record keeping. Although Botswana requires individual identification of cattle through the BAITS system (see Section 3.2), which simplifies record keeping, most individual animal owners in Ngamiland do not possess knowledge or resources to keep proper records or even to comply with these requirements. Skilled herders record animal treatment, signs of disease, vaccinations and instances of contact with potentially disease-carrying wildlife as required. These records can be used for the certification of farmer compliance with market requirements.

Sustaining herding and kraaling efforts

Sustained herding by skilled herders and their active implementation of modern technologies can only be achieved if they are deployed as part of an integrated program that enables farmer compliance with best husbandry practices. Improved market access provides a key incentive for investing in best practices by farmers. It requires a full value chain approach starting with improved rangeland management, which in turn leads to improved animal health and production and increased market access. It is community-driven, sustained by favourable risk/reward returns and is thus not only authority-driven. It allows for creative involvement of enterprises, especially by ecotourism and conservation entities that benefit directly from the adoption of best practices by livestock farmers that are both wildlife friendly and climate smart. The H4H programme that supports communities, government and implementing agents to employ CBT in an integrated, community-driven way is a useful source of additional information (https://www.peaceparks.org/h4h/).

3.1.4 Rangeland management

Meat quality is one of the most important determinants for access to higher prices. Prior to slaughter, meat quality is determined by various factors such as breed, age and sex, the stress the animal experienced during handling and transport, and very importantly the body condition of the animal. A significant challenge for producers on communal rangelands is ensuring a consistent supply of carcasses in a good condition throughout the year. In extensive livestock production systems as in Ngamiland animal condition typically varies with the condition of the rangeland, which in turn is influenced by the level of grazing pressure and the variation in climate and rainfall patterns. The more unpredictable the rainfall patterns become due to climate change, the more unpredictable the carcass quality will be at any given time. Besides sanitary considerations, this reality severely restricts the ability of the abattoirs in Ngamiland to secure appropriate and reliable markets. Higher-value markets generally demand a consistent supply of a specific quality and quantity of a product – two things that are hard to normalise in Ngamiland.

To overcome inconsistent carcass quality and quantity, abattoirs in many places rely on feedlots to secure a reliable supply. However, in Ngamiland and similar areas elsewhere, feedlots may prove challenging for various reasons including availability of affordable feed. In the absence of feedlots, the alternative is to invest in proper rangeland management and some basic animal conditioning before animals are delivered to the abattoir. This approach allows for grass-fed and/or free-range certification, for which demand is growing in some societies.

In Ngamiland livestock occur in variable numbers wherever communities exist. Due to the semi-arid environment in Ngamiland, people associate with river systems where water is consistently available through direct access or through boreholes around which cattle posts occur. As a result, cattle density in communal farming areas is not evenly distributed and where cattle occur in high densities there is a higher

probability for overutilisation of available rangelands. Overgrazing occurs when the impact of trampling and forage consumption exceeds the natural regenerative capacity of the rangeland and may result in the rapid deterioration of soil, grass cover and species composition. Degraded rangelands severely restrict animal performance and ultimately carcass yield and quality, with reduced revenue to farmers. Degradation also has an adverse effect on the rangeland's ability to maintain healthy water and nutrient cycles despite a changing climate. Livelihoods become vulnerable due to lack of water and loss of biodiversity. A common and growing threat to protected areas (and their grazing and water resources) is incursion from adjacent livestock rearing communities with high levels of rangeland degradation. Such practices increase livestock-wildlife conflict significantly.

Analysis of grazing capacity and estimated stocking rates in Ngamiland

In order to identify areas in Ngamiland where livestock pressure on protected areas is most pronounced, remote sensing data were used to estimate the grazing capacity (Figure 8). Grazing capacity and livestock numbers were overlaid to predict the level of over/under stocking (Figure 9). Note that a Large Stock Unit (LSU) is defined as the equivalent of one head of cattle with a body weight of 450 kg and gaining 0.5 kg per day.

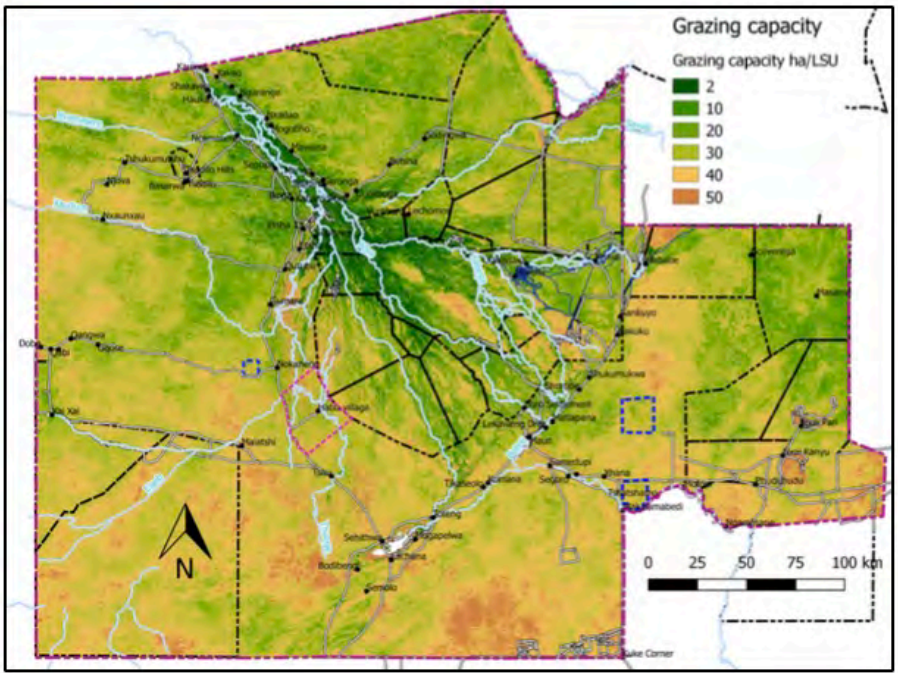

Figure 8. Estimated grazing capacity (ha/LSU) of Ngamiland.*

* Grazing capacity estimates were derived using the South African grazing capacity map to construct a regression model to predict grazing capacity for Ngamiland from NDVI satellite maps. One thousand random samples (a sample every 8-16 days between 2016-2017) of Landsat NDVI (30 m resolution) maps were used to generate the data. The median value of every pixel sampled was extracted and used to derive a 2nd order polynomial fit to reflect grazing capacity in Ngamiland. The grazing capacity estimate reflects the condition of the rangeland in Ngamiland over the years 2016-2017. Grazing capacity is expressed in hectares available per large stock unit (ha/LSU) (Z. Venter, 2018, H4H unpublished report).

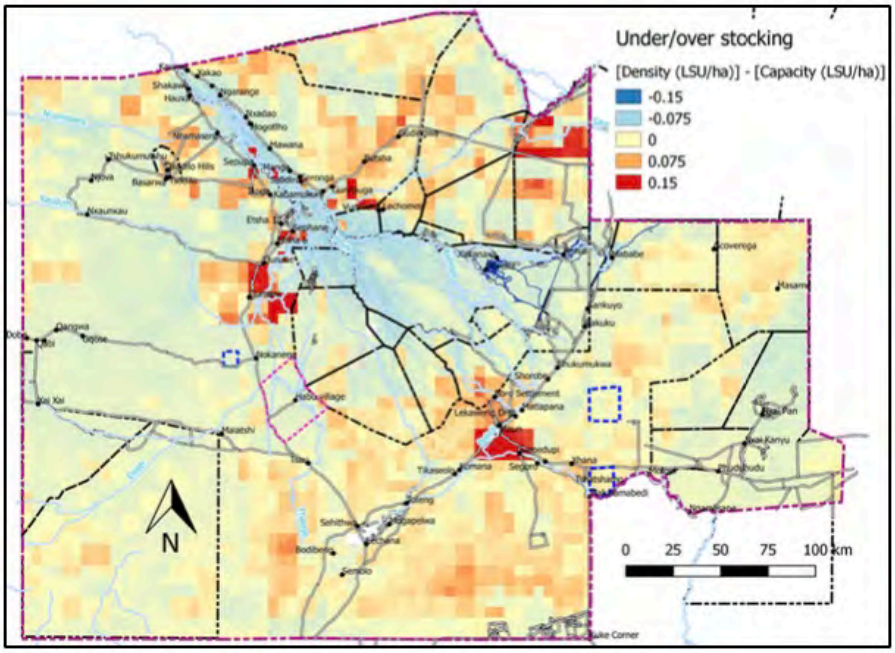

Figure 9. Estimated under/over stocking in Ngamiland.**

** Grazing capacity estimates were overlaid with livestock numbers in Ngamiland. Livestock numbers sourced from the FAO livestock database of cattle densities were used to derive spatially explicit estimates of livestock grazing densities over Ngamiland (Stocking Density (LSU/ha) – Grazing capacity (LSU/ha). Areas exceeding grazing capacity are indicated in red and areas stocked below grazing capacity are indicated in blue (Z. Venter, 2018, H4H unpublished report).

Ngamiland's rangelands cover a total of 11,174,003 ha, with protected areas (national parks, game reserves etc.) comprising 5,035,246 ha and unprotected areas comprising 6,138,757 ha. Using DVS cattle population estimates and the remote sensing described above, in 2016 the estimated number of cattle in Ngamiland was ~317,000, yet the rangeland condition allowed for a grazing capacity of approximately half that, i.e. 147,330 cattle (based on rangeland size and condition outside protected areas). It is often mentioned that the grazing capacity of Ngamiland is 250,000 cattle (25ha/LSU), which is still above the current capacity of the rangeland due to a prevailing dry cycle across southern Africa that led to rangeland degradation where stocking rates were not adapted appropriately. It is especially important in periods of below average rainfall to reduce grazing pressure either through de-stocking or through moving of animals to areas with lower grazing pressure. Unfortunately, the FMD control measures and abattoir closings over the last number of years in Ngamiland resulted in grazing pressure being maintained despite the need to adapt to prevailing weather conditions. In periods of below average rainfall, communities without proper grazing planning have little prospect of adapting in time, and as a consequence rangeland and animal condition, or survival, is compromised.

Considerations for rangeland management in Ngamiland

The following should be considered for the sustainable management of rangelands in Ngamiland to contribute to animal performance and the development of reliable market systems in the long term:

- *The need for rangeland rehabilitation and planned grazing.* The rehabilitation of degraded rangelands in Ngamiland must be a priority if animal performance is to be normalised so that reliable market access can be achieved. Importantly, without healthy rangelands outside the protected areas the pressure to access grazing in protected areas in an uncontrolled manner will grow, which will ultimately result in higher human-wildlife conflict. The only way rangeland restoration is likely is if farmers are enabled and motivated to implement proper planned grazing, as promoted by programmes such as H4H as described in Section 3.1.1. Development of legal/policy

instruments that support collective grazing plans and related animal husbandry practices may however need to be considered to prevent invasion of land that is resting.

- *Use of skilled herders*, as described in Section 3.1.3. Importantly, when animal movements are uncontrolled the rangeland is subjected to continuous grazing pressure and trampling, especially within 5 km of kraals and water points. Livestock, unlike migratory wildlife, will remain in the vicinity of their known range despite the deterioration of the rangeland, adding further pressure.

- *Dynamic stocking rates for maintaining/restoring functional heterogeneity*.[4] Rangelands are inherently diverse in composition, which provides resilience to environmental change and enables grazers to adapt their nutrient intake according to a range of seasonal and climatic conditions. Planned grazing should promote functional heterogeneity in Ngamiland to maintain rangeland resilience. Stocking rates must be dynamic as far as possible, which may pose a challenge if farmers are unwilling to sell. Dynamic stocking rates should not only rely on animal offtake, but should primarily be a result of adaptive rangeland management where areas of utilisation versus rest are continuously adapted to herd size, animal requirements, rangeland condition, climate and rainfall. The development of seasonal rest and utilisation areas that can be rotated as needed will greatly enhance functional heterogeneity. This may require seasonal provision of water in areas with good grazing but limited water access as part of an integrated grazing plan as facilitated and monitored by skilled herders.

3.2 Animal identification and traceability

3.2.1 Animal identification

Identification of livestock provides many advantages and has a long history globally both at farmer and national levels. Originally its main use was to discourage stock theft and enable retrieval of stolen or strayed animals, but other useful applications are to maintain records for production purposes and to support disease control programmes. Increasing concerns about food safety resulted in the development of systems for traceability of foodstuffs, at least to the area or even farm of origin. The bovine spongiform encephalopathy (BSE or 'mad cow' disease) outbreaks in the UK that started in 1996 and the probable connection between BSE and neurological disease in humans that emerged led to more stringent requirements for linked individual animal identification and traceability systems. In 1997, in response to the BSE crisis, the EU introduced Council Directive EC820/97 which made it mandatory for all beef entering the EU to be identifiable and traceable back to the individual animal of origin (ITC, 2014).

Botswana traditionally relied on a branding system to identify cattle at the herd level with the livestock owner. To ensure continued access to the lucrative EU market, Botswana initially implemented a Livestock Identification and Trace-back System (LITS) using radio-frequency identification reticular boluses. However, due to a number of challenges, the government decided to replace the bolus system with electronic ear tags. In 2014, the new digital electronic system – known as Botswana Animal Information and Traceability System (BAITS) – was rolled out. Unlike the previous government centred LITS system, BAITS was designed to be more farmer-friendly, enabling them to access and upload information into the database and undertake certain transactions online (or by manually submitting them to DVS) (see Table 4).

In 2015, an FMD audit of Botswana carried out by the European Commission (European Commission, 2015) identified the absence of any legal power to enforce BAITS as a threat to its correct application and therefore the reliability of the traceability of the cattle. The GoB has since enhanced the necessary legal and regulatory framework i.e. Diseases of Animals (Animal Information and Traceability System) Regulations, 2018, and Statutory Instrument No. 7 of 2018. Under these regulations BAITS will be implemented throughout

[4] Functional heterogeneity, in its simplest form, can be defined as an ecosystem containing a mix of functional wet- and dry-season habitats within viable migration distance of each other (Fynn et al., 2014).

Botswana. It requires mandatory registration of every keeper (people who own animals) and their holdings (areas where animals are kept). The regulation also compels farmers to apply a combination 'radio frequency identification device' ear tag together with a visual unique numbered tag to their cattle and to register their cattle in BAITS. Animals should be tagged at the age of six months. Furthermore, only tagged cattle will be issued with permits to be moved to a quarantine station or slaughter facility.

Table 4. Overview of BAITS system including role players and expected deliverables.

BAITS DELIVERABLES		
Primary objective - Establish an accessible farmer centric animal information and traceability system as tool to facilitate animal and public health controls		
Role players	Deliverables	
	Primary	Activities
Farmer	None regulatory	i. Buy Combo ear tag ii. Application of combo ear tags iii. On-line registration of ear-tagged cattle or manual submission to DVS or certified tagging and data entry agents iv. Undertake transactions either on-line or manual submission to DVS or certified tagging and data entry agents (TADEA) v. Updating keeper ID information details on line or manual mission vi. Query and retrieve reports on-line vii. Animal movement request and approval subject to animal and public health restrictions viii. Notification of cattle deaths
Other Stakeholder participation	Facilitator	i. Certification of tagging and data input agents ii. Established partnership with stakeholder i.e. internet providers
BMC/Other slaughter facilities	None regulatory	i. Arrive and terminate slaughtered cattle ii. Query and retrieve reports on-line
Department of Veterinary Services	Official regulation	i. Capturing of animal and public health data ii. Imposition of animal and public health controls iii. Use BAITS data to inform decision making on animal and public health programmes, strategies and policies iv. Auditing on BAITS and holdings v. Build capacity on BAITS (certification of tagging and data input agents, staff, keepers and others) vi. Develop, review and enforce legislation vii. Procure and resell ear tags
Botswana Police Service	Law enforcement	Law enforcement

(Source: https://www.icar.org/wp-content/uploads/2015/09/Modisa.pdf).

BAITS has not yet been fully implemented in Ngamiland. Prior to its introduction, all cattle in the district had to be identified with an owner brand (registered with the Brand Registry Office) as well as a zonal brand (Branding of Cattle Order 36:02 (https://www.ecolex.org/details/legislation/branding-of-cattle-act-chapter-3602-lex-faoc065796/). Unbranded cattle are considered stray animals dealt with under the Matimela Act Chapter 36.06 (http://www.gov.bw/globalassets/mlg/acts/matimela-act.pdf); the unvaccinated *matimela* cattle around Lake Ngami increase the risk of FMD outbreaks.

Factors hampering the implementation of BAITS in Ngamiland include:

- Lack of computer capacity has complicated the registration process; currently the only computer linked to BAITS is at the BMC abattoir in Maun
- Insufficient bandwidth to support a fully electronic system; internet access in Ngamiland is generally poor
- Poor distribution and initial availability of ear tags (only a proportion of the ear tags distributed to farmers were used, while in some areas cattle presented for vaccination were not tagged because no tags were available); DVS is also experiencing low returns on purchased tags e.g. removals following death and slaughter (O. Tshireletso, pers. comm., June 2019)
- Refusal by some farmers to tag their cattle
- Few farmers have internet access and those who do reported it to be very inefficient, only available at some times, and extremely expensive

- Farmers identified further problems as follows:
    - Farmers need better access to ear tags; those who are willing to sell to BMC often cannot do so because their cattle do not have ear tags
    - DVS staff do not have equipment to scan ear tags when cattle are presented and instead have to phone head office to confirm vaccination status
    - Owners have to be present when cattle are tagged e.g. during vaccination campaigns
    - There is no way to know whether cattle that were tagged by their owner and not during vaccination campaigns have been vaccinated or not (i.e. responsibility for application of ear tags has been transferred to farmers but there is no verification/control plan in place).

Farmers are frustrated by being prevented from selling their cattle due to system problems and in 2018 requested a shutdown of the system until it is functioning properly. According to a press release issued on 7th June 2018 the system was to be shut down during the month of July for upgrades. Upgrades involving BAITS infrastructure and applications, data migration and training are unlikely, however, to improve the situation in Ngamiland unless a functioning offline version can be deployed. The challenges that an online system such as BAITS poses within Ngamiland have also been identified in a study undertaken on LITS where 84% of cattle farmers reported having no access to computers or the internet (Mooketsi, 2013).

Positive developments include:

- A GPS acquired by DVS in March 2018 will enable crush pens and holdings to be registered and linked to zonal and owner brands.
- The ongoing BAITS upgrade (BAITS-2) is due to be released (mid-2019) with an 'offline' module for farmers and extension officers enabling data to be entered offline for later uploading when there is connectivity. DVS officers will also be issued with robust laptops installed with the offline module and will have the capability of retrieving individual animal vaccination status in the field.
- A joint initiative by the MoA and the Ministry of Youth Empowerment, Sport and Culture Development is underway to provide 60 villages with BAITS cafes consisting of a portacabin, computer and internet connection to improve uptake of BAITS by farmers. The 60 villages have been selected countrywide, only seven of which are in Ngamiland (Etsha 6, Gumare, Komana, Maun West, Nokaneng, Tsau and Kareng). Applications for privately run BAITS cafes is ongoing (O. Tshirelestso, pers. comm., June 2019). Villages such as Habu would like to be included. Habu Elephant Development Trust has already developed infrastructure (an office with solar power) that could function as a BAITS cafe.

3.2.2 Movement control

The movement of animals and animal products in Botswana is subject to the issue of a movement permit to move animals: (i) between different zones for rearing or breeding, (ii) to a cattle quarantine, (iii) to slaughter at an export abattoir, or (iv) to slaughter at other abattoirs or for own use. In addition, imported animals are issued with a permit to move from the border to their final destination (http://www.gov.bw/en/Ministries--Authorities/Ministries/MinistryofAgriculture-MOA/Tools--Services/Licensing-and-Permits/Animal-Movement-Permit/). Since the introduction of BAITS, cattle are required to have the combo ear tags and to be traceable on the registration system with proof of vaccination in order to be issued with a movement permit. With the challenges of the BAITS rollout, this has created bottlenecks in the flow of cattle for slaughter and is obviously causing financial losses to both the farmers and the abattoirs.

3.2.3 Use of multiple identification systems for cattle

The importance of cost-benefit studies to ensure that investment in a particular animal identification and traceability system is justified by the returns that it will generate has been emphasised repeatedly (COMESA, 2009; Meuwissen et al., 2003; Sousa Monteiro & Caswell, 2004). While it is ideal to have all the cattle identified according to a single system, until that system is functional throughout Ngamiland it may be

necessary to accept that other systems should continue in use depending on the target markets. Given the high cost of BAITS, it may be that less costly systems can be applied for lower value markets. The United States Department of Agriculture, for example, offers a variety of animal identification and traceability options for different circumstances and production systems (USDA, 2016).

In summary:

The BAITS system meets the requirements of certain markets for individual animal identification and traceability. There have been challenges to its implementation in Ngamiland due to lack of bandwidth to support an electronic system, few farmers having access to a computer or internet, and technical hitches in the implementation of the system. This has resulted in farmers being unable to sell their cattle due to inability to comply with the system or to problems with implementation of the system. This situation will be improved for farmers who will have access to the planned BAITS cafes. Alternative approaches including the existing branding system should be used in the interim to permit farmers whose cattle are not BAITS compliant to be slaughtered for markets that do not require individual animal identification.

3.3 Field situation with respect to FMD

A more detailed evaluation of the situation is provided in Annex B.

3.3.1 FMD in Ngamiland, past and present

Outbreaks of FMD in cattle in Botswana, as was the case in other southern African countries, occurred repeatedly between 1933 and 1981 (i.e. after the buffalo and cattle populations of southern Africa recovered from the Great Rinderpest Pandemic of 1896-1904). During the following 20 years (1982 – 2001) no FMD outbreaks were diagnosed in Botswana, including in Chobe and Ngamiland districts where large concentrations of buffalo have historically been present. This FMD-free period coincided with the introduction of improved FMD vaccines manufactured locally by BVI. Since 2002, however, the incidence of FMD in cattle has increased remarkably in Botswana despite regular vaccination campaigns against FMD being conducted two to three times a year in the north-west of the country. The reason(s) for the resurgence of FMD is unclear and probably multifactorial.

In southern Africa, FMD outbreaks are caused by the SAT (South African Territories) viruses (SAT 1, 2 and 3) that are associated with African buffalo. Evidence that buffalo sometimes transmit SAT viruses to nearby cattle is irrefutable although the precise mechanisms of transmission are not fully understood (Vosloo & Thomson, 2017).

Between 2002 and 2011 outbreaks of FMD occurred at various places in Botswana close to the Zimbabwean border (e.g. in the vicinities of Pandamatenga, Lesoma, Selibe Phikwe twice and Francistown). That led to the supposition that they originated from Zimbabwe and that was supported by the fact that FMD outbreaks in cattle in Zimbabwe increased dramatically after 2000. Phylogenetic analysis provided by the FAO's World Reference Laboratory for FMD (Pirbright, UK) supported the suspicion that the 2006 Selibe Phikwe and 2011 Francistown outbreaks were caused by viruses that may have been introduced from Zimbabwe. However, the analysis showed the outbreaks at Pandamatenga and Lesoma in Chobe District were caused by viruses indigenous to that area, and a further useful piece of information provided by genome sequencing is that FMD events in Chobe and Ngamiland districts have so far been caused by different viral lineages, indicating that FMD events in cattle in these two districts have so far been unconnected.

Data reported to the OIE are reflected in 11 immediate notifications related to 51 associated outbreaks in Ngamiland that began in October 2007 and have continued to the present (July 2018). On average FMD events in Ngamiland have lasted 9 months (range 4–25.5 months) and consequently Ngamiland has been more or less continuously afflicted by FMD events in cattle for all but 22% of the time between October 2007 and July 2018, i.e. a period of 10 years 7 months. This provides a measure of the extent of disruption

to cattle production and trade in animal commodities over that decade. On the other hand, the direct effects of FMD on cattle over this period were limited, evidenced by apparently low morbidity rates, with only a small proportion of the cattle developing clinical signs of FMD. As is the case with SAT viruses in southern Africa generally, FMD in cattle in Ngamiland is a mild disease with low morbidity and very low mortality (Vosloo & Thomson, 2017).

Currently, FMD in southern Africa including Botswana is most commonly ascribed to buffalo contact, but this analysis has found that local veterinarians note that outbreaks in Ngamiland have often been difficult to link to buffalo herds, and that they suspect cattle involvement to be responsible for spread of the infection. As surveillance for FMD is currently based on observation of typical clinical signs, which, owing to the mild nature of the disease and an inadequate level of observation of free-ranging cattle in the absence of skilled herdsmen, may be overlooked, it is likely that many outbreaks are neither observed nor reported. It has also been observed that sub-clinical FMD is prone to occur in partially immunised cattle populations (Sutmoller & Casas Olascoaga, 2002) and, in this respect, consultation in Ngamiland has revealed that good vaccine coverage in the cattle population is infrequently achieved (see Section 3.4). The implications of viral circulation in the absence of notable signs of disease for surveillance and control are discussed in more detail in Annex B.

Progress on better understanding of the epidemiology of FMD in Ngamiland will depend on systematic sampling of the buffalo populations in and around Ngamiland and more systematic studies on infection, as opposed to disease, in Ngamiland cattle in future. Limited sequencing data on virus isolates obtained from buffalo in Botswana are available, with almost none from Ngamiland in recent times.

3.3.2 Control of FMD in Ngamiland

Control of FMD in Botswana in modern times has had two objectives: (1) keeping the disease out of the 'green (FMD-free) zones', thereby enabling beef exports to the EU and other high value beef markets, and (2) controlling the disease as effectively as possible in endemic areas of the country. In the latter respect control of FMD in Ngamiland has, as is the case in other southern African countries such as Namibia and South Africa, been founded on a combination of mass prophylactic cattle vaccination programmes and separation of cattle and buffalo populations through cordon fences, i.e. the Northern and Southern Buffalo fences.

The integrity of the buffalo fences for achieving separation between cattle and buffalo populations is widely recognised as being inadequate, primarily because maintenance of extensive fencing systems subject to on-going elephant and human damage and periodic flooding is tedious, difficult and expensive. While the WFB project was not mandated to address this issue, anecdotal reports came to our attention concerning the periodic large-scale ingress of cattle to the Okavango Delta through the buffalo fences during the driest months of the year, as well as occasional egress of buffalo into cattle-raising areas of Ngamiland during wet seasons. However, it appears that the extent of this problem has never been accurately measured.

The vaccination issue is covered in Section 3.4 of this report, which notes that there is *prima facie* evidence for the current vaccination programme being inadequate.

In conclusion, further research is needed to enable a better understanding of the epidemiology of FMD in Ngamiland in order to develop appropriate control strategies.

3.4 FMD vaccination

3.4.1 Background

Vaccination of cattle against FMD and the buffalo fences that separates western and southern Ngamiland from the Okavango Delta (designed to minimise contact between African buffalo and cattle) have been the mainstays of FMD control in Ngamiland for decades. However, while those measures appeared to have been successful initially, they have not prevented unexplained regular outbreaks of FMD in Ngamiland

cattle since 2007 (OIE/WAHID, 2018). The FMD situation in Ngamiland is similar to the experience of other southern African countries where cattle and African buffalo have an interface (Vosloo & Thomson, 2017); consequently, the escalating FMD problem in Ngamiland is not unique (Thomson et al., 2013a).

Fundamental to understanding the limitations of vaccination against FMD is the fact that, while immunity induced by current FMD vaccines can be effective in preventing development of disease, vaccination does not necessarily prevent infection (Lyons et al., 2016). Nevertheless, vaccination can reduce or even prevent virus excretion by previously vaccinated animals that become infected. Therefore, mass vaccination over many years has been successful in eradicating Eurasian types of FMD virus from large land-masses such as the EU and parts of South America in the relatively recent past (Leforban & Gerbier, 2002). The SAT viruses, by contrast, present a more difficult problem because of their high variability and instability, difficulty in adaption of field isolates to produce the large quantities of virus necessary for vaccine manufacture and an apparently brief duration of protective immunity (Lazarus et al., 2018; Robinson et al., 2016). These factors, together with the epidemiological and diagnostic peculiarities associated with SAT-type viruses, have been shown to preclude the possibility of SAT virus eradication through mass vaccination in southern Africa (Thomson & Penrith, 2017).

3.4.2 Investigative actions undertaken

A questionnaire was provided to DVS to enable the factors listed in Table 5 to be assessed. Most of the answers returned lacked sufficient detail to enable meaningful analysis or interpretation. The result is that it is impossible to address many of the issues listed in Table 5. However, some general comments on the relevant issues are provided below.

Table 5. Possible reasons for failure of vaccination programmes in FMD-endemic areas (after Lyons et al., 2016).

Vaccine failure		**Failure to vaccinate effectively**	
Animal related causes	**Vaccine related causes**	**Usage related causes**	**Programme related causes**
• Immune deficiency • Suboptimal response • Immature immune system • Poor health • Waning immunity • Immune interference • Incubating infection	• Low potency • Incorrect serotype • Poor match between vaccine & field virus • Capsid stability • Interference by other vaccines • Manufacturing problem, e.g. poor batch	• Incorrect dose/route • Inadequate primary immunization or boosters • Poor storage (cold-chain related) • Beyond expiry date	• Vaccine availability • Availability of cattle for vaccination • Incorrect timing (e.g. relative to risk period) • Sub-optimal schedule (regularity & timing of vaccination) • Inappropriate consideration of local epidemiological circumstances

Animal related causes of vaccine failure

Although difficult to measure without longitudinal studies which have yet to be conducted, the issue of poor nutrition of cattle in dry seasons and under drought conditions – leading to sub-optimal immune responses – perhaps contributes to poor vaccine performance in places like Ngamiland.

Mass vaccination programmes carried out two or three times a year do not incorporate the necessary flexibility to ensure a sound primary immune response in calves. Therefore, calves in Ngamiland are unlikely to receive the recommended first two inoculations of vaccine 2-8 weeks apart at approximately six months of age, i.e. soon after the waning of maternal immunity, to enable the required primary immune response. Other potential animal-related factors listed in the first column of Table 5 are unlikely.

Vaccine related causes of vaccine failure

FMD vaccines used throughout southern Africa are currently manufactured by BVI which has a good reputation and an international technical partner. Furthermore, the capacity and quality of vaccines provided to southern African countries has been improved through large-scale upgrading of and investment in the BVI production plant. Therefore, at least in a general sense, apparent vaccine failures are unlikely to be ascribable to poor vaccine quality.

As indicated above there are specific issues that render manufacture of SAT vaccines more problematic than is the case for vaccines against Eurasian FMD types. To what extent those factors are involved in Ngamiland can only be speculated upon because data on which such assessment could be based are not currently available in the public domain. The issue of vaccine strain 'matching' is particularly important for SAT virus control because of the viral diversity within SAT types, the lack of identified subtypes and the narrow range of vaccine strains available (Maree et al., 2014). The information provided by BVI in that respect appears to indicate good matches, although the data are unconventional and therefore difficult to compare with matching based on r_1 values.

Usage related causes of vaccine failure

The most common problem in this category is poor maintenance of the 'cold chain' during storage, transport and administration of vaccines, particularly in warm climates. It is well known that Botswana, among southern African countries, has in the past paid special attention to preventing this potential problem. However, the WFB project team had no opportunity to assess this aspect on the ground.

Programme related causes of vaccine failure

A fundamental requirement of any vaccination programme against all epidemic diseases is to generate a high level of herd immunity.[5] The level of desirable herd immunity in the case of FMD is generally accepted as >70%, i.e. the proportion of animals that need to be immune in order to halt virus circulation in the population of concern. It needs to be appreciated that the level of herd immunity is generally lower than 'vaccine coverage', i.e. the proportion of the susceptible population that is vaccinated, because not all vaccinated animals develop an effective immune response.

Workshops and discussions as well as a brief field assessment conducted by a WFB project veterinarian revealed a number of possible reasons for poor coverage. The Ngamiland DVS indicates that while they may achieve 70-80% coverage in the dry season, it is likely to be only 60% or lower during campaigns conducted during the rainy season. Additionally, DVS has an ongoing problem in persuading cattle owners to present their animals regularly for vaccination at scheduled times, as well as in getting owners to present all of their cattle at each round of vaccination. This is complicated by factors such as weather conditions (e.g. droughts or floods), owner fatigue caused by the necessity for frequent rounds of re-vaccination without apparent benefit and the fact that for many herds only milking cows and calves are kept close to the homestead. The others (steers and oxen) are left to roam free or are herded long distances away from the homestead. There is a particular problem around Lake Ngami where a large number of free-living cattle, many apparently feral, tend to congregate because of permanent water availability.

This vaccine coverage issue is complicated by the fact that BAITS is not yet fully operational and therefore the size of the cattle population of Ngamiland is founded on imprecise data.

There is a consequent general belief that poor vaccine coverage constitutes the principal reason for failure of the vaccination programme to protect the cattle population of Ngamiland against FMD effectively, but this needs to be objectively assessed based on hard data.

[5] The herd immunity required depends on what is known as the basic reproduction number (R_0) of the infection of concern. In the case of SAT viruses in southern Africa no information on this value is available.

3.4.3 Necessity for measurement of the level of herd immunity generated by the FMD vaccination programme

The extent of the potential problems highlighted above can to a large extent be gauged by post-vaccination monitoring for which an international guideline is available (FAO/OIE, 2016). While post-vaccination monitoring is unable to differentiate between the various factors that may contribute to failure of a vaccination programme, it has the invaluable attribute – when conducted correctly – of measuring the level of herd immunity generated to the virus strains incorporated into the vaccine.

It is common knowledge that post-vaccination monitoring exercises have been conducted in Ngamiland at least periodically in the past. However, the results of those exercises have not been made available to the project team. In addition, none of the DVS team that participated in an FMD outbreak response strategy development exercise in Gaborone in July 2018 said they had ever seen such data. This is arguably the single most important piece of information required to improve the performance of the current vaccination programme.

In conclusion, there is *prima facie* evidence for the vaccination programme in Ngamiland being insufficiently effective since 2007. Bearing in mind the cost and effort that goes into the programme on an annual basis and the socioeconomic impact that FMD has had on the human population of Ngamiland since 2007, there is more than enough reason for post-vaccination monitoring to be conducted regularly and diligently and for the results to be made available to all stakeholders as soon as practically possible. Such data are based on simple serology and therefore neither technically difficult nor expensive to generate.

4. TRANSPORT

Motorised and disinfected vehicles

In the past, cattle were trekked to quarantine and/or abattoir facilities, but today it is required that all animals be transported in motorised vehicles. This also includes cattle movements within sub-zones in Ngamiland. Transporting cattle to the abattoir is undertaken by private individual or commercial transporters, although which option is used is often dictated by the abattoir. During periods of oversupply, BMC-Maun maintains a quota system and private delivery of animals by communal farmers is precluded (as described in Section 2.4.1 above). Private abattoirs, however, will accept deliveries by both private individuals or commercial operators. In all cases DVS participation is required both for issue of movement permits and disinfection of trucks at the abattoirs, i.e. between batches. In addition, a police clearance certificate is required to guard against stock theft.

Animal welfare

Besides animal disease considerations, transport of livestock also has to comply with national regulations, which are in line with EU regulations, regarding animal welfare (FAO/MoA, 2013). This includes requirements for minimum space per animal and the maximum number of hours animals can be transported. In Botswana, an animal welfare concern came to light in 2007. At the time, BMC was experiencing an increase in the number of 'dead on arrival' animals and carcasses condemned for excessive bruising. As a result, BMC increased the rate charged to transporters for 'dead on arrival' animals from P850 to P1,150 in 2008. Prior to this, overloading was extremely profitable, ensuring trucks would carry more than the desired numbers, sometimes arriving with unbearable losses and heavily bruised animals. In the EU export zone (green zone), load formulas were also introduced with transporters being paid based on the length of the trailer, type of animal loaded, and distance covered. It should be noted, however, that transporters are paid on a per head basis in Ngamiland.

Transport costs

The price of transporting cattle to an abattoir is an important factor in the economics of cattle sales. Costs vary in Ngamiland, but most farmers pay between P300-400 per animal. This is higher than commercial transport costs for comparable distances in the FMD-free green zone (Table 6), likely due to factors including limited road infrastructure and a lack of transport competition.

Table 6. Transport costs per animal in Ngamiland in 2018 compared to commercial rates in the green zones.

Loading Area	Ngamiland BMC rate	Ngamiland transporter rate	Commercial cost for moving cattle a similar distance within the green zones
Sehitwa	P200.00	P275.00	P60.00
Nokaneng	P250.00	P320.00	P126.00
Shakawe	P280.00	P500.00	P230.00

For example, many production areas are more than 10 km from a tarred road along deep sandy tracks, which limits vehicle access. Seven-ton trucks are able to access locations like these which larger rigs cannot, but due to economies of scale the cost per head is higher i.e. 12-15 head per vehicle still requires one driver and vehicle-associated costs. Moreover, limited access reduces transporter competition, resulting in less bargaining power on the part of the producer.

BMC appears to be trying to mediate the situation, implementing its own transport rates in certain situations. When BMC buys cattle in the field at predetermined buying points (during periods of undersupply) they will negotiate a BMC rate, via expression of interest, with transporters. These rates are lower than those charged by Ngamiland transporters, with cost savings being passed on to producers. BMC has also further advised that it will only contract trucks capable of loading a minimum of 30 head. While this ensures larger, more efficient loads, it reduces market access for farmers living further away from buying points. Furthermore, during periods of oversupply at BMC, or for farmers requiring transport services to private abattoirs, producers are left with no choice but to pay higher non-negotiated rates.

Transport related to CBT implementation

As described in Section 2, not all markets will require quarantine. Those that do, however, will need to comply with OIE TAHC Article 8.8.22. This includes transporting animals in disinfected vehicles both from the field to the quarantine station and then later on to the abattoir. Thus, while compliance with Article 8.8.22 (a CBT approach) will enable greater market access, some additional transport costs will be incurred – as was likely the case when cattle used to be quarantined prior to 2007. BMC and farmers began negotiating how this would be handled in early 2018 (Weekend Post, 21 May 2018 - http://www.weekendpost.co.bw/wp-news-details.php?nid=5170). Farmers initially proposed that BMC purchase cattle on a live weight basis at the source and cover transport costs. However, BMC has noted that the cost of transport will need to be reflected in the purchase price.

Challenges

Transportation presents a number of challenges to communal livestock farmers, including:

- many production areas are not easily accessible for motorised transport
- transport costs reduce formal market participation, with many farmers choosing to sell their cattle to local butcheries at a lower price
- the traditional oxen (versus weaner) production system means farmers are unlikely to have the means of transporting large, individual animals to market themselves (in a pick-up truck) and must rely on commercial transporter services

- many production areas (e.g. along the western delta) are located considerable distances from existing quarantine and/or abattoir facilities (see Section 6.2).

5. QUARANTINE

In 2015, the FMD chapter of the OIE TAHC was revised to include incorporation of quarantine systems into risk management for deboned beef derived from areas not recognised as free from FMD. This provides, for the first time, an international standard for exporting fresh deboned beef from Ngamiland to FMD-free countries or zones.

Prior to 2007, a quarantine system functioned satisfactorily in Ngamiland, as no FMD outbreaks in any quarantine station (QS) or anywhere else in Ngamiland were reported. The present situation, with frequent outbreaks in the district and probable circulation of FMD virus in cattle, demands rigorous implementation of a high level of biosecurity to prevent outbreaks in the QS and provide a level of assurance that supports export certification. Attaining the necessary level of biosecurity will require investment in infrastructure as well as ongoing investment in providing the level of management required to maintain the high standards.

Quarantine is, however, only required for cattle whose chilled or frozen meat is destined for export to markets in FMD-free countries or zones. Cattle slaughtered for beef that will be marketed locally, processed in compliance with TAHC Article 8.8.31 or sold to countries of equivalent status should be moved straight to the abattoir, as before. Although a figure of 5,800 cattle per month has been calculated to keep the three existing abattoirs operating at full capacity (Section 5.1), it is likely that, at least for the foreseeable future, less than half this number will need to be quarantined to satisfy market requirements.

Considerations related to the use of government operated QSs are delineated below. The option of export from Ngamiland without quarantine, as well as possible future quarantine scenarios are also discussed.

5.1 Infrastructure, availability and siting of existing government quarantine stations

Prior to the FMD outbreak in Ngamiland in 2007, government operated QSs were an essential part of the Ngamiland beef production system, enabling cattle that were not destined for the EU to be marketed through the EU-rated export abattoir in Francistown. The process was discontinued as a result of the outbreak and over the last 10 years the four facilities (Makalamabedi, Shorobe, Nokaneng, and Kgomokwane) have fallen into disrepair. Apart from sporadic live-trade through Makalamabedi, and the small development of artificial insemination camps, there has been basically no significant use for the designated quarantines.

The growing elephant population in Ngamiland has contributed significantly to the deteriorating situation. Shorobe had signs of elephant movement a decade ago, but this was the exception, not the norm. Makalamabedi had no visual elephant impact, and Nokaneng and Kgomokwane had just started to report intrusions from elephant. Today, the whole picture has changed – damage caused by burgeoning elephant numbers and their movements, coupled with theft of fencing materials, has left Ngamiland's quarantine infrastructure in a very dilapidated state. The austerity measures placed on MoA/DVS and other ministries have curtailed their capacity for repair and maintenance, resulting in almost total degeneration of the once essential, workable quarantine facilities.

Makalamabedi, Shorobe and Nokaneng were visited and evaluated in 2018 for the purposes of this report. The important findings for the three QSs are summarised in Table 7. Kgomokwane could not be evaluated for the report as it was inaccessible by road in 2011 and DVS reported that nobody has tried to access it since that time. Its estimated size in 2007 was 11,500 ha. In 2007 it was being used to quarantine cattle from Zone 2a, involving a 20 km trek through deep sand for the cattle to reach the camp from Samochina Gate. Access by vehicle took over an hour. The facility was burnt out in 2008. Nevertheless, if it could be rehabilitated it would provide better access to quarantine for one of the main cattle-raising areas in Ngamiland.

Table 7. Evaluation of existing quarantine infrastructure.

Name of QS	Size(ha)	Basic characteristics	Cost of refurbishment	Concluding considerations
Makalamabedi	16,825	• Fencing in N & W in reasonable state • Internal fencing overgrown, stolen or damaged • Cut lines in N & W accessible • Cut lines in S & E practically nonexistent • Considerable elephant damage • Theft & vandalism affected large parts • Water reticulation inadequate • 2 functioning boreholes • Considerable bush encroachment • Staff housing been recently upgraded but suffers bat infestations	*Basic design* P400/ha less 20%[6] for use of old material = P320/ha. Total = P5,384,000 *Improved design* - 17 camp systems for better control & grazing P700/ha less 20% for use of old material = P560/ha. Total = P9,422,000 *Bush clearing* P250/ha over 5 years = P4,206,250 (P841,250 pa)	• Most accessible QS with strategic location • Currently the only functioning QS • Elephant incursions a concern
Shorobe	28,301	• Fencing in W in reasonable state • Fencing in N & S practically nonexistent • Internal fencing overgrown & destroyed • Cut lines in N & S inaccessible • Considerable elephant damage • Considerable bush encroachment • Water reticulation nonexistent • Main borehole supply on Boteti/Thamalakane supplies header tower ~40km away	*Basic design* P400/ha less 10% for use of old material = P360/ha. Total = P10,188,360 *Improved design* P700/ha less 10% for use of old material = P630/ha. Total = P17,829,430 *Bush clearing* P350/ha immediate = P9,905,350	• Accessibility a challenge - sand road for ~40km • Best designed facility with central water tower • Severe bush encroachment • Severe elephant impact • Existing fencing system inappropriate
Nokaneng	6,118	• All perimeter fencing nonexistent • All cut lines inaccessible • Considerable elephant damage • Some internal fencing rejuvenated • Water reticulation available at central loading kraals • Bush encroachment not as bad as Shorobe • Overgrazing • *Dichapetalum cymosum* (mogau) in northern paddocks makes winter grazing a challenge	*Basic design* P400/ha less 30% for use of old material = P280/ha. Total = P1,713,040 *Improved design* P700/ha less 30% for use of old material = P590/ha. Total = P3,609,620 *Bush clearing* P250/ha = P1,529,500	• Accessible • Considerable elephant impact • Extent of mogau and bush encroachment would make it susceptible to overgrazing quickly
Kgomokwane	~11,500 (2007)	• Hard to access due to deep sand corridor • Not utilised for an extensive period of time means facility has degraded		• Considered non-viable

[6] Percentages vary across facilities, based on visual assessment of the state of each facility during site visits.

The total estimated cost of refurbishing the three quarantines visited varies depending on the type of refurbishment undertaken (basic or improved design), and whether bush encroachment clearance costs are factored in, i.e. (i) basic design: P17,285,400, (ii) improved design: P23,219,980, and (iii) addressing bush encroachment: P15,641,110 (Table 7). For Makalamabedi, estimates range from around P5,384,000 for basic refurbishment to P9,422,000 for an improved design, excluding the cost of bush clearing. This is in line with estimates from other sources. For example, in December 2017, North West District Council Chairperson, Mr Duncan Enga noted that the cost of repairs to Makalamabedi stood at P8 million, excluding labour costs and fence destruction by elephant (Botswana Daily News - http://www.dailynews.gov.bw/news-details.php?nid=40124).

DVS received P2 million in April 2018 to begin rehabilitation of Makalamabedi and Kgomokwane, and more should become available over time; however, budget constraints remain a challenge and DVS is currently focusing efforts on Makalamabedi. At present, five paddocks at the QS have been rehabilitated and are structurally ready for use.

While work on Makalamabedi has begun, it must also be borne in mind that to service the needs of the existing abattoirs in Ngamiland if all cattle were required to go through quarantine (which is not the case given the various potential market destinations), Makalamabedi would need to accommodate, feed, monitor and release as free from FMD around 5,800 head of cattle monthly, i.e. at full capacity, assuming 20 kill days per 28 day cycle: BMC (120 head/day) n = 2,400; Batawana Beef (70 head/day) n = 1,400; Ngamiland Abattoir (100 head/day) n = 2,000. At a conservatively estimated carrying capacity of 1 LSU/10 hectares it is evident that a QS at least twice the size of Makalamabedi or additional QS would be needed, excluding consideration of necessary resting periods for the available grazing. As carrying capacity is determined by a number of factors, it could at times be as low as 1 LSU/25 hectares or considerably lower (more details are provided in Section 5.4 below).

Summary

- Makalamabedi is the most accessible QS in Ngamiland and stands strategically at the exit point of Zone 2. Five paddocks have been rehabilitated and the first entry of cattle into the quarantine took place in April 2019.
- Shorobe is a well-designed facility with a central water tower that can potentially service all the water points. However, difficulty of access, very severe bush encroachment, a high degree of elephant activity, and extensive destruction of the previously existing fences with evidence of buffalo incursion during the site visit may render its rehabilitation as a QS inappropriate.
- Nokaneng is easily accessible and appropriately sited. However, on its own, it would be unable to service the high cattle population of the surrounding area due to its small size, aggravated by the fact that 50% of the area is infested with a lethal poisonous plant, *Dichapetalum cymosum* (mogau, gifblaar), making grazing there impossible in winter so that overgrazing of the rest becomes inevitable. Therefore, regeneration of this facility, even after bush clearing, would need to be evaluated as a practical proposition.
- The inaccessibility of Kgomokwane suggests that its rehabilitation would present practical problems.
- An environmental management plan will need to be implemented to ensure sustainability (see Section 5.2 below).

5.2 Environmental management plan

Ideally, a quarantine facility should be small and allow for intensive/semi-intensive management of the animals to enable compliance with all applicable biosecurity measures, such as animal movement and contact; staff movement; control over feed, water and bedding and, importantly, also waste management. Quarantine facilities are most commonly used worldwide to manage disease risk when live animals are exported or imported for genetic material, sports, or as pets.

For areas such as Ngamiland, where quarantine is a routine trade requirement for export of beef to destinations that are free of FMD, large numbers of animals have to continuously pass through the facility to ensure sufficient stock flow to the export-approved abattoirs.

In order to provide sufficient grazing for such a large number of animals in a semi-arid environment such as Ngamiland, the quarantine facilities have to be very large properties subdivided into smaller paddocks, in which the grazing is efficiently managed to prevent degradation of the rangeland and consequent loss of condition by the cattle during the quarantine period. If grazing is to be the only source of feed for the quarantined cattle, the paddocks should be arranged and managed according to an environmental management plan developed with support from animal production and rangeland scientists. Although a generic stocking rate of 1 LSU/10 hectares has been used in the above calculation (see Section 5.1), grazing capacity is dynamic and varies according to rainfall timing and volume, grazing pressure, and rangeland condition. Ensuring availability of consistently adequate grazing through full implementation of the environmental management plan requires skilful management. Without excellent rangeland management, supplementary feeding of the cattle is likely to be necessary to prevent severe loss of condition.

A spatial analysis conducted with Landsat NDVI images (30m resolution) using median values derived from two years of satellite imagery sampled every ten days, evaluating percentage change in woody plant cover over 30 years, as well as applying a spectral unmixing technique using Sentinel 2 (optical) and 1 (radar) data at 10m resolution, revealed the following (Table 8 and Figure 10):

- Bush encroachment is most prominent in Shorobe (5.7% increase over 30 years) where the tree cover is also the highest at 48.8% of ground cover
- Bare ground cover is highest in Nokaneng (2.2%)

Based on this, the average number of cattle that can be kept per paddock ranges from 41 animals in Nokaneng to 70 animals in Shorobe. These figures must be updated based on actual biomass consumption and impact, and will fluctuate significantly based on rainfall and variation in range condition within paddocks. Still, with the number of enclosures and the estimated sustainable carrying capacity, the demand for cattle from the existing abattoirs in Ngamiland working at capacity ***far exceeds*** the supply capability of the QSs.

Table 8. Data on the property size and ground cover of Shorobe, Makalamabedi and Nokaneng quarantine stations in Ngamiland.

	Size (ha)	No. of paddocks	Average paddock (ha)	Paddock size range (ha)	Bush encroachment (%)	Bare ground cover (%)	Grass cover (%)	Tree cover (%)	*Estimated total number of cattle per facility	*Estimated average number of cattle per paddock
Shorobe	28,185	16	1,762	1,429-2,460	5.7	0.1	51.1	48.8	1,127	70
Makalamabedi	16,790	16	1,049	730-2,107	5.5	1.2	70.5	28.3	672	42
Nokaneng	6,117	6	1,020	774-1,381	4.5	2.2	72.4	25.4	245	41

*Recommended grazing capacity in Ngamiland range between 20-29 ha/LSU. The remote sensing data of this report estimated the average grazing capacity of the quarantine stations to be between 45-51 ha/LSU based on recent satellite imagery and calibration with known values from South Africa, which may be an underestimation. It does, however, reflect on the state of the rangeland in the enclosures. In this table a figure of 25ha/LSU was used for calculations.

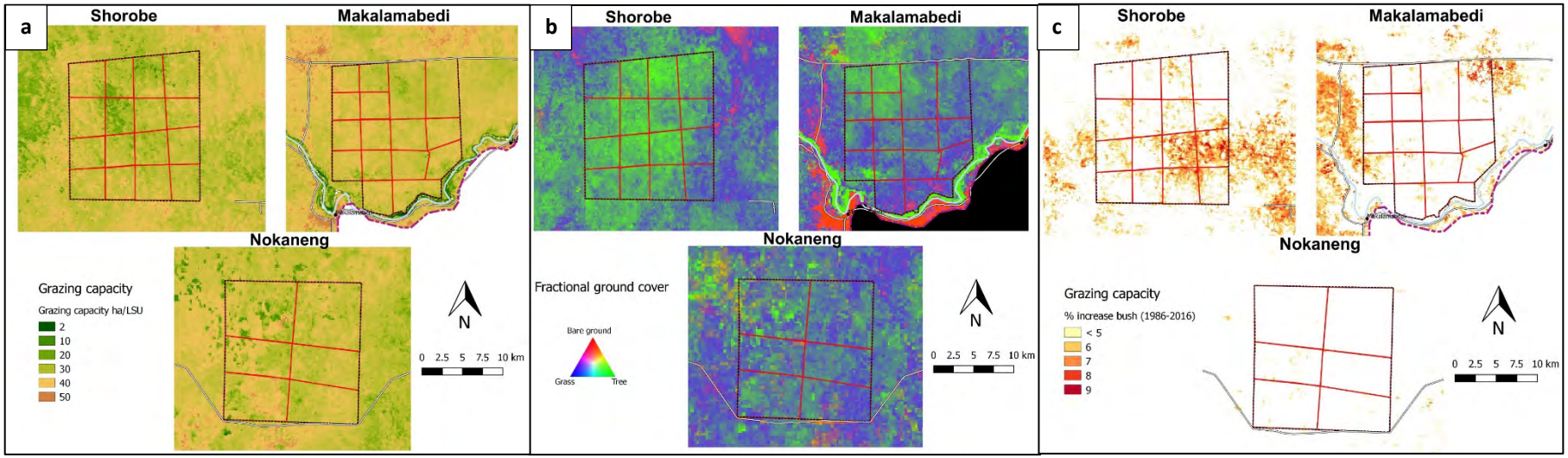

Figure 10. Maps of Shorobe, Makalamabedi, and Nokaneng quarantine stations in Ngamiland. Maps indicate spatial data of (a) grazing capacity, (b) fractional ground cover, and (c) percentage increase in bush encroachment between 1986-2016 (Z. Venter, 2018, H4H unpublished report).

The following factors will be essential to the Environmental Management Plan of a quarantine facility in Ngamiland:

- *Responsible authority*. DVS is the responsible authority for enforcing biosecurity measures at a quarantine facility (to comply with TAHC Article 8.8.22). However, in the case of a QS that requires intensive environmental management, such as grazing management and rangeland restoration, the mandate, expertise, and scope of work falls outside that of veterinary services. DVS would therefore require support with the necessary skills and resources to develop and implement an appropriate Environmental Management Plan. Ideally, an interdepartmental team that consists of veterinarians, animal production, and rangeland scientists should work collaboratively to ensure the required level of biosecurity and rangeland management. An alternative would be to outsource these responsibilities to stakeholders in the value chain to operate the QS on a commercial basis within a framework provided by the relevant government departments and audited and controlled by DVS. It is of importance to the producers as well as the abattoirs that receive animals from the quarantine facilities to add value to the animals. They could therefore invest in value addition through proper rangeland management during the quarantine period in order to ensure animal condition is at least maintained.

- *Paddock layout and capacity*. The system of paddocks within a demarcated quarantine facility in Ngamiland is of utmost importance for both rangeland management and animal supply to the abattoir. The paddock system should allow for continuous grazing by animal batch sizes equal to the abattoirs' daily requirement and should allow for adequate rest after each 30-day intensive grazing cycle in the growing season. Fenced corridors should connect paddocks with loading and receiving pens and handling facilities. Water distribution has to enable proper paddock set-up and rotation.

- *Rangeland restoration*. The skill and capacity should be available at the quarantine camp to plan and execute rangeland restoration. Many of the quarantine paddocks in Ngamiland have areas where bush encroachment strongly reduces the availability of grass. Dense thickets outcompete the grass layer, which gradually disappears. Soil erosion may occur in areas with a slope and active restoration of such sites is important to avoid the loss of top soil and increased rangeland deterioration.

- *Grazing capacity*. Grazing capacity is dynamic and varies according to rainfall timing and volume, grazing pressure, and rangeland condition. Proper rangeland management requires skill and dedicated, continuous monitoring and evaluation to enable adaptive management. In a QS it is of utmost importance that DVS receives advice to ensure alignment of decision making related to biosecurity and stock flow requirements with considerations for rangeland management (which paddocks to use when, how many animals can be stocked in a paddock for how long and how long paddocks need to rest). Generally, overgrazing takes place as soon as grazing capacity is set at a generic stocking rate across seasons and years that is not adapted based on the natural variation in rangeland condition.

- *Use of ecorangers*. It is recommended that in the Ngamiland QSs ecorangers be appointed to assist with proper animal handling, record keeping, rangeland restoration and rangeland management. Ecorangers are trained in these skills and through the *Ipalageng* Job Creation initiative of Botswana in association with initiatives such as the H4H programme they can add much value to the management of quarantine facilities. In instances where quarantine paddocks are too large, internal mobile paddocks can be used according to a grazing plan to ensure that both rangeland management and biosecurity measures are upheld while animal condition is not compromised. Ecorangers can use mobile paddocks to facilitate rangeland restoration and the improvement of rangeland condition in existing quarantine paddocks. Mobile paddocks are cheaper and more adaptable than fixed fences. A combination of fixed and mobile fences to ensure proper rangeland

restoration and rangeland management as facilitated by trained ecorangers can change the quarantine facilities into manageable units to the benefit of all concerned.

In summary, the following options should be considered to provide practical solutions to the need for enhanced QS capacity and optimal QS management:

- Enhancement of quarantine capacity through one or more of the options outlined in Section 5.3 below.
- Appointment of ecorangers to assist with proper animal handling, record keeping, rangeland restoration and rangeland management. They are trained in these skills and can be available through the *Ipalageng* Job Creation initiative of Botswana in association with initiatives such as the H4H programme.
- In instances where quarantine paddocks are too large, internal mobile paddocks can be used according to a grazing plan to ensure both rangeland management and biosecurity measures are upheld while animal condition is not compromised.

5.3 Identification of options/scenarios for fresh beef export without or with quarantine (please refer to Table 1 above)

5.3.1 No quarantine

In the absence of functional quarantine facilities, 'no quarantine' has been the only option for export of beef from Ngamiland. This option is appropriate for export markets that have an equivalent FMD status to Ngamiland, as well as for export of beef products that have been processed by methods recommended for the destruction of FMD virus (TAHC Article 8.8.31). The range of markets not requiring quarantine could be expanded through bilateral negotiation with trading partners in terms of beef produced in value chain-based systems that include maturation, deboning and removal of visible lymph nodes with pre- and post-slaughter risk mitigation, supported by a risk analysis if sought. Markets such as Angola could accept beef from Ngamiland because the whole of Angola is recognised by the OIE as a FMD-infected country. The same applies to Mozambique and DRC and several other countries in the region and beyond. Relatedly, the existing beef import permit for DRC does not stipulate pre-slaughter quarantine. Accessing a selection of such markets and supplying local consumption that does not require quarantine will help reduce bottlenecks for beef production in Ngamiland, as would the establishment or revival of meat processing facilities at abattoirs. However, some of the above markets for fresh beef are generally of lower value and competition with similar commodities such as Indian carabeef makes access to higher value markets both outside Botswana and in the green zones in Botswana an attractive alternative. That will, however, for the foreseeable future require quarantine. With establishment of a robust BAITS system that provides traceability throughout the process of production to slaughter or live trade, a range of quarantine scenarios could potentially be applied. Some alternatives appropriate for Ngamiland are described below and their advantages and disadvantages are summarised in Table 9.

5.3.2 Quarantine in designated government facilities

These facilities (i.e. Makalamabedi, Shorobe, Nokaneng, and Kgomokwane) have been most recently used for live trade to Zimbabwe. Infrastructure is severely compromised, bush encroachment severe, and predators (lion, spotted hyaena and leopard) are resident in Makalamabedi and Shorobe. In addition, the total throughput required by the existing three abattoirs cannot be satisfied by these facilities. That will create bottlenecks, potentially adversely affect the condition of marketed animals, and may increase the risk of FMD if biosecurity is not adequately implemented. To prevent this, SOPs should be followed in the quarantines (see Section 5.4 below).

Currently only one of the government facilities, Makalamabedi, is in the process of becoming functional again. More than one such facility would be needed to service the whole of Ngamiland. This implies high

government upgrade and maintenance expenditure. Ideally, animals would be sold on a live weight basis and transported by abattoirs, such as BMC, in batches for pre-slaughter quarantine in government facilities that would be managed by a single entity, e.g. a quarantine management committee. Compliance with quarantine requirements is easier with a single management entity but complicated if cattle are looked after by different owners, as was previously the case.

Constraints for this system would be additional costs for transport to and from quarantine, dependence for maintenance on slow government tender processes and public sector labour issues.

5.3.3 Quarantine in privately managed facilities

DVS has, in principal, approved the establishment of private quarantines in the Hainaveld farms, or at locations close to the two private abattoirs. To comply with OIE standards for export from zones not free from FMD, such facilities need to be controlled (i.e. approved and supervised) by DVS, which would add a significant burden to DVS activities, although it would be far less onerous than full operation of a QS. Facilities that are private sector driven and maintained, with a focus on profitability that depends on the cattle thriving, are likely to be managed in such a way as to avoid risks to animal health or condition. However, the high cost of development and maintenance as well as the financial risk to private quarantine operators might require insurance, and may result in lower prices to farmers to recoup the cost.

5.3.4 Quarantine-compliant feedlots

Quarantine-compliant feedlots could be achieved by separating the feedlot into an induction area and a feeding facility that are well separated and separately staffed. The time spent in a quarantine-compliant feedlot will vary according to the age and condition of the animals (as well as market requirements) but will always exceed the requisite quarantine period of 30 days. The induction area receives cattle, where they are vaccinated and fed an induction ration, are mobbed into small batches, and are effectively quarantined for 30 days. They are then released to a feeding facility, also providing effective quarantine, where they are revaccinated against FMD, grain-fed and finished. The quarantining would need to be supervised by DVS.

The system would improve consistency of supply to abattoirs, enable farmers to use their own transport to quarantine (weaners could be transported in smaller vehicles), and ensure better quality beef that could feed into the wildlife friendly beef model based on grass fed breeding herds with a grain fed final product. Potential constraints include lower price to farmers due to feed costs borne by the feedlot owner, financial risk to the feedlot owner and the need for good waste management, e.g. composting for fertiliser production.

5.3.5 Mobile quarantines

In areas where suitable grazing is identified, mobile fences and herding could be used to separate mobs of cattle from other cows. This should improve grazing, but DVS and farmers need to discuss acceptable protocols that are transparent and understood by both parties. DVS will need to provide the same level of control as for conventional quarantine, while compliance by the farmers will need education and training. An important consideration will be supply of water to the quarantined animals, as they will not be able to leave the mobile pen to visit water sources.

Mobile quarantines could become a private sector driven and DVS approved combination for trade in live animals and a range of products, from half carcasses to deboned beef, that will meet the demands of different markets and provide farmers with the opportunity to get the best prices for their animals. Educating farmers to develop and market better quality, young tender of beef with reduced seasonal variation will help farmers to become more resilient to the effects of climate in the short and long term.

The long-term development of a market that recognises Good Agricultural Practice and HACPP principles, and is willing to pay more for a wildlife friendly certified product, would be the ultimate target. This model

could be supported by mobile quarantines, privately managed feedlots and, where appropriate, mobile abattoirs (see Section 6.3.2).

Table 9. Comparison of quarantine options (all must be controlled by DVS to ensure compliance with OIE standards)*

Government		Private ownership	Private QS + feedlot	Mobile quarantines
Full government management	**Owners manage own cattle**			
Advantages: • Full compliance with OIE control requirement • Potential for high level of biosecurity	Advantages: • Saving for government	Advantages: • Higher potential for efficient operation • If linked to an abattoir can eliminate double transport costs	Advantages: • As for private • Eliminates problem of insufficient grazing • Improves quality of animals slaughtered • Assures consistency of supply of cattle for slaughter (no seasonal effect)	Advantages: • Eliminates double transport costs • Managed by farmers on own farms • Many less accessible areas can be serviced • If linked to mobile abattoirs can eliminate transport costs • Can be used to improve rangeland management
Disadvantages: • High cost to government (must employ and house additional staff) • Maintenance subject to bureaucratic delays	Disadvantages: • Biosecurity breaches likely • High investments by owners in time or salaries	Disadvantages: • Financial risk to owner	Disadvantages: • Financial risk to owner • Dependent on a steady supply of cattle and safe high quality feed	Disadvantages: • Lack of models and guidelines

* Shared potential disadvantages such as not having sufficient grazing (with the exception of the option that includes a feedlot) are not included in the table.

5.4 Biosecurity

5.4.1 Biosecurity of existing QSs in Ngamiland

As indicated in Section 5.1, Makalamabedi is the only government station that is currently partly operational, so it serves as the basis for this section.

A ten-page document entitled 'Procedure for Arrival of Animals into a Quarantine Station' (SOP Number DVS-OCp-Doc: 046, dated 23 November, 2017) and 'FMD Contingency Plan for Botswana' provide the available documentation concerning quarantine for FMD in Botswana. The title of the first document is somewhat misleading because it deals with some aspects of biosecurity management that go beyond arrival procedure, i.e. other management issues are also addressed. However, in addition to this document a basic biosecurity plan needs to be developed that provides details on the day-to-day management and maintenance activities essential for the effective biosecurity of QSs. Accordingly, considerations to ensure appropriate biosecurity of identified biological hazards and risk mitigation measures are discussed below.

Implementation of the biosecurity plan in the day-to-day management of the QS will require an adequate number of well-trained staff. The number of full-time staff appears to be inadequate to carry out inspection of the quarantined animals at the frequency stipulated in the current SOP, and in addition the staff will need to perform other routine tasks such as fence inspection and dealing with emergencies that can threaten the biosecurity of the QS such as mortalities that may occur, breaches in the perimeter fence due to elephant or other damage, or an outbreak of FMD in the QS. An accurate assessment of the number of staff required for the holding capacity and the level of training they should have should be made.

The document DVS-OCp-DOC: 046 quotes the OIE's definition for a QS, which is provided in Box 1.

Box 1: OIE definition of a quarantine station

Quarantine Station: an establishment under the control of the veterinary authority where animals are maintained in isolation with no direct or indirect contact with other animals, to ensure that there is no transmission of specific pathogenic agents outside the establishment where the animals are undergoing observation for a specified length of time and, if appropriate, testing or treatment.

The 'animals' with which there should be no contact are in this case animals that are susceptible to FMD.[7] It is also clear in terms of ensuring 'that there no transmission of specific pathogenic agents outside the establishment' that the definition refers to an import facility and not a facility primarily designed to protect the animals against transmission of FMD virus into the QS from outside the establishment. However, to comply with the requirement for preventing direct or indirect contact between quarantined and other ruminants, the QS must be proof against either incursions or escapes.

There are at least two considerations in ensuring the functionality of a QS, *viz*. (1) the location, design and physical state of the facility and (2) management measures implemented within the QS to ensure appropriate biosecurity in respect of identified biological hazards. In this case the primary biosecurity concern is FMD. The most important biological hazards that have to be considered are (i) contact with infected cattle or other domestic cloven-hoofed livestock, (ii) contact with infected wildlife species, in particular African buffalo, and (iii) contact with fomites and/or people contaminated with FMD virus.

Contact with infected cattle or other cloven-hoofed domestic livestock

The main focus will be on cattle and goats, as sheep and pigs are scarce or absent from Ngamiland. Contact with infected cattle or goats could occur either through intentional introduction of cattle into the QS or through accidental contact with local cattle/goats that happened to be infected due to breaches in the integrity of the perimeter fence.

Contact with infected wildlife species

Elephant and human damage to fences has been reported to occur widely in Ngamiland, including at Makalamabedi, and incursions of wildlife, including buffalo at some of the QSs, has been observed. Although the presence of cattle and human activity might be a deterrent for wildlife, breaches in the perimeter fence including those caused by humans are the most important biological hazard in terms of FMD.

[7] The OIE definition of animals in the TAHC is 'mammals, birds, reptiles and bees', which clearly does not apply in the case of FMD.

Contact with contaminated fomites

Humans who have been in direct or indirect contact with infected cattle can be a source of infection for the quarantined cattle. Other sources of infection could be contaminated equipment. Lack of adequate grazing capacity, identified elsewhere in this section, is likely to necessitate supplementary feeding, and contaminated feed could provide another potential source of infection.

Risk mitigation measures

Article 8.8.22 of the OIE TAHC specifies that an official vaccination programme against FMD should be in place in the country or area of origin and that cattle presented for slaughter for export should have been vaccinated at least twice, with the last vaccination not more than six months and not less than one month before slaughter. In Botswana, cattle are not accepted at a QS without proof of vaccination on at least two occasions, the last one less than six months ago. Cattle should be revaccinated upon entry into quarantine, one month prior to slaughter, reducing the probability of virus circulation. The following additional measures should be in place to prevent direct contact and to a lesser extent indirect contact between different groups of cattle:

- Separation of batches (the SOP specifies an 'all-in-all-out system' for paddocks if possible).
- Each paddock should have its own water point, sited so as to avoid contact between animals from different paddocks when drinking, that receives water directly from the piped system.
- Ideally adjacent paddocks should be separated by double fencing. Given the cost of fencing, mobile fencing could be used to achieve the same effect.
- Cattle should be moved to handling facilities and loading ramps along corridors that prevent direct contact between batches during the moving process.
- Pre-slaughter QSs should not be used for other purposes such as artificial insemination stations or quarantine of breeding stock imported into Ngamiland.

It will be important to have a system in place to facilitate the early detection and repair of any breaches. The risk of elephant damage can be reduced by the creation of moats (deep trenches) in areas at high risk from elephants, and the presence of resident personnel trained to observe any signs of wildlife incursion, not only into the QS but into the area surrounding the QS so as to allow for protective measures to scare wildlife away.

Training in biosecurity principles and practice should include but not be limited to detailed instruction on what to do in the case of (i) cattle mortalities occurring in the QS, (ii) the immediate set of actions should FMD be detected in the QS, and (iii) actions necessary following other incidents that threaten biosecurity, e.g. elephant incursion resulting in fence breakages.

Prevention of contact with potentially contaminated people and inanimate fomites depends on good management:

- Access to the QS should be limited to QS personnel and to members of the veterinary services.
- Further training of the Principal Technical Officer and staff will be necessary to ensure that they understand the reasons for and the tasks essential to the running of a QS.[8]
- If it is seen to be necessary to allow cattle producers or their employees to participate in care of the quarantined cattle, they will also need to undergo training as above, and to understand that they cannot move freely between farms and the QS.
- Disinfection facilities should be available at the entrance to the QS as well as to the paddocks, and the staff should be provided with dedicated overalls, boots and other needed animal handling

[8] The need for this was identified during a DVS training session held in Maun in September 2018.

devices that do not leave the premises and should be changed between paddocks if QS personnel have to work in more than one paddock.
- Feed required for supplementing the cattle should be obtained by the quarantine management from sources that are known to be safe.

In addition to the above, it is imperative that toilet facilities for personnel should be provided and easily accessible. A simple office would facilitate performance of administrative duties and storage of documents.

Finally, as the number of cattle entering quarantine increases, it is likely that the workload for effectively running Makalamabedi QS will require more than the current personnel of 13 people, i.e. a Principal Veterinary Officer and 12 assistants. For example, DVS-OCp-DOC: 046 stipulates that all animals should be individually examined weekly and also 'in the field' between weekly physical inspections. It is recommended that the biosecurity plan reconsider personnel allocation as the current allocation appears to be inadequate.

5.4.2 Biosecurity in non-governmental quarantine stations

There are currently no private QSs in Ngamiland. The OIE does not stipulate that QSs have to be owned and/or operated by the official veterinary services, but does stipulate that DVS should exercise control over them. How this control should be exercised would need to be determined by DVS in consultation with the private facility operators. The biosecurity systems in place would not differ from those required for government-operated QSs, since like them they should be based on the OIE definition that requires prevention of direct or indirect contact between the quarantined population and any other animals. Additionally, they would need to comply with the vaccination and inspection requirements aimed at preventing FMD in the QS.

One of the main advantages of privately owned and operated QSs that might also operate as feedlots is that they would take some of the burden of the quarantine requirement off of the government's shoulders and might even increase the efficiency of the system. Staff of a private quarantine or quarantine/feedlot could be trained by the veterinary services to perform the day-to-day monitoring of the cattle. As they would be employed by the quarantine operator and the facilities would likely be smaller than the government QSs, it would be relatively easy to put all of the biosecurity measures necessary for decontamination of personnel that are listed in the QS SOP (DVS-OCp-Doc: 046) in place and to enforce their use. The services that would need to be provided by DVS would likely include:

- Ensuring that any necessary SOPs are provided and explained to the quarantine owner/manager.
- Assessing and approving biosecurity plans and SOPs developed by the quarantine owner/manager.
- Entry and exit inspection of cattle.
- Revaccination of cattle on entry.
- Training quarantine staff in biosecurity practices and in handling and inspection of the cattle for FMD.
- Training quarantine staff in the use of the BAITS system.
- Clinical and post mortem examinations when necessary (these could also potentially be done by a private veterinarian reporting to DVS).
- Monitoring compliance through regular visits during which all records and reports are examined, and the general health/condition of the animals is assessed.
- Where deficiencies are discovered, recommending corrective actions with a time limit and revisiting the facility to ensure compliance.

Feedlots operating as quarantines would need to function as described in Section 5.3.4. In addition to all the requirements according to DVS-OCp-Doc: 046, the following considerations would be important:

- Strict separation between the induction camp and the feeding camps must be assured – no nose to nose contact between groups, no shared personnel or equipment and strict decontamination of both on leaving the induction camp.
- Assured sources of feed that poses no risk of transmission of FMD virus or other pathogens.

As indicated previously, mobile quarantines would be a new venture. While biosecurity systems would need to provide the same protection from FMD as conventional facilities, successfully applying biosecurity measures in farmer-operated systems would likely require specific SOPs developed in collaboration with the farmers who would implement them. Veterinary control would remain a requirement, but how it would be practically exercised would have to be determined by DVS and the farmers. Mobile quarantines would contain relatively low numbers of cattle so that an outbreak of FMD would have a relatively low impact and would perhaps even be more easily controlled than if it had occurred among free-ranging cattle. The use of mobile abattoirs (see Section 6.3.2 below) would further reduce any risk posed by these facilities, as cattle would not need to be moved to distant destinations.

5.5 Compliance

To export CBT beef under the quarantine requirement of TAHC Article 8.8.22, the quarantine facility must comply with the OIE definition of a QS, which, as stated elsewhere, stipulates:

- The QS must be under the control of the Competent Authority (DVS).
- There should be no direct or indirect contact between the quarantined animal population and any other FMD-susceptible animals.

The holding period for pre-slaughter quarantine for FMD is 30 days (TAHC Article 8.8.22). Compliance requirements for non-government operated QSs under the required control by DVS have been outlined in Section 5.4.2

No quarantine is required for export of fresh beef to other FMD-infected countries or zones (equivalent FMD status to Ngamiland) or for beef products that have been processed in such a way as to destroy FMD virus (TAHC Article 8.8.31). The reader is again referred back to Table 1.

6. ABATTOIRS

The Livestock and Meat Industries Act of 1962, with several subsequent updates, provides for the slaughter of domestic livestock, and the control of operations at abattoirs, slaughter slabs, cold storage facilities, and meat processing and canning plants. Slaughter of animals for commercial sale is only permitted at registered abattoirs, under the supervision of DVS. Three such abattoirs currently operate in Ngamiland, namely the government run BMC-Maun abattoir and two private ones, namely Ngamiland Abattoir and Batawana Beef. A community run abattoir at Sehithwa and a municipal one at Gumare have also been proposed.

6.1 Infrastructure and operational situation

6.1.1 Government abattoirs

BMC-Maun

The plant has a capacity of 120 head a day and contains a lairage, abattoir, deboning room, chiller, a meat cooker (no longer functional), and can make carcass meal. There is a small in-house laboratory for microbial analysis. No other laboratory services are available in Ngamiland. It is open for 10.5 months of the year,

with an annual closure of six weeks for maintenance. In the past it exported chilled, deboned[9] and matured beef intermittently into the FMD-free green zones of Botswana for domestic consumption, but after the 2017 outbreak, this was stopped (to meet EU export requirements for green zone beef). Today, all deboned beef destined for the green zone domestic market needs to follow TAHC Article 8.8.22 and include quarantine. BMC-Maun is, however, exporting to DRC and has also exported product to Kuwait and Vietnam. Carcass meal is exported to Zambia and Zimbabwe. The abattoir has ISO certification (an internationally recognised Quality Management System). Cattle deliveries are controlled by a quota committee.

In 2016, when Ngamiland was free of FMD outbreaks for nine months, BMC-Maun slaughtered 20,000 cattle, but figures have mostly been lower since then owing to prolonged closures due to FMD outbreaks, exacerbated by extending the closure to undertake the annual 6-week scheduled maintenance immediately after the end of the outbreak had been announced and the ban on cattle movement lifted. In addition, delays in payment to farmers after slaughter (sometimes four to five months), and disputes between BMC and farmers over future pricing once quarantine is established (http://www.sundaystandard.info/ngamiland-farmers-boycott-bmc-over-low-purchase-prices), have led to farmer reluctance to sell their animals to BMC. The price dispute is, however, more likely linked to limited understanding by farmers on how to calculate prices on a live weight versus carcass weight basis (also see Section 6.4 below).

BMC-Maun has been government subsidised and it is anticipated that it will continue to be supported by the GoB with an annual budget for the near future (the procedure is unclear but is actually part of the National Strategy to privatise the BMC).

6.1.2 Private abattoirs

Ngamiland Abattoir

Ngamiland Abattoir is located between Komana village and the Sitatunga area outside Maun. The current capacity of the abattoir is approximately 100 head per day, which was achieved once a new deboning plant was commissioned (prior to this, deboning caused a bottleneck in the numbers of animals that could be slaughtered daily). The abattoir slaughters five days per week for export to DRC via Zambia as well as for the Maun domestic market. Service slaughter for the local market is also offered for a fee (P350 per carcass in 2018, raised to P390 in 2019).

Access to a wider range of export markets is envisaged through the adoption of HACCP/CBT processes and importer certification requirements are being researched (for example, the Angolan market requires SGS [Societé Générale de Surveillance] certification). FMD outbreak response-mandated cessation of cattle movements, resulting in closure of abattoirs, of course has an extremely negative impact on private enterprises like Ngamiland Abattoir.

In the last quarter of 2018, the abattoir noted it had a monthly quota of 60 tonnes with DRC but that it had only been able to manage 24 tonnes due to challenges sourcing cattle. These challenges could be due to several factors, including: (i) the price differential between BMC and the private abattoirs and/or (ii) delayed payments to farmers. When the abattoir initially opened, it would pay farmers immediately. However, payment is now within 2-3 weeks. This is still considerably faster than BMC, but slower nonetheless than previously. Seasonal factors also contribute to the shortage of cattle for slaughter.

Batawana Beef

The recently constructed abattoir is located just outside Toteng. It was granted permission to operate with the first day of slaughter on 19 March 2018 after some drainage issues had been resolved. Slaughter floor staff were still being trained when visited by the project team in mid-2018 and the abattoir was therefore

[9] +/- deglanded (unclear at what time deglanding was instituted at BMC).

operating under capacity. With training completed, slaughter capacity is estimated to be around 70 head per day. Some export is being undertaken to DRC, and the abattoir offers service slaughter for the local market for a fee of P350 per carcass.

6.2 Distribution of abattoirs in relation to cattle, markets and quarantines

Two of the abattoirs, BMC-Maun and Ngamiland Abattoir, are situated in and on the outskirts of Maun respectively. The third abattoir, Batawana Beef, is situated near Toteng 65 km southwest of Maun on the A3 to Sehithwa. The only functional QS, Makalamabedi, is 100 km from Maun in a south-easterly direction. According to a map showing the cattle distribution before the 1996 elimination of the population due to CBPP (Figure 11), the highest numbers of cattle were found between Nokaneng and Seronga, with smaller concentrations at Shakawe and Sehithwa (Scott Wilson, 2000). It is unlikely that this pattern would have changed because cattle production is strongly dependent on the availability of water (Bendsen, 2002).

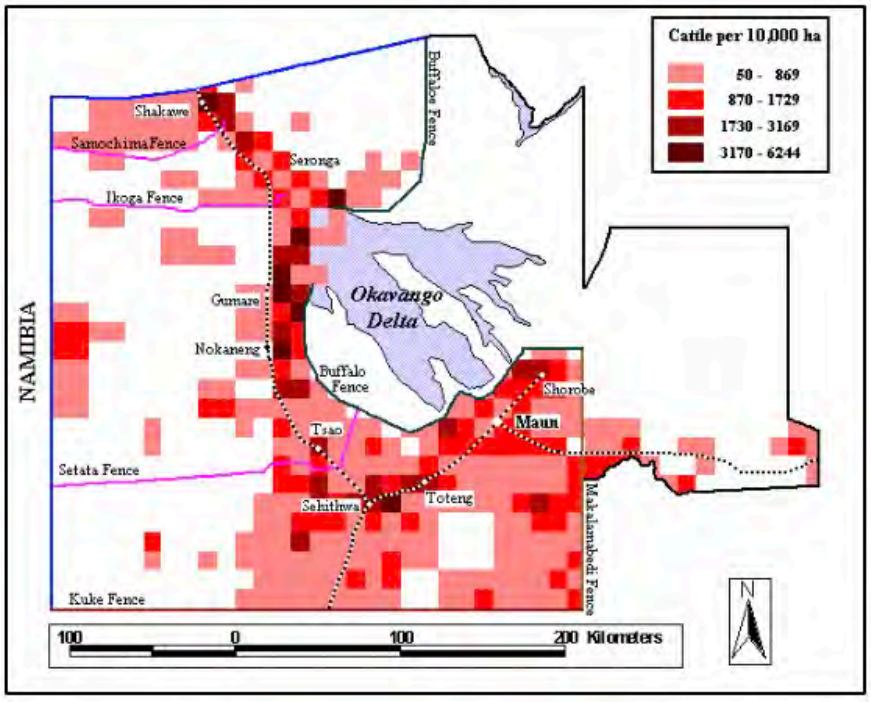

Figure 11. Cattle distribution in Ngamiland pre-CBPP in 1995. Source: Scott Wilson, 2000.

The location of the abattoirs in the south of the district means that cattle producers from the north-western part of the district, where there is a large population of cattle, are disadvantaged by their distance from the abattoirs. The quarantine requirement exacerbated their situation, since their cattle need to go to Makalamabedi QS, adding a minimum of 200 km to the journey from the area of production to the QS and then to an abattoir. Producers in Shakawe are located 450 km from Makalamabedi QS and those from Seronga must travel up to 560 km or more. Rehabilitation of the Kgomokwane QS near Shakawe would alleviate the problem of the additional distance to Makalamabedi but is likely to prove impractical due to the prevailing state of disrepair and high cost of making the QS operational. Furthermore, the relief afforded by a QS nearer to Shakawe will depend on who will be responsible for the transport costs from the QS to the abattoir. If farmers are required to maintain ownership of their cattle during quarantine (versus selling live weight at the site of production) and still need to arrange and pay for transport of the cattle to the abattoirs located near Maun after the quarantine process is completed, the only relief will be elimination of the extra cost of transporting the cattle to and from the QS. Conversely, if the abattoirs buy cattle from the areas of production, they may need to recover transport costs through their costing structure to farmers. This situation is not unique to Ngamiland. The distribution of the QS and abattoirs relative to producers has proven a

significant barrier to equitable participation in formal trade in similar areas elsewhere, such as in the Zambezi Region of Namibia, where distances were much shorter (van Rooyen, 2017). Typically, only the largest farmers can absorb the high transactional costs. If the introduction of mobile abattoirs (see below) proves feasible, these, in combination with a mobile QS, could provide much greater inclusivity for small-scale producers (see Section 6.3.2).

6.3. Alternatives

6.3.1 Potential and/or proposed abattoirs

A multi-species community-owned abattoir that would slaughter cattle, small stock and donkeys primarily from the Sehithwa communal area has been proposed by the Nhabe Agricultural Management Association. A feasibility study, funded by the United Nations Development Programme's Sustainable Lands Management project, was completed in 2018; however, an EIA still needs to be undertaken and P70 million is required in capital investment (http://www.weekendpost.co.bw/wp-news-details.php?nid=5713). Planning permission has also been granted for a municipal abattoir in Gumare, but as yet this has not been constructed.

6.3.2 Mobile abattoirs

An initiative under investigation in other parts of southern Africa (e.g. South Africa and Namibia) is the use of mobile abattoirs, the idea being to provide slaughter facilities for cattle-owning communities located in areas with poor access to established abattoirs. Photographs of a prototype developed in South Africa are shown in Figure 12. Upgrading of the system shown is in progress.

Figure 12. Mobile abattoir unit with associated stunning crush and refrigerated truck for transportation of carcasses.

Mobile abattoirs allow those producers that are furthest from the market (and smallest scale) to still participate in the market. The core principle is that it is easier to move and disinfect a mobile abattoir than it is to move animals. The system is spatially and temporally flexible and does not require heavy operating costs that would be compromised in the event of a market shutdown or reduction in supply.

In the context of Ngamiland, mobile abattoirs may be most appropriate on the periphery of the delta and for small-scale farmers who have smaller herds. The use of mobile abattoirs could also be considered for use in sub-zones of the District (i.e. 2e and 2f) which are or are intended to be 'FMD-free protection zones with vaccination', whereas the other sub-zones (2a, 2b, 2c and 2d) are considered FMD-infected zones with vaccination (FMD Contingency Plan for Botswana, Revision 4, 2015). It is recognised in SOP: DVS_OCp_Doc:046 that cattle derived from localities of different FMD status should not be quarantined in the same facility. Consequently, in the absence of functional quarantine facilities for sub-zones 2e and 2f, an alternative arrangement may be advisable. This could include use of associated mobile QSs. Mobile abattoirs could also be considered to provide an approved service in areas where smallholder farmers are unable to afford the cost of transporting their cattle to the existing abattoirs situated in and around Maun. The meat could be sold locally and to zones or countries of equivalent status, or if combined with a mobile QS could be processed in Maun for sale to a wider range of markets. It has been suggested that potential

regulatory issues in connection with mobile abattoirs might be overcome if the mobile abattoirs are linked to existing abattoirs and operate as satellite facilities.

While mobile abattoirs have obvious potential advantages, they also have limitations that are currently being addressed, with a view to minimising them. Current limitations include the need for a cement slab on which the mobile abattoir needs to be parked, limited daily capacity, need for adequate potable water and power supplies, as well as issues related to safe liquid and solid waste disposal. At present, these constraints mean mobile abattoirs have limited reach, but future developments are likely to improve this situation.

A trial on the western periphery of Kruger National Park has had some success and benefited from the proximity of a processing plant that could monitor critical control points, such as pH. A ready market in the tourism facilities of the park itself has also been key. The pilot has also benefited from a very close collaboration with the official veterinary services and conservation organisations. This initiative by the H4H programme and Meat Naturally has enabled farmers in a FMD protection zone to receive market-related prices for their beef. Participating farmers commit to complying with a set of requirements (i.e. producer protocol/conservation agreement as described in Section 3.1) and in return, market access is facilitated by mobile abattoir technology. While still in the pilot phase, CBT-adopting cattle farmers now earn up to twice as much per animal and enjoy local market access despite an ongoing FMD outbreak.

6.4 Operational issues for abattoirs

In order to function optimally, abattoirs need a consistent supply of cattle as well as suitable markets for the beef that they produce. Markets also require consistency, so interruptions in the operation of abattoirs pose the risk of loss of market access.

FMD outbreaks and fluctuations in the supply of cattle are thus the most important threats for Ngamiland's abattoirs. Recurrent FMD outbreaks since 2007 have resulted in prolonged closure of the abattoirs due to bans on cattle movement that have lasted up to six months or longer. The fact that BMC-Maun is subsidised by the government reduces some of the impact of FMD outbreaks, but cannot prevent reduced market access. For the private abattoirs that have recently started operations in Ngamiland, the threat is far greater that they will go out of business altogether.

Seasonal fluctuations in supply of cattle are experienced in most semi-arid areas where they are reared in extensive rangeland systems, due to loss of condition that occurs during the dry season and consequent reluctance on the part of the owners to sell. This decline in supply can be offset by supplementary feeding or finishing of the cattle in feedlots. The problem is likely compounded by the traditional oxen production system because there is no age limit on keeping the animals. Other contributing factors are that the siting of the abattoirs around Maun means that they are mostly competing for a relatively small part of the cattle population of Ngamiland. Farmers in more distant areas are often discouraged by the high cost of transporting their cattle to the abattoirs and prefer to sell them locally. The quota system operated by BMC-Maun may also be a contributing factor, although alternative arrangements are made during times of scarcity. At such times buying points are established at various locations and producers are invited to provide cattle for slaughter. Availability of cattle also decreases during vaccination campaigns because the exercise consumes farmers' time. Finally, poor communication, price differentials and lack of a consistent and readily accessible market information system may also be a deterrent for farmers. These constraints have been exacerbated by the difficulties experienced in the roll-out of BAITS, as described in Section 3.2.

When there are sufficient cattle to satisfy export quotas, currently mainly to DRC, abattoir capacity for slaughter for local sales is reduced. BMC-Maun's quota system precludes *ad hoc* sales for local use when money is needed and the service fees of P350-P390 charged by the private abattoirs may act as a deterrent.

Market differentiation

It is expected that abattoirs in Ngamiland will be selling beef to markets that require quarantine and markets that do not. Strict separation of batches emanating from QSs and batches coming directly from the field will be necessary, supported by documented guidelines to reassure markets that there is full compliance with their particular requirements.

Understanding pricing

As noted above in Section 6.1.1, disputes between farmers and BMC's Maun abattoir over future pricing once quarantine is established may be linked to limited understanding by farmers on how to calculate prices on a live weight versus carcass weight basis. This is generally a very misunderstood part of beef production in Botswana. Working out prices to compare return is essential to making profitable decisions. All prices should ideally be worked back to the live weight value on the farm. A simple formularized Excel model (Figure 13) could assist in explaining such calculations, i.e. changes to any of the green blocks allow different pricing scenarios to be determined.

		Weight	CDM %	Price
	Ox 1	450	0.48	19.50
Transport	300			
CDM	216			
Abattoir Return	4212			
Less Transport	3912			
Liveweight Return	8.69			

Figure 13. Simple live weight return model*

* In Botswana, carcasses are typically weighed as hot dressed mass on the slaughter line and 3% deducted to give the cold dressed mass (CDM). CDM % represents the meat and skeletal portion of an animal compared to its live weight and accounting for 3% carcass shrinkage.

Producers also need to understand what risks they would take on under different scenarios. For example, when cattle are purchased on a carcass weight basis, much of the risk falls on the producer i.e. losses during transport (injury, bruising, death), carcass downgrades (measles) and potentially additional transport costs from the quarantine to the abattoir. However, if cattle are sold live on the farm, using the above scenario, it is easy to see that the producer would be better off selling at P9.00 per kg (i.e. the live weight return) than risking the above for P19.50 per kg carcass weight.

6.5 HACCP compliance for CBT in abattoirs

As a means to protect the food supply, HACCP has been adopted by the food industries, and also by regulatory agencies around the world. The primary objective of HACCP is to conduct a systematic analysis of the value chain to identify biological, chemical or physical hazards that are reasonably likely to occur, and to determine respective controls for any hazards that have been identified for the specific food product/production process. HACCP plans are developed by creating a detailed and accurate value chain flow diagram that includes all steps, as well as all inputs (ingredients and packaging) and outputs (by-products and waste). The subsequent step is to perform a hazard analysis for each step to determine if biological, chemical or physical hazards are introduced, enhanced, or controlled at each step. Steps in the process that serve as controls for the identified significant hazards may be identified as Critical Control Points. These Critical Control Points must have predetermined critical limits, monitoring methods, corrective actions, verification and validation protocols, and finally, record keeping. This constitutes the contents of the HACCP plan for a specific food and for a specific facility. Separate HACCP plans for different food products and even different locations are required. Depending on the production methods of a particular facility

location, foods may have different hazards and subsequently different Critical Control Points. More recently, HACCP concepts have been applied to quality focus programmes, such as Safe Quality Foods as well as part of specific ISO programme requirements – and most recently as the basis for Preventive Controls. An essential part of HACCP programmes is to have current and comprehensive prerequisite programmes that control for potential hazards that should be controlled by Good Manufacturing Practices as well as effective sanitation operating procedures.

Numerous countries have HACCP requirements for imported foods, which require the exporting countries to produce the food under those requirements. Although the majority of food safety concerns are bacterial and parasitic pathogens, the same principles can be used to control viral animal disease safety risks, including FMD.

Abattoir site visits

As a means to assess the current HACCP and prerequisite compliance of Ngamiland's abattoirs, site visits to perform mock food safety audits and implementation assessments were conducted in August 2018. Three abattoirs of varying size and age were visited (see also Section 6.1). Overall, all three facilities were new or newly renovated. The largest facility, BMC-Maun, was well established in having a HACCP plan and ensuring the implementation, and meeting the requirements, of its HACCP plan. This facility would likely be able to meet the HACCP requirements for export markets, assuming adequate control of FMD was in place. A complete assessment of BMC-Maun's production practices was not possible due to the closure of the facility. The assessment undertaken was based on site visits during non-slaughter production visits, and through discussions with HACCP-responsible personnel and the plant manager. The high throughput facility had recently been renovated and the equipment was relatively modern, and the plant was not having any significant problems. The facility appears to have good carcass flow that prevents cross contamination from the slaughter side of the production system to the cutting and deboning side.

The remaining two smaller abattoirs did not have HACCP plans developed for their facilities. One of the smaller abattoirs, Ngamiland Abattoir, had been in operation for more than a year, and had comprehensive prerequisite programmes developed and written SOPs for the prerequisite programmes which would contribute towards developing a HACCP plan. The records for each of the prerequisite programmes were being monitored and the monitoring records included critical limits for each prerequisite SOP, as well as corrective actions for when critical limits were not being met. The slaughter line and deboning personnel were observed during production and did not have any Good Manufacturing Practices deficiencies during the observation period. Each employee had clean working clothes and footwear that were in good repair. The facility had minor issues such as minor floor cracks, but the equipment was in good condition and appeared to be clean due to their effective cleaning and sanitation procedures. It appeared that the facility makes significant efforts to comply with their prescribed prerequisite programmes. The facility had a linear flow during slaughter, as well as clear separation for condemned carcasses. The deboning area was separate from the rest of the facility, and the employees were designated for this area only. Based on the assessment of the facility, practices, and existing prerequisite programmes and monitoring, this facility would only require formal HACCP certification for selected employees, development and implementation of a HACCP plan or plans by these trained employees, and a facility HACCP certification (an optional and country/company specific requirement) to produce beef under HACCP. In short, relatively minor financial investments would be required if they wanted to seek markets that require the production of beef under HACCP.

The third and newest abattoir, Batawana Beef, had only been in operation for approximately three months. The facility was newly constructed and based on modern abattoir facility plans. This facility did not have any written SOPs for their prerequisite programmes and did not have a HACCP plan. The plant manager was responsible for implementing the prerequisite programmes but was not producing any written records for the prerequisites. Basic requirements such as thermometers in walk-in chillers were absent, but the plant manager indicated that the company was installing an electronic data acquisition system for their cold

rooms and freezers. Despite having relatively new slaughter line personnel, the workers appeared to comply with the prerequisite programmes set forth by the plant manager. A significant investment of personnel time would be required to develop written SOPs, as well as the monitoring records associated with each prerequisite. Additional equipment such as thermometers, certified thermometers, pH meters, etc., would be required to comply with the requirements of OIE TAHC 8.8.22. After the prerequisite SOPs and monitoring have been implemented, the facility could focus on HACCP compliance requirements to produce HACCP certified product.

Specific to the smaller abattoirs were additional hurdles that include sufficient potable water, waste water treatment and recirculation, condemned product and waste disposal, and a reliable and adequate power supply.

6.6 Biosafety

The general aspects of hygiene and biosafety are covered by legislation, *viz*. the Livestock and Meat Industry Act (2007) (Meat Inspection and Control of Red Meat Abattoir) Regulations, that include:

- Health, personal hygiene and good handling practices of persons working in the abattoir
- Structure, cleaning and disinfection of the plant (First Schedule)
- Cleaning and disinfection of vehicles (Second Schedule)
- Measures to prevent contamination of the facility or healthy animals awaiting slaughter by the introduction of a sick animal and measures to prevent contamination of carcasses or meat in the facility (Part II, Regulation 8; Part V, Regulations 16-24; Schedules 1-)
- Assurance of potable quality water for use in the plant (Schedules 1, 5)
- Drainage and ventilation
- Safe disposal of waste and condemned material (meat not fit for human consumption) (Part II, Regulation 5 (issue of licences), sub-regulation (6)
- Responsibilities (Director) and supervision (Part III, Regulation 9)

There is no mention of the implementation of a HACCP system in the legislation.

A number of issues that require attention were identified during site visits relating to potentially unsafe disposal of waste and condemned material:

- Heads were being sold from the BMC-Maun abattoir, posing a potential risk for FMD; during a second visit it was stated that this was no longer being done and the heads were being processed for carcass meal for use in fertiliser. However, the private abattoirs still sell heads; and in late 2018 the transport of heads was observed in Maun and upon enquiry, it was stated they had been purchased from BMC.
- Bones were being disposed of at the municipal dump by the two private abattoirs.
- Inedible meat (offal, intestines) from all the abattoirs was being disposed of at the municipal dump; this is potentially unsafe and not in line with legislation.

While the local council has since taken steps to try and manage the situation, forcing abattoirs to reduce the waste deposited at the municipal dump, this still needs to be monitored to ensure compliance.

Apart from Regulation 5, sub-regulation (6), the Regulations available in the public domain do not provide specific directions for disposal of solid waste and condemned material; there are directions for safe storage of such material until it is 'taken away'. Apart from directions for disposal of used water in septic tanks in lower throughput facilities, no description of on- or off-site facilities for disposal are provided. Schedule 17 relating to the transport of fresh meat does not include transport of waste/condemned material for disposal off-site.

6.7 Support for export approval for abattoirs

Approval of abattoirs for export is needed at three levels. Firstly, the exporting country may approve abattoirs for export subject to certain conditions. Secondly, importing countries require assurances of the safety of the product in order to approve the facility that produces them to supply them, subject to certification of the products by the Competent Authority of the exporting country. Thirdly, there are a number of optional standards that abattoirs and meat processing plants may comply with in order to obtain formal third-party certification (Theuvsen et al., 2007).

Legislation for the licensing of abattoirs is provided in the Livestock and Meat Industries Act of 2007 (Meat Inspection and Control of Red Meat Abattoir) Regulations. No distinction is made between export and non-export abattoirs, but the Control of Livestock Industry Act of 1941 (last amended by Act 32 of 1977) stipulates that meat for export must emanate from an export abattoir or from another facility under a permit from DVS, that suppliers of cattle to export abattoirs must be registered as such and must be allocated a quota to supply to a specific abattoir, and that the abattoir should have a total floor space of not less than 92 m^2. Construction of abattoirs capable of export is subject to prior written consent by the President and subject to any conditions imposed by the President.

Depending on the importer's level of confidence in the exporting country, the fact that an abattoir has been registered for export may suffice, but usually some form of inspection will take place when importers are exploring new markets. Importing countries may also impose higher standards than those required by the exporting country. The implementation of a HACCP system is not a legal requirement for registration of an export abattoir in Botswana, but many importers including the EU and South Africa require that a HACCP system must be in place. Currently, only BMC-Maun has ISO certification.

7. FURTHER PROCESSING AND PRODUCT DIVERSIFICATION

7.1 Use of by-products

Animal by-products, described in many parts of the world as the 'fifth quarter', are an important and potentially valuable aspect of livestock-based value chains. These include all parts of a live animal that are not part of the dressed carcass such as heart, liver, stomach, intestines, kidney, blood, fat, spleen, meat trimmings, hide, hooves, horns and glands. The classification of animal by-products differs from country to country but can be generally divided into edible by-products (non-carcass meat or offal) or inedible by-products (non-meat products, including discard). The potential uses of these animal by-products have been comprehensively reviewed (Alao et al., 2017 - http://www.mdpi.com/2071-1050/9/7/1089) so not all are repeated here. However, the development of industries around the fifth quarter, which is currently lacking in Ngamiland, could improve income along the value chain.

7.1.1 Edible by-products

Over 40% of livers are condemned at BMC-Maun due to liver fluke infestation, but all abattoirs are able to sell non-condemned livers, as well as fresh tripe (stomach) and kidneys to the local market. There is, however, no cooking plant in the district for processing offal. Heads are also sold locally at the two private abattoirs. BMC stated that it has discontinued this practice (late 2017) and instead utilises this animal by-product in its carcass meal production; however, as of late 2018, it appears they may have resumed the sale of heads – see Section 6.6 on Biosafety. Batawana Beef exports frozen offal to DRC, with plans to service the local Kasane market in future (Table 10).

Table 10. Summary of current use of animal by-products in Ngamiland.

Abattoir	Type of By-Product					
	Hides	**Heads**	**Tripe**	**Organs**	**Blood**	**Bone**
BMC- Maun	Dry salted (2018), landfill (2019)	Carcass meal	Sold locally	Sold locally	Carcass meal	Carcass meal
Ngamiland Abattoir	Dry salted (2018), landfill (2019)	Sold locally	Sold locally	Sold locally	Landfill	Landfill
Batawana Beef (current)	Dry salted (2018), landfill 2019	Sold locally	Frozen (DRC)	Frozen (DRC)	Landfill	Landfill
Batawana Beef (future)			10 kg boxes (Kasane)	10 kg boxes (Kasane)	Compost	

7.1.2 Inedible by-products

Pet food: Offal, together with bones and hooves, could be developed for production of pet food and pet products. Nearly 95% of pet food distributed and sold in Botswana comes from either Namibia or South Africa. This industry has potential for job creation. Currently there is significant wastage at all three abattoirs, with many by-products being discarded at the Maun landfill. Some of this waste could be processed into pet food products.

Meat and bone meal (animal feed & fertiliser): The use of meat and bone meal (MBM) is restricted in many countries due to health concerns over the transmission of BSE, also known as mad cow disease. Botswana's Diseases of Animals (Stock Feed) Regulations (2004) prohibit (i) feeding of MBM to certain livestock, and (ii) use of fertiliser that contains MBM where stock have uncontrolled access. These regulations further control the manufacturing, labelling and retail sale of MBM. Restrictions on the use of MBM are not the same in all southern African countries, and BMC-Maun, which is the only MBM (referred to locally as carcass meal) rendering plant in Ngamiland (Figure 14), exports this by-product to Zimbabwe and Zambia. However, bones are still discarded to the local landfill by both private abattoirs. The Maun landfill has, however, recently raised concerns over the amount of bone being dumped at the landfill. Consequently, abattoirs will need to consider alternative disposal options.

Figure 14. Carcass meal production at BMC-Maun.

Hides: Hides and other fifth quarter sales help offset abattoir running costs, and in early 2018, the majority of hides at the three abattoirs were sold as raw products. Hides from BMC-Maun were salted and processed

for export by Batawana Beef, together with their own hides. Ngamiland Abattoir also sold salted raw hides. However, hide prices globally have experienced substantial declines in the last year – prices in South Africa have dropped from around R150 per raw hide to R17.50 (F. Camphor, pers. comm., Mar 2019). Thus, their export is no longer financially viable and nearly all hides in Ngamiland are discarded as waste.

Leather processing does, however, have the potential to create employment in Ngamiland, but it typically requires the use of chemicals to treat and soften hides. These chemicals can contaminate water sources. As a case in point, BMC's Westblue tannery in Lobatse has been for sale for more than 10 years, following its closure in 2006 due to the long-term threat associated with the management of waste from the facility – particularly chromium that has leached into the underground water (Mmegi Online – http://www.mmegi.bw/index.php?sid=1&aid=330&dir=2011/April/Monday18). While BMC has floated tenders for business ventures to partner with them on an environmentally suitable and financially sustainable model of processing hides and skins, no willing buyer has come forward. Thus, consideration would need to be given to ensure that any tanneries developed are well contained to prevent a similar scenario happening in Ngamiland, especially given the location of the Okavango Delta. Small-scale artisan, vegetable tanning (conducted by a dry drum process, or in closed circuit vat) minimises waste, uses less water, and is more eco-friendly – something that might provide a niche market targeting high-end foreign tourists visiting Ngamiland. The grade of leather can be lower, but this is not always the case. Morocco produces some of the finest leather in the world using artisanal processes. More recently, other tanning methods have become available. Each has advantages and disadvantages. Thus, when choosing a tanning method, the environmental impacts as well as the properties of the finished leather need to be considered (UNIDO, 2013).

Zimbabwe's leather industries are a leading sector in the country's developing economy. A bench marking trip to Zimbabwe in 2018 by a member of the WFB project team identified numerous leather factories, and discussions with Zimbabwe's University of Science and Technology suggests they would welcome the idea of working with Ngamiland producers on leather skill development. However, branding of cattle affects the quality of hides. Hence there is a need to review the Branding of Cattle Act (Koloka & Moreki, 2010). Widescale implementation of the BAITS system would reduce the need for brand-based identification. In the interim, local tanning for production of products such as belts and shoes could likely be achieved.

Tallow: Research on livestock value chains from other parts of Africa suggests that improving the quality of hides produced and developing the value chain offers a more viable investment than exports of dried hides (Wanyoike et al. 2018). The same applies to harnessing and processing of tallow into an array of products that include soap, cooking oil and candles. In 2015, Botswana's Local Enterprise Authority, whose mandate is to identify business opportunities for uptake by small, micro and medium enterprises (SMMEs), commissioned a report to explore business opportunities related to beef by-products that SMMEs could invest in (LEA, 2015). It found that in Botswana tallow was mainly used for the manufacturing of soap, but the industry is still in its infancy and does not satisfy the local market as evidenced by high import values of P522 million in 2014 for soap, candles, and related products. Within Ngamiland, SMME development centred around soap and other tallow-related products, either for sale to wholesale markets or for production in smaller quantities aimed at high-end tourist lodges in northern Botswana, provides an opportunity that should be explored. Constraints in other parts of Africa, however, include significant competition with imported soaps from Asia. Therefore, niche markets would likely need to be identified.

7.1.3 Condemned/discarded parts

Animal feed industry: The use of black soldier fly larvae as a food source for chickens (the most expensive protein available at supermarkets in Ngamiland due to the distance from the market for feed) could also be considered by entrepreneurs using the blood, intestines, and rumen contents as the primary food source (RAID Australia - https://www.raidaustralia.net/index.php/news/item/228-black-soldier-fly-larvae-one-of-the-best-kept-secrets-of-sustainable-farming).

Bio-gas and organic fertilisers: Intestines represent additional processing costs since all abattoirs currently hire skips to transport waste to the municipal landfill. Intestines and intestinal tract contents could potentially be used for production of various products including bio-gas or organic fertiliser components. A plant in Gaborone (Organic Fertiliser Manufacturers Botswana) currently produces organic fertilisers that have demonstrated a viable market in the Pandamatenga farms in north-east Botswana. As part of its EIA, Batawana Beef is able to compost intestines, blood, and rumen contents for organic compost production. Development of environmentally friendly organic fertilisers in Ngamiland could further lead to job creation and economic development.

7.2 Further processing and value addition

Processing in the context used here is more properly known as 'secondary processing'; primary processing of meat entails only slaughter and dressing of carcasses. Secondary processing includes deboning carcasses, cutting into portions and cuts, and further value addition (e.g. cooking beef, production of fresh and canned sausages, salting and drying). A comprehensive overview of meat processing for small and medium enterprises is available (FAO, 2010).

7.2.1. Current processing in Ngamiland

Some export of dressed carcasses and deboned beef is currently taking place (permitted under World Trade Organisation Sanitary and Phytosanitary principles of equivalence and OIE TAHC Article 8.8.22 respectively). Opportunities also exist for further processing which could add value and expand the array of products eligible for export or for sale locally. However, further processing of beef is only currently being undertaken by a handful of operators. BMC had a cooking plant at its abattoir in Maun, but it is no longer operational. When it was, cooked beef was transported in brine to its facility in Lobatse, where the brine was discarded, and canned stewed steak produced under the ECCO brand. This was typically sold in the local market; however, transporting the product in brine from Ngamiland added to the cost. The two private abattoirs debone beef, but neither have additional cooking and processing facilities on site at present. Batawana Beef has indicated it is likely to develop a cooking plant to process cooked meat for the South African market.

In addition to the abattoirs there are three meat processing operators, namely: Beef Boys, Delta Meat Deli and Kalahari Meat Deli. All process whole carcasses for the tourism sector in Maun. Fillets are usually sourced locally but whole rumps, hindquarters and ribeye are sourced from the green zones from feedlot finished carcasses, except when carcass quality rises in Ngamiland from April to July. Indications are that about 150 tonnes per annum of deboned hind quarter cuts are imported from the green zones specifically for tourism companies (Bing et al., 2017). The meat processing operators also undertake further processing at a small scale, including production of breakfast beef sausage, boerewors, biltong, kebabs and salamis for the local market.

7.2.2. Potential opportunities for further processing

When it comes to processes that are able to inactivate (i.e. destroy) FMD virus, the OIE recognises three alternatives, *viz*. canning, thorough cooking (to reach a temperature of 70° C for 30 minutes) and drying after salting (water activity reduced to 0.85 or below – TAHC Article 8.8.31). In most FMD-endemic areas in sub-Saharan Africa, further processing other than canning has not been routinely used to ensure FMD safety of meat – although the potential in this respect is considerable. An exception is the successful company 'Farmer's Choice' and its subsidiary 'Choice Foods', located in Kenya (a FMD-endemic country), which export a wide range of processed pork, beef and lamb products to a variety of internal and external markets (www.farmerschoice.co.ke). Zambeef also produces quality meat products, although these are consumed locally within Zambia.

Production of processed meat involves investment in a plant and equipment as well as acquisition of the necessary technical expertise. In addition, the products produced (unless processed into packaged cold meats such as pastrami, cooked beef and sausages) generally sell for less than chilled beef would off the same carcasses. That said, value addition via processing beef into salamis, sausages, meat pie fillings and other processed vacuum-packed meat cuts could be viable in Maun, and would diversify the industry (Bing et al., 2017). These products could be targeted not just to the tourism sector within Ngamiland, but also potential markets within the green zones as well as the larger SADC region. Processed product proposals based on CBT principals for Ngamiland beef have been put forward by private sector investors and the GoB is urged to re-evaluate these. In addition, at the September 2018 consultations in Maun held by the President of Botswana, His Excellency Dr Mokgweetsi E. K. Masisi, a recommendation was made to source a considerable portion of the beef needed in Ngamiland, which could include stewed beef required for government-run institutions (schools, prisons, military, etc.), from Ngamiland itself, thus offering Ngamiland beef a domestic market while freeing-up the green zones' quota for export. Currently, government tenders do not specify where beef is sourced from.

Theoretically, cooking plants can remain open for slaughter, canning and export during FMD outbreaks. Any products processed in accordance with TAHC Article 8.8.31 could also be exported anywhere in the world, with little to no market disruption. However, due to the upfront investment in equipment, it would be important to identify products and potential markets that have the capacity to generate a positive return on investment. It would also be important to be able to ensure a supply of cattle during outbreaks.

7.3 Wildlife friendly beef brand development

The rise in eco-labelling and branding initiatives follow recent trends of environmentally conscious consumers becoming aware of the ecological impacts of food production (Aquino & Falk, 2001; Wykstra et al., 2017). Businesses have responded using various eco-labels and certification schemes that provide assurances to consumers that the products they are buying comply with environmental as well as social standards. Implementing CBT in an integrated way that includes husbandry (herding and kraaling) and rangeland management practices linked to wildlife conservation and human-wildlife coexistence lends itself to branding and marketing of a wildlife friendly product.

In general, wildlife friendly branding promotes best science-based practices for conservation in combination with secure commercial benefits that support local communities. WFB production practices may be applied specifically to land and livestock management that aims to conserve key wildlife species and their habitats while improving the livelihoods of the people who coexist with those species.

7.3.1 Definition of wildlife friendly beef: Wildlife Friendly Enterprise Network certification

While there is no single model of wildlife friendly product development, the general concept has been embraced by producers of various products around the world and can be seen as part of a green markets movement addressing sustainability, climate change, and human health and livelihoods. The Wildlife Friendly Enterprise Network is an NGO that has developed a recognisable brand certification with potential applicability in Ngamiland. Their Certified Wildlife Friendly® (http://wildlifefriendly.org) and Predator Friendly® (http://www.predatorfriendly.org) labels certify companies and producers that meet production standards specific to their industry. The Production Standards for North America recognise wildlife stewardship on farm and ranch lands and articulate a list of conditions to be met to acquire the certification (http://wildlifefriendly.org/standards/). Participating producers employ a mix of proactive practices and careful observation, and adapt their management in response to changing conditions to allow wildlife and livestock to coexist.

7.3.2 Conservation agreements

The primary objective of WFB brand development is to marry compliance with conservation agreements (see Section 3.1.2) with benefits that can accrue to producers through a WFB brand (market access, price subsidies, stock and rangeland improvement). These benefits are leveraged into management and production standards specific to the product, its market and its supporting ecosystem management challenges.

To develop a WFB brand in Ngamiland, it may well be possible to adapt some of the production standards from the Wildlife Friendly Enterprise Network's Wildlife Friendly and/or Predator Friendly certifications, for example, to meet the requirements of habitat dispersal permeability as identified for the KAZA TFCA and its landscape-scale Wildlife Dispersal Areas. The full set of the Standards for American predator friendly certification is provided as an example (http://wildlifefriendly.org/wp-content/uploads/2015/09/predator-friendly-standards-final-2013-v1-0.pdf).

To understand how the WFB initiative could become certified under the Wildlife Friendly Enterprise Network's Predator Friendly or Wildlife Friendly labels, in 2017, a member of the WFB project team together with Dennis Sizemore (Round River Conservation Studies) met with the President of the network, Ray Victurine, in Seattle to discuss WF Ngamiland beef and value-added products. It became apparent that each submission for certification is responsible for identifying the production standards that would be submitted for review as criteria. Then vetting of producers to identify compliance with the production standards would follow.

7.3.3 Husbandry

Rangeland management underpinned by risk appropriate livestock husbandry constitutes the foundation of WFB development in Ngamiland. Husbandry practices include herding and kraaling at night by trained, skilled professional livestock and grassland managers, called community scouts or ecorangers. In addition to addressing the costs of unsustainable grazing practices, professional herding and kraaling would reduce livestock contact with buffalo and with predators, thereby helping to reduce not only the risk of FMD transmission but also the current aggressive antagonism toward predators by Ngamiland's traditional cattle farmers. Most of such antagonism results from losses of livestock and low opinions of the value of wildlife.

The Habu pilot project (see Section 12) has hired 16 full-time community scouts who are receiving training in ecological monitoring, grassland ecology, herding practices, mobile kraaling and livestock health evaluation. All these practices are seen as requisite components of a set of production standards that will form the basis of conservation agreements for which compliance will enable WFB branding. In addition, a Cattle and Conservation Working Group including commercial beef producers, conservationists and tourism operators, and spearheaded by Dereck Joubert (as National Geographic Explorer), was assembled in 2018 as part of the National Geographic Society's 'Big Cats Initiative Phase II' programme. Phase I dissolved as a predator conservation grants programme in 2017, and a refocus on the larger issues around livestock management at landscape scales has been developed which includes CBT implementation, WFB branding, husbandry, grazing land management and coexistence. To date, two conference call meetings have been convened to discuss the initiative and a workshop to be held in Kenya is planned for 2019. The Habu pilot project has been identified as one of two projects (with a second one in Kenya) to be developed with expectations of generating support through this working group.

7.3.4 Business model

Two business models have been identified as examples from which lessons can be extracted for the Ngamiland WFB initiative:

1. ***American Prairie Foundation's "Wild Sky Beef"*** (http://wildskybeef.org) uses a model in which payments are made directly to ranchers based on evidence of compliance and measures of coexistence with target wildlife species.

2. ***Meat Naturally*** (https://www.meatnaturallyafrica.com) is a social enterprise that uses ecological science, a government job creation programme, and market interest in sustainable meat to implement communal grazing systems that result in improved water and food security. The system is said to provide a scalable vehicle for African communal farmers to enter into a growing niche market for grass fed and sustainably-produced meat. Within South Africa, the enterprise has two key revenue streams: one focusing on production and land restoration support by ecorangers paid by the South African government, and another focused on sales and auditing support paid by farmers and retailers. Ecorangers manage grazing to improve soil and allow for crop planting and fertilisation to be integrated into resilient food systems.

A business model for Ngamiland's WFB has yet to be developed. Incentives identified to encourage participation include: price subsidies, reliable commerce (sales) and facilitated liquidity, Community Farmers' Cooperatives to assist with compliance with DVS/government conditions for sales and movement (e.g. BAITS), and development of improved stock. However, the current demand for beef in Ngamiland is being serviced by existing local butcheries and wholesale beef brokers *including distributors from the green zones* (in Gaborone). This situation seems unsustainable given the costs and lost opportunities for Ngamiland. Restructuring the local supply of beef to service the tourism sector as well as the local demand with locally produced WFB will be challenging but is critical. It will probably require an entirely new intermediary broker who can provision the current local distributors with a wildlife friendly branded product.

7.3.5 Marketability: Botswana's wildlife tourism sector

As noted in Section 2, tourism contributes an estimated 11.5% to Botswana's GDP with most of it focused on photographic wildlife tourism deriving from international markets. Botswana's predominantly high cost tourism operations collectively represent the economic drivers of northern Botswana's light industry and consumer goods sales. However, to date there are almost no linkages between the tourism industry and local producers of domestic products. This is in part a consequence of an absence of domestic production of consumer goods, but nowhere is there a greater disconnect between an industry demand for product and the local production of that product than in Ngamiland's beef sales.

Furthermore, the relationship between local beef producers and Ngamiland's wildlife tourism industry remains disconnected despite the well understood economic and ecological costs to the wildlife sector. An integral component of WFB development in Botswana would be to provide opportunities for Ngamiland's communities, currently largely disenfranchised from wildlife-associated revenues, to benefit from coexisting with wildlife, including from wildlife-based industries (e.g. tourism, game farming).

In order to progress this, members of the WFB project team have met with Dereck and Beverly Joubert, CEOs of Great Plains Conservation to discuss the Cattle and Conservation initiative and the need to engage Ngamiland's tourism sector and secure commitments to support local farming communities. Dereck Joubert has given assurances that Great Plains will enthusiastically commit to supporting a WFB brand initiative once the business model has been developed and implemented to ensure compliance with wildlife friendly practices. He also committed to help drive buy-in from the rest of Ngamiland's tourism industry leaders.

Demand for beef by Ngamiland's tourism sector suggests that tourism beef consumption alone could absorb 20-25% of BMC-Maun's maximum annual throughput, or 20-25% of current throughput of all three local abattoirs. Additional markets for Ngamiland WFB or free range/grass fed beef would be integral to a long-term sustainable business model that achieves envisioned conservation and economic goals. However, issues of seasonal variation in meat quality and supply would need to be addressed.

7.3.6 Broader markets

Development and conservation professionals are increasingly facilitating 'green' microenterprises to contribute to biodiversity conservation and poverty alleviation for local communities. Progress has been made in some parts of Africa involving communities in good conservation practices, a foundation for sustainable enterprises that contribute to local livelihoods. Yet, these innovative enterprises often struggle to understand potential markets for their products and how to access them.

Botswana as a whole has focused on the EU export market for Botswana beef, but there are domestic and regional opportunities that Ngamiland could exploit – particularly when it comes to WFB. In addition, there is no national or product-level branding of Botswana beef (ITC, 2014). Conversely, Namibia has focused on smart branding and marketing, shifting from selling products to attributes (Katjiuongua and Omore, 2013). For example, through branding, it sells certified free-range high-quality beef to niche markets like Woolworths. Moreover, niche products such as Farm Assured Namibian Meat and the Kalahari Kid Corporation promote local products, engage in branding and quality assurance, and build the capacity of emerging farmers (Rich, 2009).

7.4 Employment opportunities

Professional herdsmen and ecorangers at field level

- CBT and WFB call for resurrection of traditional herding and kraaling practices, but performed at a new professional level. Several NGOs in Ngamiland are working on complementary projects that relate to improved livestock husbandry practices and reduced human-wildlife conflict including Botswana Predator Conservation Trust, CLAWS, Elephants for Africa, H4H, and WildCRU. Some of their programmes involve training and employment opportunities for ecorangers, community scouts and/or professional herdsmen (see Section12 - Habu pilot project).
- Conservation International is also in discussions with the Green Climate Fund which, if successful, will allow for establishment of a large ecoranger programme to work with livestock farmers on rangeland rehabilitation and climate-resilient livestock production. As part of the process, the GoB has expressed willingness to repurpose its youth job creation programme, *Ipelegeng*, to support this – which would create 3,000 jobs, many within Ngamiland.

Complementary employment at field level

- BAITS cafes (Section 3.2.1) will be established initially in nine villages in Ngamiland. The potential exists to expand these to more villages to provide greater access to services for farmers while providing additional youth employment at the village level through *Ipelegeng*.
- Kraal building, farriery to reduce predation of animals with foot/mobility problems, and livestock guarding dog programmes for small stock are all examples of job creation that could potentially occur if farmers were able to access markets and thus be incentivised to better manage their cattle.
- Development of community-run tourism operations in areas where cattle are well managed (agritourism and ecotourism) could also create jobs (see Section 12 - Habu pilot, where eight community-owned campsites have recently been developed).

Government quarantine stations

- Refurbishing and running the government-owned quarantines will require additional staffing and thus create job opportunities.
- Charcoal and braai wood production from manual bush clearing of government-owned quarantines could also provide employment while creating more room for palatable plant species that can support livestock production.

Private quarantines and feedlots

- Development of feedlots and private quarantines would lead to direct job creation, with employment opportunities varying from unskilled to skilled jobs, e.g. buyers in the field, transporters

using smaller vehicles for smaller animals, grain transporters, facilities management staff and labourers.

- Manure from feedlots could be collected for direct addition to fields or could be incorporated as a component of organic fertiliser. Organic Fertiliser Manufacture Botswana uses chicken and feedlot derived manure in manufacturing organic fertilisers with a high organic matter content, and has developed an 'Okavango Eco Fertiliser' suited for those areas that are ecologically sensitive to chemicals (http://www.sundaystandard.info/botswana-company-looks-hike-organic-fertiliser-exports-sa).
- Local centre pivots on the Boteti River that are in close proximity to feedlots could produce sorghum or maize silage for the feedlots, as well as use the manure from the same source.

Abattoirs

- Two newly constructed private abattoirs have already generated a number of jobs locally. Batawana Beef has also indicated that it is likely to build a cooking plant, which will create additional jobs.
- The addition of the proposed Sehithwa Community multi-species abattoir is estimated to generate direct employment for 50 people, most of whom would be local. According to the feasibility study, indirect employment is also expected to grow, with the establishment of some formal and informal SMMEs once the abattoir is operational (Wellfield Consulting Services, 2018).
- Introduction of mobile abattoirs in less accessible locations in Ngamiland would also provide for additional job creation. For example, a mobile abattoir pilot project on the periphery of Kruger National Park employs women to produce organic fertilisers, thereby solving the waste disposal problem.

Further processing and value addition

- Development of a meat cooking and packaging plant in Ngamiland, either attached to one of the private abattoirs or through an upgrade to BMC-Maun's production line, will require technical expertise as well as local training and skills development, but would create additional local jobs.
- Development of niche products such as WFB salamis, sausages and biltong offers an opportunity for local entrepreneurs and artisanal industries to develop.
- Options exist for creating employment and livelihood opportunities from innovative livestock by-products value addition. Examples are available from other parts of Africa, including implementation of small-scale soap or bone-crafts (trinkets) production (Kinyanjui & Sajjad Noor., 2013; Mtimet et al., 2018), which requires specific training. For example, an FAO-supported seed grant initiative created 120 direct jobs as well as reduced piles of bones that were initially discarded into municipal landfills contributing to environmental pollution (a public health hazard). The by-product value addition also served as an alternative source of employment and wealth creation for women and youths who were the main beneficiaries (Kinyanjui & Sajjad Noor, 2013).
- Leather processing also has the potential to create rural employment, particularly if niche markets are developed with the tourism sector. As noted above, discussions with Zimbabwe's University of Science and Technology suggests they would welcome the idea of working with Ngamiland producers on leather skill development. Furthermore, SMMEs based around leather production would contribute to rural economic diversification.

8. PACKAGING AND TRANSIT OF BEEF

8.1 Batch identification

Slaughter batch identification is important to enable backward and forward tracing if a significant issue arises that could affect animal or human health. The main reason for the plethora of legislation that exists internationally for batch identification is to enable prompt recall of product when a significant human food safety concern has been identified, and to enable corrective action to prevent recurrence (Yordanov & Angelova, 2006). In terms of FMD (not a food safety issue), the EU has a requirement that deboned beef from

southern Africa cannot be imported until 21 days have elapsed since the animals from which the beef was sourced were slaughtered, to allow for recognition of recent FMD outbreaks (Paton et al., 2010). This requirement led to a regulation in Namibia that meat would not be released from the abattoir in the FMD-infected zone of Zambezi Region until 21 days post slaughter. Accordingly, batch identification in Namibia is necessary to ensure compliance with the regulation. The post slaughter 'quarantine' of deboned beef is an additional risk mitigation measure. When the slaughter batch is identified, the following information must be recorded for both carcasses and cut meat: identification, date of slaughter, species slaughtered, mass, quantities and destination (Bergh, 2007). Thus, an abattoir should have a document management system that provides for the retrieval of data related to each identified slaughter batch. There should also be a documented product recall procedure that is approved by the relevant government agency.

Batch identification is also driven by the desire of modern consumers to know more about where their food comes from as well as to support branding (van der Merwe & Kirsten, 2015). Branded products such as Karoo Lamb in South Africa are labelled with all the necessary information to support the validity of the brand claim (van der Merwe & Kirsten, 2015). This must be borne in mind when developing the WFB brand.

8.2 Transit of beef destined for export

The transit of beef from the area of production to the importing destination can present challenges. Certain countries or trading blocs, notably the USA and the EU, require that beef going to those destinations should not transit FMD-infected zones or countries. These requirements would currently not affect beef from areas not free of FMD, like Ngamiland, because it would in any case be excluded from import. These requirements also go beyond OIE recommendations.

Transit of red zone beef under TAHC Article 8.8.22

CBT and Article 8.8.22 foresee export of fresh, chilled, deboned beef from areas that are not free of FMD to destinations that include countries that are free of FMD or have FMD-free zones (because matured, deglanded, deboned beef is a very safe product as far as FMD is concerned). While it seems unlikely that the USA or EU would agree to anything but the current geographical standards, it is anticipated that Ngamiland beef will be able to access regional markets including in countries that are free or have zones that are free of FMD. There is precedent: before an outbreak of FMD in 2007 in what was then Namibia's FMD-infected Caprivi region, South Africa had imported matured, deboned beef from which visible lymph nodes had been removed based on a favourable risk assessment. Further, Botswana's revised movement protocol for Ngamiland District (Ministry of Agricultural Development and Food Security, press release dated 26 February 2018) allows for the export (either to external markets or to the rest of the country) of fresh beef that has been deglanded and has 'successfully undergone deboning and maturation' and was derived 'from animals that have undergone 30 days of quarantining', i.e. is compliant with Article 8.8.22.

Transit of red zone beef to other FMD-infected zones or countries (equivalence)

Unfortunately, the transit restriction is also applied to beef that originates in an area not free of FMD travelling to an import destination of equivalent status. In the case of Botswana, the restriction is applied internally and bone-in beef from an infected zone is not allowed to move through an official FMD-free zone on the way to another infected zone (or country). Currently bone-in beef is exported from Ngamiland to DRC without any restrictions, but there are concerns that as Botswana expands the existing green zones issues of transit may arise. In addition, other transit countries may prevent the movement of that beef, for example, bone-in beef destined for other parts of Africa (e.g. northern DRC) but needing to transit Namibia's Zambezi Region (an FMD-infected zone).

Summary

Whether the restrictions placed on transit are either fair or scientifically justifiable merits debate, and in some cases, it is possible that negotiation would resolve the problem. However, when possible and cost-effective, it may be simplest to try to plan routes that avoid road transit through OIE recognised FMD-free zones or countries unless a clear policy for transit conditions (including specifications related to sealed vehicles etc.) can be developed at a regional level and acceptance can be gained from trading partners and/or neighbours who impose the conditions. If Botswana were to place additional restrictions on itself on red zone beef exiting the country, serious consideration should be given to (1) recommending alternative routes where these are available and (2) developing a set of conditions that would assure safe transit rather than denying Ngamiland livestock producers the opportunity to access export markets.

9. MONITORING & AUDITING FOR COMPLIANCE & CERTIFICATION ALONG THE VALUE CHAIN

9.1 Certification requirements along the value chain

9.1.1 Primary production

An integrated approach to managing risks related to animal diseases and food safety throughout the value chain begins during primary production. Participating farmers are required to adhere to a protocol that has been developed to specify good husbandry practices aimed at producing a healthy animal and mitigating the risk of FMD by minimising contact with wildlife and feral cattle, and complying with DVS requirements for identification and vaccination (see Section 3). To participate in a certification program, farmers initially sign an agreement to follow the protocol, but a monitoring process needs to be in place to support the farmer and when necessary help him/her to identify and correct deficiencies in compliance. In practical terms, it is not possible for the already overstretched DVS to undertake this task. It has to be delegated to people who are in frequent contact with the producers and will reliably convey necessary information to DVS. In a previous pilot project in Namibia, a mentorship programme for farmers was in place and the mentors, who were local persons with farming experience, performed the task of monitoring implementation of the protocol. As there is no equivalent programme in Ngamiland, the monitoring may need to be done by extension officers, senior farmers in the community, ecorangers or a combination. One possibility would be for farmer associations to assume the responsibility of appointing monitors or monitoring committees who would visit the farmers at regular intervals and would report their findings to DVS to assist them with the certification process. Monitoring would largely consist of perusing the records kept by the farmers as stipulated in the protocol, following up on any issues of concern that were identified, and recommending and monitoring corrective action.

9.1.2 Transport from the farm to quarantine or directly to an abattoir

Motorised transport (as opposed to trekking) for delivering cattle to quarantine stations and slaughter at the abattoirs is required by both the GoB and Article 8.8.22 of the OIE TAHC to mitigate the risk of animals encountering infected wildlife or cattle in transit. The use of motorised transport is considered to be a CCP in the application of HACCP to the value chain. Movement permits[10] are required by law and cattle are not accepted for slaughter unless they are delivered by vehicle accompanied by a movement permit. Compliance with the CCP is demonstrated by the movement permit records. The trucks must be cleaned and disinfected before loading and again after delivery of the cattle.

[10] http://www.gov.bw/en/Ministries--Authorities/Ministries/MinistryofAgriculture-MOA/Tools--Services/Licensing-and-Permits/Animal-Movement-Permit/

9.1.3 HACCP certification for abattoirs

Compliance with HACCP during the slaughter process and certification of the process is discussed in Section 6.5 in relation to the Ngamiland abattoirs. As described in Section 6.7, third party certification for HACCP is available from a variety of organisations but is by no means always an importer requirement. It will, however, enhance the reputation of the abattoir and increase the spectrum of markets available for the product. For example, Angola is a country that is not free of FMD and is willing to import beef from Ngamiland but requires SGS certification of the abattoir to allay food safety concerns.

9.1.4 Health certification by DVS

All importing countries require that imported livestock and livestock commodities, apart from cooked and other products compliant with Article 8.8.31, be accompanied by a veterinary health certificate issued by the competent authority, i.e. the official government veterinary services. Chapters 5.1 and 5.2 of the OIE TAHC provide guidance for veterinary certification, but individual countries develop their own certificates to be completed by their official veterinary services depending on the importer's requirements in terms of animal health. For countries with concerns about FMD, it would be necessary for DVS to certify that the beef complies with the requirements of TAHC Article 8.8.22.

9.2 Skills and human resources

The implementation of CBT to manage the risk of FMD takes place along value chains that start with the farmer and end with the final product to be traded, which will be determined by the needs of the target market and the capacity of the exporter to supply it. The human resources and skills required will increase with increasing complexity of the value chain. Quarantines that also serve as feedlots, and meat processing plants that transform fresh beef into various value-added products, require the greatest skills development, employ more people and create opportunities and greater product diversity in the beef sector.

9.2.1 Skills and resources in primary production

Actors in the production chain in Ngamiland are cattle owners and people who assist with the cattle, if any, who may be family members or employed herders. To be able to comply with the CBT requirement for good husbandry, farmers require a level of literacy and numeracy that enables them to maintain production and health records for their cattle, provide basic health care such as parasite control to their animals, and implement BAITS. They should also understand the measures needed to minimise contact between their cattle and wildlife or stray cattle, and comply with official vaccination campaigns.

Employment of professional herders by individual farmers or by collectives as described in Section 3.1 would relieve farmers of most of these tasks and would provide additional competencies such as rangeland management through rotational grazing and situational awareness with regard to buffalo movements. Finally, the owners need to select cattle to be marketed, make the necessary arrangements with agents or abattoir managers for transporting them to QSs or abattoirs, obtain movement permits if this is not done by the agent or "miller", and ensure that cattle are loaded correctly.

Well-trained extension officers from DAP can make valuable contributions during the primary production phase of the value chain as a source of information and advice, in particular for record-keeping, as they may be more accessible to farmers than veterinary staff.

9.2.2 Skills and resources for transport of cattle

Motorised transport is covered in Section 4 of this report. Cattle owners, agents and transporters need to ensure that loads comply with the national regulations for health and welfare and that the cattle are loaded in such a way as to minimise injuries which, apart from contravening welfare norms, often result in

downgrading of the carcass, loss of meat due to bruising, damage to hides and in the worst instance, death when an animal falls and is trampled.

The requirement that trucks must be cleaned and disinfected before loading and after offloading (see Section 9.1.2 above) must be well understood and diligently practised by the transporters.

9.2.3 Skills and resources for quarantine station operation

The aim of pre-slaughter quarantine in FMD-infected areas is to ensure that cattle do not come into contact with potential sources of FMD virus and that clinically affected cattle are not presented for slaughter. QSs should also be managed so as to protect the general wellbeing of the animals by ensuring adequate grazing and water, excluding predators and monitoring the livestock's general health.

QS staff have significant responsibility that will require personal sacrifices, such as not being able to come and go freely or allow their friends and relatives to do so. To be able to carry out their work diligently, they need to be well trained and to understand the purpose of the QS and the need to avoid practices that could jeopardise the FMD-free status of the QS.

The skills required for good QS management are basically those required by good stockmen. Proficiency in handling cattle is essential, because the protocol for QSs (DVS-OCp-Doc: 046) stipulates inspection of cattle upon reception at the QS and weekly individual animal inspection by DVS technicians with some monitoring in the camps in between the weekly inspections. The persons performing the inspections should be familiar with the signs of FMD even in the very early or late healing stages, as well as be able to recognise any other abnormalities that need to be recorded and receive veterinary attention. Record-keeping is an important skill in a QS.

Ensuring the integrity of the perimeter fence and inner fences of the QS is a critical responsibility of QS managers and staff, and any signs of incursion of wildlife or stray domestic ruminants should be rapidly noted and reported. Entry of persons not employed by the QS must be prevented unless authorised by the manager.

One of the major challenges in QSs is to manage the grazing in order to ensure that it is sufficient for the number of cattle quarantined. QS staff should therefore have basic knowledge of range management and be able to recognise early signs of overgrazing. Ideally, an ecoranger with training in rangeland management and restoration should be included among the QS core personnel, particularly in a large QS that is fully dependent on grazing for animal fodder. It is also important to ensure that water is available at all times.

9.2.4 Skills and resources in a quarantine-compliant feedlot

Combining a QS with a feedlot has the advantage that less land is required because the cattle do not depend on grazing. Workers in such a facility need to combine the skills enumerated under Section 9.2.3 with additional skills required to operate a feedlot, where animals are kept in close contact and issues of behaviour and ensuring adequate access to feed for all the cattle arise. The quality and safety of the feed is key to finishing animals in a combined QS-feedlot. Feed must be sourced from trusted suppliers or produced in an area where absence of contamination by potentially infected wildlife or non-QS cattle can be guaranteed. Workers must ensure that rats and birds cannot access the feed and be observant for any signs of mould or contamination with poisonous plants.

9.2.5 Skills and resources in the abattoir

The skills required at the abattoir for implementation of CBT revolve around maintaining Good Hygiene Practices and complying with the HACCP system in place at the abattoir. Good Hygiene Practices start in the holding pens and are maintained until the finished product leaves the abattoir. The size of the staff, the

sophistication of processes and the skills required to perform them efficiently will depend on the throughput and the target markets. All of the abattoirs currently operating in Ngamiland are targeting export markets, some of which do not have a requirement for HACCP certification, but to take advantage of all marketing opportunities that become available with CBT, it is likely that all of them will aspire to obtain certification.

9.2.6 Skills and resources for further processing and value addition

One of the CBT options is to produce processed products that have been treated in various ways to inactivate the FMD virus. Processing meat requires additional skills like following recipes and monitoring the processes to ensure that time and temperature requirements are satisfied, both for the destruction of the virus and the quality of the final product. As in the abattoir, Good Hygiene Practices are paramount and HACCP systems are widely used to ensure food safety.

In conclusion, a diverse multi-layered value chain for CBT beef, from the simplest scenario, where beef is exported to countries with equivalent FMD status, to those requiring a feedlot finished young animal's beef, requires a level of investment by operators. Labour and human resources constitute one such investment.

Lengthy disruption of business due to FMD outbreaks has a negative effect on recruiting and retaining skilled workers. Greater employment opportunities and higher prices for cattle will be realised when the value chain is stable, with fewer disruptions. Additional skills will be needed to support a more complex value chain, and opportunities for employment in the beef sector will improve, but this can only happen with an enabling environment for beef production.

10. RESPONSE TO FMD OUTBREAKS

The 1995 outbreak of CBPP in Ngamiland was a devastating experience for cattle owners, despite the fact that compensation was paid to them by the Government. By 2007, the restocking of cattle in Ngamiland was actually complete and refurbishment of the BMC-Maun abattoir, which had closed due to the CBPP outbreak, was in progress, portending normalisation of the cattle industry. Unfortunately, in October 2007 a SAT 2 outbreak of FMD occurred at Habu that was not resolved for more than two years. Moreover, after 2009 a further series of FMD events (an event consists of one or more apparently related FMD outbreaks) occurred on an almost annual basis despite the best efforts of DVS to prevent that from happening. This ongoing FMD problem and the associated control efforts have curtailed the ability of cattle owners to trade their animals, leading to impoverishment of many households, severe overstocking and compromised economic development in Ngamiland.

In an effort to assist DVS to develop a strategy to deal more effectively with FMD in Ngamiland, a small DVS team appointed by the Director and a small AHEAD team held a three-day strategy development session in Gaborone in July 2018. The principal objective was alignment of a future FMD control strategy with CBT approaches in order to improve market access and continuity of beef supply from Ngamiland. This approach was based on the assumption that, for the time being at least, FMD in Ngamiland is unlikely to be eradicated. There is good scientific evidence to support that assumption (Thomson & Penrith, 2017). Nevertheless, through exploitation of the fundamentals of SAT-type FMD epidemiology and CBT principles, there is considerable potential for improving the sustainability and marketability of beef produced in Ngamiland.

10.1 Current FMD strategy for Ngamiland

The FMD Contingency Plan for Botswana (Revision 4, 2015) contains the following response procedure for occurrence of FMD in an infected zone where vaccination is practised, i.e. the official position of Ngamiland with respect to FMD:

- Initial once-off vaccination using a high potency, non-purified[11] vaccine to boost immunity;
- Follow-up vaccination using a standard potency, non-purified vaccine at 14 day intervals until the outbreak is contained;
- Reversion to the scheduled vaccination campaign routine (2-3 times a year) once the outbreak has been contained and officially declared as resolved.

What is not mentioned in the Contingency Plan is the erstwhile practice of declaring movement standstills over all or large parts of Ngamiland for a period of at least three months (in many instances much longer) following occurrence of FMD outbreaks. That has usually been accompanied by a halt in the slaughter of cattle at the BMC-Maun abattoir. Bearing in mind that over the period 2007-2017 eleven FMD 'events' (comprising 37 outbreaks) occurred; this meant that for about 80% of that time standstills and abattoir closure were applied (see Section 3.3.1 on FMD in Ngamiland, past and present).

10.2 More desirable FMD strategy

During the strategy development workshop held in Gaborone in July 2018, the epidemiological characteristics of SAT-type FMD (as opposed to Eurasian-type FMD) that lend themselves to limiting the extent and duration of animal movement restrictions needed to prevent FMD outbreaks from spreading were discussed, together with how those characteristics can be integrated into non-geographic trade-risk reduction methodology, i.e. through the application of CBT. In the latter respect the decision-tree contained in the *Guidelines on Commodity-Based Trade Approaches for Managing Foot and Mouth Disease Risk in Beef in Southern Africa* (see Figure 6, Section 2.4.2 above) was explained and discussed for two scenarios, *viz*. (1) management of FMD in inter-epidemic periods (i.e. during 'peace time') and (2) FMD management when outbreaks occur (i.e. in 'war time'). Working groups of the DVS team then developed an outline for both (1) and (2) for further consideration.

In respect of FMD outbreak management the following issues were addressed:

- Notification and communication
- Outbreak confirmation
- Surveillance in and around the outbreak focus
- Intervention measures
    - Data that need to be collected
    - Measures to prevent further spread
    - Vaccination within the affected area (outbreak focus)
    - Ring vaccination around outbreak foci
    - Length of time over which control measures need to be applied
    - Criteria for determination of the resolution of an outbreak.

The details of proposals related to most of these issues are not reproduced here because they are routine. However, the following is a summary of significant intervention principles that the DVS team incorporated into their proposal:

- Outbreak foci should comprise an area with a radius of approximately 10 km around crushes or villages where clinical cases have been identified;
- Immediate vaccination within the outbreak focus with purified vaccine needs to be applied with a follow-up round of vaccination 28 days later;

[11] The Contingency Plan refers to 'impure' FMD vaccine but that is not strictly the correct term because it implies an inferior product. In reality 'purified' vaccine refers to additional steps in the manufacturing process to remove non-structural viral proteins from the antigen preparation to enable serological differentiation between animals that have been infected or not, irrespective of their vaccination status. Both purified and non-purified FMD vaccines should be equally effective in inducing immunity against FMD.

- Ring vaccination around outbreak foci to a width of 10 km with follow-up re-vaccination 28 days later; and
- Maintenance of movement restriction is unjustified beyond 30 days after the last clinical case is identified in an outbreak.

While both the DVS and AHEAD teams considered these departure points potentially advantageous for management of FMD outbreaks, including minimising interruption of trade, they will need to be either ratified or amended by the decision makers within DVS. Furthermore, the above issues only provide a backbone for intervention policy directed at management of FMD outbreaks, i.e. more detail needs to be built into the strategy and provided as a guide or SOP.

It also needs to be borne in mind that the basis of the strategy proposed above is not fully in line with international standards and norms for management of FMD. The reason is not that the strategy is necessarily faulty, but that international standards and norms have to date ignored the epidemiological dissimilarities between SAT- and Eurasian-type FMD. For that reason, the alternative approaches proposed by the working group are considered necessary and could be explained to any interested trade partner.

11. STAKEHOLDER COORDINATION, COMMUNICATION AND OUTREACH

11.1 Communication, cooperation, coordination and collaboration

Successful implementation of a CBT value chain approach to beef production relies on a diverse range of stakeholders including, but not limited to, farmers raising quality cattle in the field, transporters, abattoir operators, meat processors, SMMEs that make other commodities from animal by-products, and a range of government entities that are responsible for setting the conditions within which this chain can function. In such a multi-disciplinary, multi-stakeholder environment, communication, cooperation, coordination and collaboration become critical to implementation success, to ensure that all the moving parts work in synergy, towards a shared vision but with clear roles, functions and benefits so that no one sector or role player is overburdened.

That said, while all role players in the value chain have their own valuable function to perform, that of the farmers is absolutely pivotal. Their buy-in and ownership will in essence make or break CBT as a regional initiative. Recognising this, concerted and conscientious efforts need to be made to ensure they are an inherent part of planning, interventions and activities for CBT rather than simply being consulted once decisions have already been made. Undoubtedly, challenges will emerge as the initiative unfolds. At these times, communication and information sharing will become even more imperative, as these are necessary to establish trust, as acknowledged by stakeholders at the WFB inception workshop held in Maun in 2017 (http://www.wcs-ahead.org/dvs_ahead_maun_workshop_2017/dvs_ahead_maun_workshop_2017.html).

11.1.1 Collaboration and coordination at the field level

There are a range of conservation NGOs and projects that are working with farming communities in various parts of Ngamiland on improving husbandry practices to help mitigate wildlife (particularly carnivore)/livestock conflict, and/or to help implement CBT at the community-level. Techniques such as active kraaling and herding reduce the likelihood of depredation by carnivore species or contact with buffalo, while simultaneously improving the quality of cattle for sale by farmers (see Section 3.1). Professionalising the herding function through the enhancement of skills of herders is one way in which herding is being re-introduced to these communities.

- The *H4H* programme being jointly implemented by Conservation International and Peace Parks Foundation was developed to help implement CBT at the community level by offering equitable trade opportunities in a way that catalyses wildlife/livestock coexistence. In Ngamiland, H4H is supporting Habu Elephant Development Trust and Botswana Predator Conservation Trust in Habu village to trial

communal herding and training professional herdsmen in skills that include primary animal health care, holistic planned grazing, record keeping and wildlife avoidance.

- *Botswana Predator Conservation Trust* and *Habu Elephant Development Trust* are also working with partners to address the drivers of illegal bushmeat hunting through improved animal husbandry and a training and employment programme based in Habu. Interventions include herding, mobile bomas and grassland management. In addition, 16 community scouts were hired and trained in 2018 (see Section 12).
- *CLAWS* is piloting the "pride in our prides" project in the village of Eretsha. The effort will eventually extend to include the villages of Seronga, Gunotsoga, Beetsha and Gudikwa along the eastern Panhandle of the Okavango Delta. Kraaling and communal herding are being encouraged and some trainings have already been conducted in 2018, covering issues of grazing, kraaling, disease prevention and general livestock management principles. In 2019, the H4H programme will collaborate with CLAWS to introduce the H4H model to the area, conduct exchange visits, undertake a climate change vulnerability assessment, and assess the feasibility of H4H implementation and support through ecorangers and improved market access for beef.
- *ORI* in collaboration with *CIRAD* is working in the eastern Panhandle of the Okavango Delta, in the villages of Seronga, Gunotsoga, Eretsha, Beetsha and Gudigwa, to implement a project entitled "*Promoting sustainable livelihoods (ProSuLi)*". An initial consultation workshop was conducted with communities in August 2018. The project has been collaborating in and supporting the training offered by CLAWS in Eretsha.
- The *Ecoexist Project* works with villages in the eastern Panhandle of the Okavango Delta to improve crop yield, practise conservation agriculture, deter elephants from entering crop fields (in part by helping communities and Land Board to zone agriculture away from known elephant corridors), and strengthen communities' capacity to manage conflicts.

Communication and cooperation amongst these organisations and with government entities whose mandate dictates engagement with producers on similar or related issues, such as DAP, DVS and DWNP, can assist in ensuring that:

- There are no conflicting messages being conveyed to producers on issues of CBT, animal husbandry and conflict mitigation. Often the lack of herding is blamed on fear of running into dangerous wildlife. Consequently, improved husbandry practices must address the conflict between humans and wildlife. Furthermore, while CBT offers opportunities for improving livelihood security for Ngamiland farmers, it is equally important to manage expectations and understand the limitations of the concept, linked to the roles and responsibilities of different players.
- The curricula for professional herding are aligned/complementary. These may at some stage require accreditation through Botswana Training Authority. Botswana University of Agriculture and Natural Resources is also an important stakeholder from a perspective of sustainability and scaling up, as they offer tailored trainings to different target audiences in the agriculture sector.
- Interventions that are introduced to target different components of the value chain (such as the BAITS cafes) build on existing efforts in the pilot sites.

11.1.2 Greater intra-government, inter-sectoral collaboration

While DVS under the MoA has taken the lead in championing the CBT concept in Botswana, other sectors such as trade and finance are equally important to ensure the functioning of the value chain in the perceived fashion. Beyond working collaboratively together, these government ministries further need to engage actively with the private sector and civil society, and support mechanisms through which these role players may enter and contribute to the value chain. Instruments that aid in the establishment of trust and investor confidence in this innovative approach include SOPs on critical issues such as official response when there is an FMD outbreak and for well managed quarantine facilities.

11.1.3 Platforms for increased coordination

Several platforms already exist in Ngamiland that can be utilised to increase coordination, minimise overlap and promote efficiency. Farmers' committees and farmers' associations offer valuable, existing, local level institutions for communication, particularly amongst NGOs and farmers and government entities (DVS, DWNP and DAP).

The *Citizen Led Monitoring Forum* is a forum of conservation NGOs that offer some form of training to select individuals from target communities to assist with various monitoring functions. These may be herders, community scouts, or resource monitors. The purpose of the forum is to share lessons learned, identify commonalities or areas of overlap for greater efficiency and identify gaps that could benefit from a collaborative approach. The *Botswana Carnivore Forum* offers a platform for NGOs engaged in carnivore conservation to coordinate and, where relevant and applicable, collaborate on issues of research, human-carnivore conflict, fundraising, etc. The *Human-Wildlife Coexistence Working Group (HWCWG)* is a national working group that tends to meet in Maun largely because most members have representation in Ngamiland. Government representatives from local government, agriculture, wildlife/environment and lands, and all the NGOs mentioned above, participate in this working group. At its core, the concept of CBT is being applied in Ngamiland in order to alleviate the conflict that currently exists between two predominant land uses – wildlife and livestock. To enable coexistence, this forum seems to be the best fit to host CBT stakeholders. Working Group members concurred with this suggestion in April 2018.

Additionally, at a meeting held in Maun facilitated by AHEAD in August 2018, stakeholders agreed that, outside of the meetings convened under the umbrella of the HWCWG (which normally only take place twice a year), they would have WFB breakfast meetings to stay abreast of emerging challenges, discuss possible solutions to these and consider where collaboration in upcoming activities may be required. The first such WFB forum breakfast meeting was held in October 2018, and a second in February 2019.

11.2 DVS-farmer relationship

Admittedly, the relationship between DVS and farmers in Ngamiland is shaky following years of challenging circumstances (as per communication at different workshops held with farmers and DVS staff). Of a survey of over 100 farmers in Ngamiland, conducted as part of a market opportunities assessment for CBT beef from Ngamiland in 2017, roughly half gave DVS a failing grade for controlling FMD (Bing et al., 2017; M. Masedi, 2017, unpublished report). Both parties accept that each has legitimate concerns and that in order to move forward and successfully implement CBT, trust must be rebuilt. For this, honesty, transparency, good communication and active engagement are called for.

From DVS, farmers request more transparency during FMD outbreaks, including communication about the incidents and their corresponding response measures. Part of the perceived communication gap relates to how DVS explains or accounts for cattle that demonstrate signs of infection even when all vaccination records are in order. The recommended presence of SOPs that align technical protocols for FMD outbreak response and CBT implementation will also demonstrate DVS's commitment to creating an enabling environment for CBT implementation.

Ample communication ahead of vaccination campaigns is required in order to allow farmers the time needed to prepare to bring their cattle for vaccination. As described in this report (see Section 3.2), there are numerous factors (e.g. insufficient ear tags) that are hindering the successful roll out of the BAITS system, many of which have nothing to do with the willingness and efforts of farmers to comply with the system. Although farmers may appreciate the various attempts by DVS to resolve these challenges, the current system continues to "penalise" farmers for failures, which further damages the relationship and trust between both parties.

In terms of the farmers, DVS urge better accountability of cattle movements, adherence to any issued movement restrictions during times of an FMD outbreak, presentation of cattle for vaccination campaigns and general compliance with the producer system. Farmers have also agreed to become more proactive, rather than relying so heavily on government – for instance to self-police more, so as to address issues of stock theft.

11.3 Building capacity for implementation of CBT

The need for developing capacity within government institutions as well as amongst farmers has been recognised at recent fora including the WFB inception workshop held in Maun in November 2017 (http://wcs-ahead.org/dvs_ahead_maun_workshop_2017/dvs_ahead_maun_workshop_2017.html). Subsequently, at the behest of MoA (DVS), a series of workshops and strategy sessions targeting DVS staff were conducted with technical support from AHEAD in 2018.

- *February 2018*: over 60 participants, including 40 senior DVS veterinary officers, private veterinarians and other technical staff attended a two-day training workshop held in Gaborone. The workshop aimed to: (i) increase a conceptual understanding of CBT; (ii) enhance understanding of the technical elements that impact FMD management (FMD serotypes, vaccination programmes, surveillance, etc.); and (iii) consider approaches to FMD outbreak response in Botswana's FMD-endemic areas (like Ngamiland) that don't hobble the beef sector. One key suggestion emerging from this workshop was the need to set up a dedicated FMD coordination unit with a dedicated budget within DVS (http://www.wcs-ahead.org/botswana_dvs_workshop_2018/botswana_dvs_workshop_2018.html).

- *July 2018*: a small team assigned by the Director of DVS underwent a focused strategy development session to determine key elements of strategies/plans that support: (i) approaches to FMD risk management during inter-epidemic periods; and (ii) control of outbreaks of FMD as and when they occur. It was emphasised that planned measures need, in particular, to minimise disruption of production and trade in livestock commodities, especially during FMD outbreaks (see Section 10).

- *September 2018*: back-to-back trainings were organised to target: (i) extension officers; and (ii) FMD vaccination staff in Maun. A common objective of both trainings was to enhance understanding of FMD. Additionally, the former group considered the potential opportunities that CBT offers and their role as extension staff in its implementation, whilst the latter explored the objectives of vaccination programmes and the possible causes for their failure.

In addition:

> A series of half-day consultative workshops were conducted with farmers in 2018 around Ngamiland to introduce the CBT concept and its implications for producers. The following villages were targeted for these workshops: Tsau, Semboyo, Makukung, Habu, Nokaneng, Gumare, Tubu, Etsha 1-13, Shakawe, Mohembo East & West, Kauxwi, Xakao, Sekondomboro, Ngarange, Mogotho, Mokgacha, Seronga, Gunutsuga, Eretsha, Beetsha and Gudigwa. General feedback from the workshops was overwhelmingly positive, with farmers expressing their willingness to improve their husbandry practices, including herding and kraaling, as a means to improving cattle quality. In a bid to reduce conflict with wildlife, farmers have also requested support in identifying grazing areas away from the Okavango Delta and for installing boreholes, leaving the delta for tourism purposes. At these workshops, farmers asserted the need for further workshops on CBT and related issues such as quarantine, pricing and how this is calculated.

Whilst this has been a positive start, there is need for continued investment in developing capacity and increasing awareness so that different role players may effectively play their parts in the value chain.

Specifically:

- *Farmers* – need to understand: (i) the CBT concept and the opportunities a CBT approach might offer them; (ii) what would be required of them to ensure field-based compliance so as to be able to access desirable markets; (iii) their role in FMD control and of herders in management of disease risk in the field; (iv) pricing and how it works (CDM versus live weight); and (v) the need for quality, consistency and a reliable quantity of beef to ensure sustained access to desirable markets. Farmers associations can play a vital role in capacity development (e.g. by ensuring farmers know what is expected of them and helping them develop better bargaining skills to negotiate prices with transporters), but the associations themselves need to be strengthened and brought together.

- *Land boards* – need to be made aware of CBT and their role in ensuring rights to land and water, as access to both underpins a good grazing management system.

- *Markets and potential trade partners* – need to be made aware that CBT is a safe approach for managing risk. At the DVS FMD strategy development session held in July 2018, staff emphasised the need to invest in raising this awareness amongst the main trading partners for the country's green zone beef, the EU. The National Strategy Office could also play a role in branding and identification of markets for Ngamiland beef, emphasising grass-fed and wildlife friendly products for specific niche market consumers – something it is doing as part of the Botswana Beef Cluster initiative in the south of the country (https://www.botswanabeefcluster.com/what-we-do).

- *DVS* – has set up a dedicated FMD Unit based in Maun to improve FMD management with an approved budget for operations from Cabinet. This team could drive a programme for sustained capacity development amongst its staff to improve the understanding of the CBT concept and the critical role of DVS in its successful implementation. This is necessary due to: (i) staff transfers resulting in lack of continuity of knowledge; (ii) the training most veterinarians have received has been Eurocentric and therefore, they are unaware of the peculiarities of FMD in the southern African context; and (iii) their mandate being beyond just animal health but also ensuring animal health for the purpose of profitable production systems (L. Modisa, pers. comm., Sep 2018).

- *DAP* – need to understand what CBT is, what implications it has for the farmer, and how this affects the execution of their mandate with producers.

- *Policy makers* – need to understand how CBT can and should work so as to ensure that an enabling environment is available for implementation.

11.4 Mechanisms for communication

The farmer survey mentioned above indicated that out of 101 respondents in Ngamiland, none relied on public media for information related to livestock production. Information was predominantly relayed through farmer associations and the *kgotla*. This might in part be related to the age distribution of the farmers, with the vast majority being older than 50 (an aging farming population has been seen in statistical analyses of Ngamiland, e.g. annual agricultural survey reports). Clearly, these local institutions remain invaluable modes of communication within the village context. Beyond this, however, radio and local print newspapers may need to be more strategically utilised for communication purposes.

BMC has a SMS messaging system for dissemination of information such as buying dates, prices and other topical issues, which was developed in 2008. It is unclear if this system is still operational. However, the information contained within the system could be utilised to generate a current producers directory for Ngamiland through which such announcements (in Setswana and English) could be circulated. For the younger generation that may be more technologically savvy and more at ease with the internet and smart phone technologies, social media (e.g. Facebook, Instagram and Twitter) and Whatsapp may prove more

amenable forms of communications. Government is already utilising these mechanisms to convey real time updates on, for example, electricity and water supply/outages. It must be recognised that internet and cell coverage in parts of Ngamiland is poor, however a basic instant messaging system through SMS would reach the majority of farmers.

12. HABU PILOT SITE

The Habu community and the Habu Management Area was selected as a pilot for CBT and the WFB initiative for several reasons including the following:

Geography. Habu village is located 18 km east of the tarred arterial road servicing the communities of the western delta and the Okavango Delta Sub-District. Perhaps as a consequence of this isolation, Habu community members have a greater sense of community identity and 'community area boundaries'.

Bushmeat hunting activity. In an FAO funded investigation into the impacts and drivers of bushmeat hunting in the Okavango Delta (Rogan et al., 2015; 2017), the Habu community was identified as one of a handful of bushmeat hunting 'hotspots' around the delta. Interventions identified in the FAO report included improving livestock husbandry practices, providing employment opportunities, and developing access to wildlife industries (tourism, game farming). Subsequent FAO grant funding was acquired to focus on some of these interventions.

Additional grant support. In addition to the FAO grant funding aimed at husbandry practices and human-wildlife conflict mitigation, the Habu Elephant Development Trust, a registered Community Based Organisation with an elected board of Trustees, in collaboration with Botswana Predator Conservation Trust, has been awarded a two-year National Environmental Fund grant for community development projects that facilitate wildlife coexistence and opportunities for wildlife-based tourism. The project also aims to integrate environmental and wildlife conservation with traditional livestock farming by demarcating cattle grazing areas separated from the comparatively high-density wildlife areas near Habu village and adjacent Wildlife Management Areas (NG26 and NG 29). It is hoped that re-zoning will help create buffer zones for wildlife and associated wildlife-based enterprises including tourism, while also promoting traditional livestock management through improved husbandry (including herding, kraaling and vaccination) aimed at disease management and improved market access through CBT.

Representative community. The Habu community (~1,500 people) is an ethnically diverse but cohesive community with members from several regional tribal groups including BaHerrero, BaTawana, and BaSarwa and as such can be considered representative of the region. Situated between Sehitwa and Gumare and relatively close to the Southern Buffalo fence, the livestock owners using mostly traditional communal grazing in the Habu area have been at the centre of past FMD outbreaks and are representative of those most negatively impacted economically.

As part of the FAO funded project to address the drivers of illegal bushmeat hunting in the area, Botswana Predator Conservation Trust, in collaboration with Panthera, DWNP and FAO, has launched a herding and rangeland management training programme in Habu, employing 16 community scouts in 2018 (Figure 15). Partnering with Habu Elephant Development Trust, this project will roll out through the end of 2019, with the aim of securing additional grant funding to continue to scale-up the training and employment programme. The interventions include mapping and ecological monitoring, herding and grassland management, mobile kraals and nutrient cycling for small crop development. To date, 18 full-time jobs have been contracted in the Habu community under the FAO project, and another three will be added through the Habu Elephant Development Trust National Environment Fund supported project.

Figure 15. Habu community scouts, September 2018.

An assessment of the area to date has included an inventory of resident skills and qualifications, and mapping of infrastructure (roads, boreholes, cattleposts, and fences) as well as vegetation and wildlife. The Habu community cattleposts (n=128, with 108 water points) represent 9,418 cattle, 6,869 small stock, 855 donkeys, and 267 horses.

In addition, the H4H programme will trial communal herding with a subset of the Habu area livestock owners in 2019. This will initially comprise a total of three herds, with 250-500 cattle per herd. Each aggregate herd will include cattle from 5-10 cattle owners. Thus, up to 30 farmers will be engaged in this first phase of the Habu pilot project. The number of hectares that will be under improved grazing management has yet to be identified.

As described in Section 3, the H4H model works by hiring and training professional herdsmen in a unique suite of skills, such as primary animal health care, planned grazing, record keeping, wildlife avoidance, as well as low stress herding techniques. It has been demonstrated elsewhere that collective action at the village level enables the smallest to the largest farmer to effectively address risks whilst they work to comply with beef trade standards and biodiversity conservation agreements. By addressing risks along a value chain through a certification and risk management system such as HACCP, the combination of risk reduction and improved market access stimulate participation in best practices as well as trade. The H4H programme will provide support in this respect to the existing efforts of both the Habu pilot project and the CLAWS programme in Eretsha, Okavango Panhandle.

An important starting point of the H4H programme is rangeland restoration through enabling and incentivising farmers to implement planned grazing. In order to do this properly, farmers are encouraged to aggregate their herds, which can be facilitated if skilled herders/ecorangers are used. At the same time, this provides the opportunity to manage multiple risks such as those related to herd health, production, contact with wildlife, stock theft and predation. The approach improves record keeping and facilitates compliance with CBT standards whilst animal condition improves.

As part of this work in Habu, grazing capacity estimates have been calculated (Figure 16). These were derived using the South African grazing capacity map to construct a model to predict grazing capacity from NDVI over Ngamiland. Landsat NDVI (30 m resolution) and grazing capacity for 1,000 random points over

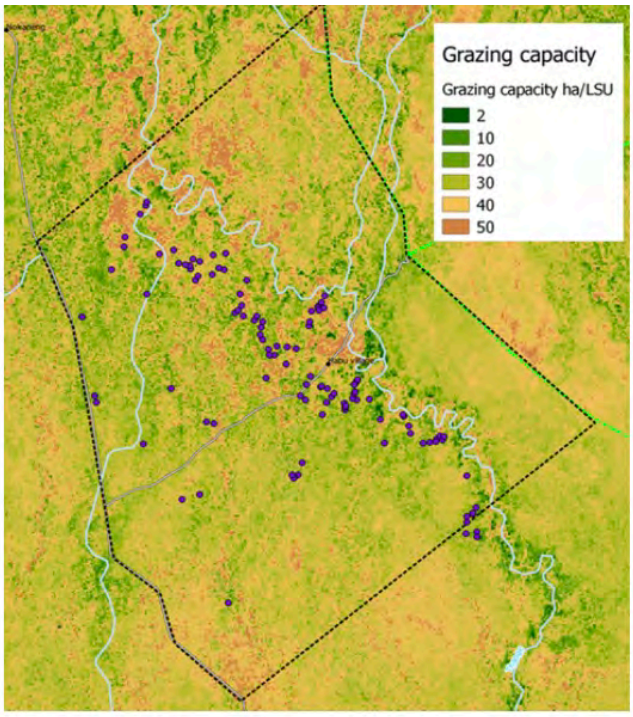

Figure 16. Cattle post locations and grazing capacity based on vegetation assessment for Habu.

South Africa were extracted to derive a 2nd order polynomial fit. This was then used to predict grazing capacity for Botswana. Grazing capacity is expressed in hectares available per large stock unit (ha/LSU). Grazing pressure was also estimated with spatial interpolation of cattle numbers.

The spatial information represented here will be compared and further informed by in-field rangeland assessments conducted earlier in 2018. Ultimately, this will enable calculation of suitable grazing areas for each aggregate herd consisting of the animals of several cattle posts in Habu (Figure 17). After rigorous consultation with community members to further refine grazing area layout, these areas will be the start of implementing planned grazing that is aligned to efforts to conserve wildlife in the community as well as promote CBT/WFB trade (B. Heermans & H4H programme, pers. comm., Oct & Dec 2018).

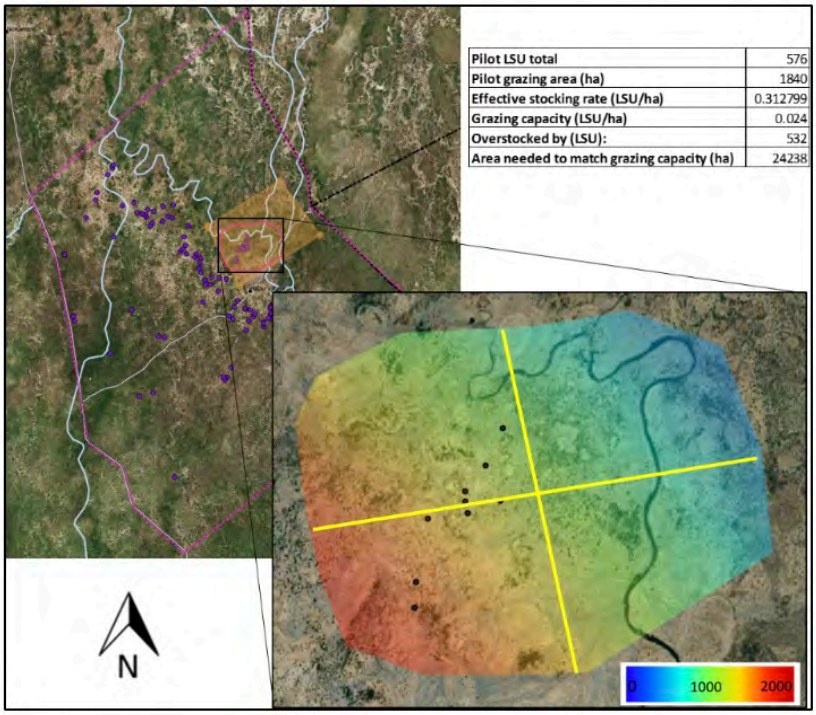

Figure 17. Example of grazing area demarcation in Habu.*

*Based on a theoretical grazing capacity and stocking rate of an aggregate herd of 567 animals from nine cattle posts. The colour indicates the part of the grazing area that is near to adjacent livestock (red) and distal to other livestock (blue), i.e. not all livestock will be in an aggregate herd. This grazing area will be further refined through ground-truthing, stakeholder and community consultation (Z. Venter, 2018, H4H unpublished report).

The Habu community has also identified and demarcated a 325 km^2 cattle free buffer zone, known as the Habu Community Game Reserve, within their area (Figure 18). Through the National Environment Fund project, they have also developed eight campsites in the area for mobile tourism operators. Anticipated future tourism activities will also include agro-tourism, horseback safaris, trail walks, arts and crafts, and *mokoro* trips when the river is flooding.

By zoning the area and removing cattle from the river to the west of the tarmac road, farmers also hope to see a reduction in the occurrence of water borne diseases in their cattle and a reduced likelihood of contact with buffalo, and hence infection with FMD.

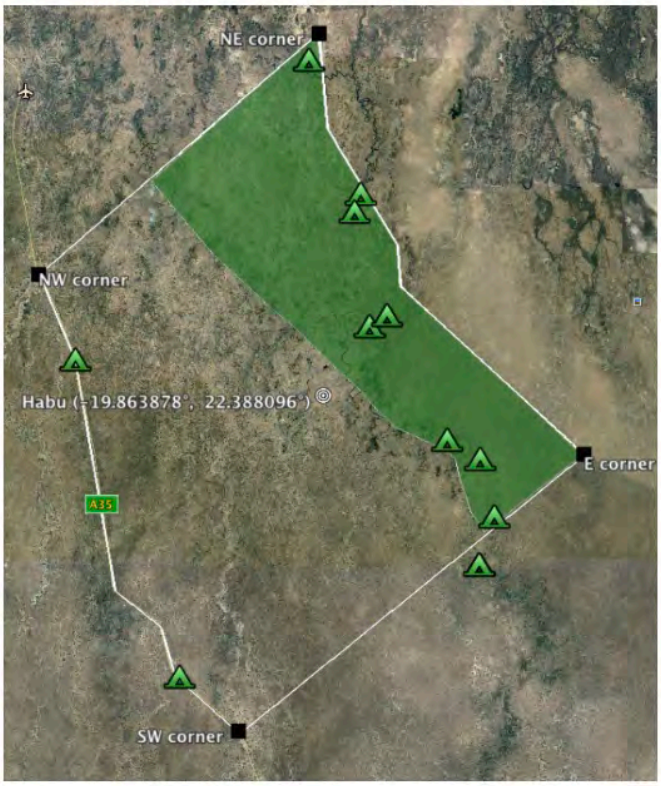

Figure 18. Habu area showing Habu Community Game Reserve (green) and campsites.

Future developments in the Habu pilot project include:

- A Habu livestock slaughter slab facility to meet current DVS slaughter requirements;
- Registration of a Habu Farmers' Cooperative under the Ministry of Investment, Trade and Industry;
- Additional implementation of projects under the Botswana Poverty Eradication Programme including community cluster crop agriculture, and borehole development for both agriculture and wildlife enterprises;
- Fire management training and firebreak construction;
- Local tourism industry training and capacity building.

13. GAPS & RECOMMENDATIONS

The study, as well as a complementary market opportunities study conducted in 2017 (http://www.wcs-ahead.org/kaza/171003_rpt_final_marketopportunitiesforcbtbeef_ngamiland.pdf), revealed that a range of potential markets exist for beef produced in Ngamiland, but currently only a few of these are being accessed, namely local markets and at least one SADC country of equivalent FMD status that does not require certification of freedom from FMD. Potentially high value local markets are also not fully exploited, for example, the market for WFB offered by Ngamiland's tourism industry. Other potential markets exist in countries of equivalent FMD status in and outside the SADC region. Implementing a CBT value chain approach to WFB production could enable access to markets in FMD-free countries or zones for beef commodities and products that comply with OIE TAHC Article 8.8.22 (i.e. through quarantine) for beef produced in areas not free of FMD – as well via Article 8.8.31 for beef that has been processed in such a way as to destroy the FMD virus.

Accessing higher priced markets requires more than freedom from FMD based on a CBT approach; compliance with international food safety standards and the offering of products of sufficient quality to satisfy consumer expectations in those markets are also essential. The gap analysis revealed that a degree of modernisation of cattle production in Ngamiland will be necessary to support a value chain that will result in a sustained demand for beef from higher priced markets.

While a number of gaps have been identified, it may be helpful to distinguish between the challenges facing CBT implementation specifically versus the challenges facing Ngamiland's beef sector overall – with or without CBT. The tables below make that distinction.

- Table 11 outlines gaps specific to CBT that need to be addressed to access most markets, with a sub-section on constraints that need to be overcome to achieve access to markets in FMD-free countries or zones, e.g. through quarantine. It also identifies gaps that need to be addressed to reduce conflict between livestock production and wildlife conservation and enable potential development of a WFB brand;
- Table 12 outlines gaps that hinder beef production and marketing in general in Ngamiland, with or without CBT, that need to be addressed.

Within the tables, all gaps are considered important. However, further distinction is made as follows:

Gaps that are considered **absolutely critical** to address, failing which, CBT implementation is unlikely to succeed

Gaps whose corrective actions are considered **low hanging fruit** in terms of being relatively easily addressed

Table 11. Constraints that specifically hinder implementing a CBT approach along the value chain in Ngamiland.

	GAPS	RECOMMENDATIONS
FIELD	**Good animal husbandry and livestock management practices not being implemented sufficiently** *Record keeping, herding and kraaling to reduce contact with buffalo, basic health care & grazing management are inadequate, affecting farmer compliance with producer protocols for CBT implementation and overall livestock productivity (& exacerbating human-wildlife conflict).*	• Provide training & extension including farmer-to-farmer extension (e.g. beef productivity training for farmers and herdsmen through DAP), and 'train the trainer' programs for DAP staff. • Introduce skilled herding, including collective herding for smaller herds, at pilot sites to demonstrate proof of concept (Herding for Health [H4H] model). • Utilise farmers associations/farmers to identify individuals for herder training. • Ensure good working conditions & job descriptions for skilled herders. • Consider collective action to enable joint sourcing of medicines & feed supplements to be shared amongst small-scale producers - minimises wastage & enables better prices & shared transport costs. • Increase understanding of conservation agreements (see Section 3.1) as mechanisms to facilitate compliance with good husbandry and livestock management practices so that benefits offered in the agreement are based on participants' sustainable use of specific natural resources. • Share responsibility for implementation among farmers, non-governmental organisations (NGOs) that provide support & government agencies. • Consider development of legal/policy instruments that support grazing plans & related animal husbandry practices.
	Challenges surrounding BAITS are inhibiting its successful implementation in Ngamiland *Animal identification systems can ensure traceability to support disease control & comply with requirements for some markets. Several factors including equipment challenges, information inaccuracies, limited bandwidth & inadequate access to computers &/or internet in many rural areas are however hampering implementation of BAITS, leading to farmer frustration. The above issues are exacerbated by the absence of transitional arrangements that would allow farmers to move cattle that are not yet in the BAITS system to abattoirs for slaughter.*	• Capacitate DVS staff as a matter of urgency (includes technical equipment as well as training & maintenance). • Increase the number of BAITS cafes in Ngamiland to at least include pilot sites for herding programmes so as to build on existing & complementary initiatives. • Explore innovative solutions through partnerships (e.g. tech & cell phone companies) to increase internet access & connectivity within Ngamiland e.g. BTC to increase bandwidth sufficiently to enable BAITS access. • Consider allowing the use of previous identification systems (e.g. identification brand & most recent vaccination brand; manual/paper-based system) that enable cattle to be moved to abattoirs & accepted for slaughter if problems with BAITS are not resolved adequately. • Share responsibility for implementation among relevant government agencies, with support from non-state actors.
ABATTOIR	**Distance between production areas, quarantine stations & abattoirs reduces formal market participation by producers** *The concentration of abattoirs around Maun makes it difficult for producers further afield to access formal markets. Increased transport costs also prevent formal market participation for some producers.*	• Consider innovative options that offer slaughter services for the formal market further afield, for instance, mobile abattoirs linked to approved slaughter slabs. • Explore the feasibility of mobile QSs to enable compliance with the requirement of some markets for pre-slaughter quarantine.

	GAPS	RECOMMENDATIONS
ABATTOIR	**Insufficient focus in some abattoirs on implementing Hazard Analysis and Critical Control Points (HACCP) or HACCP-like systems to increase spectrum of available markets** *For some markets, additional food safety requirements may need to be met.*	• Investigate requirements of a range of potential markets (not all markets have the same requirements as the EU). • Private abattoirs to formalise HACCP implementation by instituting the necessary documentation. • Formalise guidelines for different scenarios for batch separation of quarantined animals & those slaughtered for markets that don't require quarantine. • Increase laboratory capacity to detect food safety threats in abattoirs in Ngamiland.
FURTHER PROCESSING & VALUE ADDITION	**Range of secondary beef products is limited** *Value addition via processing beef into sausages, meat pie fillings, & other processed vacuum-packed meat cuts could be viable & would diversify the industry. However, investment in equipment and technical expertise would be required. BMC-Maun's cooking plant is no longer functional, but the potential exists for exporting processed cooked beef to regional markets such as South Africa. Cooking plants can theoretically remain open for slaughter, canning & export during FMD outbreaks & any products processed in accordance with OIE TAHC Article 8.8.31 could also be exported, with little or no market disruption.*	• Government agencies/parastatals in collaboration with private sector & NGOs to identify products & potential markets that have the capacity to generate a positive return on investment, e.g. emphasize quality products that can be marketed for best value. • Botswana Meat Commission (BMC) & private enterprises to evaluate whether to invest in the requisite heat treatment & other processing technology. • Government to re-evaluate previous processed product recommendations/ proposals put forward by private sector investors for Ngamiland.
	Potential market for WFB offered by Ngamiland's tourism industry not being realised *Markets for Ngamiland WFB and/or free range/grass fed beef are integral to a long-term sustainable business model that achieves envisioned conservation & economic goals. The tourism market in northern Botswana currently sources meat from outside Ngamiland. However, to tap this market, issues of seasonal variation in quality & supply need to be improved.*	• Initially, engage Ngamiland's tourism sector to secure commitments to support local farming communities to supply beef products such as bone-in beef for lodge staff; or products such as dried boerewors. • Over time, engage Ngamiland's tourism sector to secure commitments to support local farming communities & engage with the latter to provide the preferred type of beef for the niche market (i.e. younger, grass-fed animals tied into conservation agreements). • Draft comprehensive Production Standards for WFB for Ngamiland beef producers. • Pilot the above at a site such as Habu or Eretsha, to complement ongoing activities by NGOs in communal herding & kraaling.
MARKETS	**Entities such as Ministry of Investment, Trade & Industry and the National Strategy Office have not been co-opted adequately in the exploration of markets for CBT beef** *While DVS has traditionally played some role in securing markets for trade in beef, the successful implementation of a novel approach such as CBT will require expertise from other ministries such as trade & finance, working collaboratively with private sector to open up previously unexplored avenues for trade.*	• Actively engage as wide a spectrum of stakeholders (including other government ministries, parastatals, NGOs & private sector) with the requisite expertise & skills to identify & secure potential markets for CBT beef. • Ensure a legislatively grounded & transparent policy enabling environment for CBT.

	GAPS	RECOMMENDATIONS
FMD OUTBREAK CONTROL	**Approaches to managing FMD outbreaks are not fully aligned to CBT, causing trade disruption & affecting investor confidence** *Blanket movement restrictions associated with FMD outbreak management have sometimes been excessively long which inhibits trade unnecessarily. There is ongoing need for alignment of FMD outbreak response & protocols for implementing CBT. Although there have been positive developments in this respect, these need to be formalised in the form of a Standard Operating Procedure (SOP) & communicated transparently to relevant stakeholders.*	• DVS to finalise SOP on outbreak management to provide more detail, to safely enable trade in the event of FMD outbreaks. • DVS to communicate outbreak management SOPs to stakeholders so as to instil confidence in the enabling environment established by government for implementation of CBT [of importance to the private sector (& possible investors) & producers]. • DVS to revisit and clarify movement protocols for samples to the national reference laboratory to enable rapid diagnostic confirmation of suspected outbreaks; a satellite diagnostic lab in Maun is reportedly under development.
FENCING	**Lack of clear understanding of the state, impact, purpose & cost of the fencing inventory of Ngamiland** *A CBT approach to beef production facilitates the management of FMD associated trade risk while diminishing the need for expensive & often environmentally damaging fences. This has been embraced by the GoB, with the Directors of DVS, Wildlife & National Parks (DWNP), Animal Production (DAP), Environmental Affairs (DEA) and Lands re-establishing the National Committee on Cordon Fences. The Committee recognises the need for an audit on the state of Ngamiland's fences to inform decision making on which fences are no longer necessary or are more damaging than beneficial & should be considered for decommissioning or re-alignment.*	• Newly revived multi-sectoral fencing committee (National Committee on Cordon Fences) to provide technical, cross-sectoral advice on fencing issues. • Conduct an assessment of fences with respect to their purpose, exact length & alignment, state of repair, maintenance costs, & impact on wildlife movement (both within Ngamiland & the broader KAZA TFCA landscape). • Based on assessment, produce a strategic fencing plan that considers Ngamiland & the KAZA TFCA (i.e., the needs of the wildlife resource). • Fencing committee should oversee and drive implementation of the strategic fencing plan. • If some fences can be decommissioned or down-sized, DVS budgetary savings could be applied to key needs related to CBT implementation as outlined elsewhere in this chart.
STAKEHOLDER COORDINATION, COMMUNICATION & OUTREACH	**Insufficient understanding of CBT & the role that different stakeholders need to play in its successful implementation** *As a new approach being introduced into the country, adequate resources need to be invested into raising the level of understanding of CBT so that stakeholders appreciate potential benefits & their specific role(s) in that outcome & have realistic expectations.*	• Source & invest resources into developing a suite of communication tools to develop an understanding of CBT at the regional & national level in collaboration with non-state actors (farmer associations & NGOs). Communication tools range from radio & TV shows to fliers, road shows & workshops. • Specifically target government extension staff (DAP, DVS & DWNP) & farmers to raise their level of understanding by organising trainings/awareness raising workshops in production areas, in collaboration with NGOs/academia.
	Ground level activities amongst farmers, NGOs & government entities need to be coordinated *A number of projects are underway with selected farming communities in Ngamiland involving conservation NGOs in a bid to minimise human-wildlife conflict through improved husbandry practices and/or implement CBT practices at the producer level. These activities need to be coordinated to avoid conflicting messaging & training. Some progress has been made through the establishment of a Ngamiland Wildlife Friendly Beef Forum.*	• Use existing forums to increase collaboration & complementarity amongst the various projects. • Mandated government entities such as DAP & DWNP, and District Council officials, to play a stronger role in this coordination.

	GAPS	RECOMMENDATIONS
	CONSTRAINTS SPECIFIC TO ACCESSING MARKETS FOR CHILLED OR FROZEN BEEF IN FMD-FREE COUNTRIES OR ZONES (ADDITIONAL TO ABOVE)	
QUARANTINE	**In terms of the production of chilled or frozen beef, the requirement for pre-slaughter quarantine of cattle is currently resulting in a bottleneck due to producer reluctance to quarantine their animals** *Producers may be reluctant to quarantine cattle for a range of operational & other issues including lack of manpower to care for animals in QS, additional transport costs & failure to understand or accept the pricing system. Insufficient quarantine capacity is likely to create a further bottleneck in times of oversupply of cattle.*	• DVS to strictly limit the requirement for quarantine to cattle destined to supply chilled or frozen beef to markets that demand compliance with TAHC Article 8.8.22. • Actively seek and identify further markets that do not have a pre-slaughter quarantine requirement, either because they are FMD-infected or because their requirement is for matured, deboned beef from which visible lymphoid tissue has been removed, providing a scientifically accepted 'very safe' product. • Encourage further processing of products to comply with TAHC Article 8.8.31 to further reduce the number of cattle requiring quarantine. • Arrange with abattoirs for slaughter of quarantined and non-quarantined cattle on separate lines or days with complete cleaning and disinfection in between to minimise possible contamination. • Ensure that producers understand the costs involved in cattle transactions and, if necessary and feasible, modify the pricing system to accommodate their concerns.
	The location, holding space & physical state of existing quarantine stations are factors limiting quarantine capacity *Prior to the FMD outbreak in 2007, the government operated quarantine stations (QSs) were an essential part of the Ngamiland beef production system. Since then, there has been no significant use for the designated quarantines & they have fallen into a state of disrepair. Makalamabedi is the most accessible QS and the only one that could be rehabilitated for use within a fairly short space of time. However, the layout of Makalamabedi does not fully meet the requirements for biosecurity. Furthermore, it is clear that having a single QS located at a considerable distance from most of the main cattle-producing areas will not provide a sustainable solution for export of beef under TAHC Article 8.8.22.*	• MoA/DVS to complete the rehabilitation of Makalamabedi QS, taking into account biosecurity and stocking capacity concerns. • Consider the use of mobile fences to avoid the expense of installing additional internal fencing to achieve physical separation of cattle from different batches at all times, including at water points in adjoining paddocks. • Provide disinfection facilities, toilet facilities and office accommodation. • Consider all available options/scenarios to overcome the limitations imposed by having a single QS: ▪ identify as wide a spectrum of markets that do not require quarantine as practical; ▪ consider rehabilitating one or more of the other existing government QS depending on resources and practicality (e.g. location, ease of access); ▪ create an enabling environment for the establishment of smaller, intensive, privately owned facilities (such as quarantine in privately managed facilities & quarantine-compliant feedlots); ▪ conduct a feasibility study into the establishment & operation of mobile quarantines.

	GAPS	RECOMMENDATIONS
QUARANTINE	**Lack of a comprehensive biosecurity plan for quarantine stations** *Frequent FMD outbreaks in the district and probable circulation of FMD virus in cattle demands rigorous implementation of a high level of biosecurity to prevent outbreaks in the QS and provide a level of assurance that supports export certification.* *The current QS SOP (DVS-OCp-Doc:046) does not fully satisfy the requirements of a biosecurity plan. In addition to that document, a basic biosecurity plan needs to be developed that provides details on the day-to-day management and maintenance activities essential for the effective biosecurity of QSs. In particular, the plan needs to reconsider personnel allocation as the current allocation appears to be inadequate. Further training of the Principal Technical Officer & staff will be necessary to ensure that they understand the reasons for & the tasks essential to the running of a QS. The need for this was identified during a training session held in Maun in September 2018.* *Another major issue is potentially insufficient guarantee of the integrity of the Makalamabedi QS perimeter fence due to elephant incursions. The siting of Makalamabedi QS in Zone 3d Buffer makes impenetrable biosecurity imperative to avoid escape of cattle from Zone 2 into the EU Buffer Zone in 4a. Damage to fences due to incursion of elephants into the QS therefore needs further consideration in addition to the elephant-proof trench that is being dug along one border of the QS. Additionally, cloven-hoofed wildlife will need to be excluded from the facility on a continuous basis.*	• Appoint a dedicated group within DVS to document the minimum standards, develop a biosecurity plan, provide relevant SOPs & monitor implementation. • Develop job descriptions to enable an accurate assessment of the number of employees required to operate the QS to the necessary level of efficiency & biosecurity based on the holding capacity. • Consider expanding the professional workforce with ecorangers employed through the *Ipelegeng* job creation programme or H4H programme. • Reconsider the option of using owners of cattle in the QS & their employees for the day-to-day handling of cattle in the various camps due to possible increased risk of introducing FMD. However, if no alternative is feasible, put in place risk mitigation measures that include preventing uncontrolled access to the QS, training in basic biosecurity procedures including the use of protective clothing & disinfection, & ensure supervision by well-trained, full-time, core QS staff. • Provide more detailed training of the workforce in biosecurity principles & practice, including but not limited to detailed instruction on what to do in the case of (1) mortalities occurring within the QS, (2) the immediate set of actions should FMD be detected in the QS, & (3) actions necessary following other incidents that threaten biosecurity, e.g. elephant incursion resulting in fence breakages. • Consider further investment in strengthening the perimeter fence. • Make provision within the biosecurity plan for sufficient patrolling, maintenance & when necessary repair of fences to ensure the uninterrupted integrity of the perimeter fence.
	Lack of QS environmental management plan and inadequate grazing capacity to meet potential abattoir throughput demand *In a semi-arid environment, quarantine facilities need to be very large properties subdivided into smaller paddocks, in which grazing is efficiently managed to prevent degradation of rangeland & loss of condition by cattle during the quarantine period. Remote sensing data suggests Makalamabedi QS, on its own, will be unable to supply enough paddocks & grazing to ensure adequate separation of batches & maintenance of body condition during a 30-day holding to meet potential abattoir throughput demand.*	• Develop an appropriate Environmental Management Plan with support from animal production & rangeland scientists (e.g. from ORI/NGOs) to ensure optimal management of grazing in the QS. • Consider enhancing quarantine capacity through one or more of the scenarios described above, while also maximizing development of products & markets (including within Ngamiland itself) that don't require quarantine. • Provide rangeland management & restoration skills through appointment of ecorangers, who can also assist with animal handling & record keeping. • Consider the use of internal mobile paddocks according to a grazing plan to ensure compliance with both rangeland management & biosecurity measures whilst not compromising animal condition.

Table 12. Constraints that hinder beef production and marketing in general in Ngamiland, with or without CBT.

	GAPS	RECOMMENDATIONS
FIELD	**Overstocking and overgrazing are leading to rangeland degradation** *The estimated number of cattle in Ngamiland in 2016 was 317,000, yet rangeland condition allowed for a grazing capacity of approximately half that (147,330). Overstocking & consequent overgrazing have been exacerbated by lack of opportunities to market cattle, leading to low offtake, particularly during lengthy movement bans following FMD outbreaks. Damage to rangelands also results from uncontrolled movement of cattle.*	• Based on planned grazing and pasture management trials at pilot sites, upscale to other areas in the district to counter rangeland degradation. • Appropriate and practical grazing plans with which farmers comply can significantly buffer the apparent overstocking, but that will have to be linked to capacity in professional herders and reliable market access. • Share responsibility for implementation among farmers, NGOs that provide support & government agencies/institutions (e.g. ORI).
	Low offtake consisting of primarily larger, older animals has implications for quality of beef & consistency of supply *The traditional production system results in large oxen being marketed for beef, which has implications for quality, production costs & transport. It also carries higher risk of loss of animals during drought, although it is a traditional risk mitigation strategy for communal farmers. For free-range beef to be competitive & potentially access niche markets, it should be derived from animals <2years, which could improve supply of cattle to abattoirs, reduce production & transport costs, reduce rangeland degradation & result in high quality meat, fetching higher prices at the abattoirs. It would also provide a supply of suitable animals for feedlot finishing.*	• Encourage collective herding and kraaling as a strategy for holistic risk management. • Develop a conducive environment for feedlot investment where feasible to enable animals to be finished as necessary. • Increase level of understanding among farmers on the possibilities that CBT brings, as well as the requirements to ensure the quality, consistency & quantity of beef that are critical to sustained access to desirable markets. • Encourage farmers to market younger animals & incorporate weaner production. • Through consultation and discussion at farmers' days, DAP/DVS to introduce the concept of payment for quality rather than weight alone.
	Information pertinent to appropriate management of FMD in Ngamiland, including science-based information on the efficacy of the vaccination programme, is insufficient *The incidence of FMD in cattle has increased remarkably in Botswana despite regular vaccination campaigns being conducted 2 or 3 times/year. The reason for this is unclear & probably multi-factorial. Potential contributing factors include insufficient information on the epidemiology of FMD in Ngamiland, lack of an independent assessment of post-vaccination monitoring data, and the fact that the estimated size of the cattle population is founded on imprecise data.*	• State and non-state actors to conduct further research to provide the information needed to develop appropriate control measures. A list of potential research questions is provided in Annex C. • Independent assessment of post-vaccination monitoring data is needed to determine whether the current vaccine programme is being conducted effectively or not. • Depending on the results, ▪ develop a programme to establish the reason(s) for vaccine failure, institute corrective measures & assess their effect, or ▪ seek other reasons for repeated outbreaks of FMD in Ngamiland. • Obtain reliable information on size & distribution of the cattle population. • Improve understanding of SAT-type virus behaviour in both wildlife & livestock populations generally.
	Need to strengthen plan of action to deal with the Lake Ngami cattle population *Unvaccinated, feral cattle congregated around Lake Ngami poses an unacceptable FMD risk.*	• MoA to continue engagement with farmers associations to develop a mutually agreed plan of action to deal with the Lake Ngami cattle given the risk posed for all producers. • Consider the involvement of game capture contractors in the mutually agreed plan to ensure human safety.

	GAPS	RECOMMENDATIONS
ABATTOIR	**Lack of consistent supply of cattle to meet slaughter capacity & fulfil export quotas** *Seasonal fluctuations in cattle supply are usual in areas with a marked dry season & can only be overcome by systems based on proper planned grazing with supplementary feeding, including feedlots if appropriate and feasible. Other contributory factors in Ngamiland are the siting of the abattoirs in relation to the distribution of the cattle population & traditional production systems, as well as non-quality-related pricing that favours sale of older animals. Severely delayed payments are also problematic. In order to supply sufficient cattle to enable all three abattoirs to operate at capacity a change in the demography of the cattle population over time will be necessary.*	• Consider expanding the available production systems to include sale of younger cattle, weaner production & quarantine compliant feedlots. • In consultation with stakeholders including the farmers, initiate negotiations for quality-based pricing systems based on carcass grading & ensure that farmers understand the principles & importance of consumer preferences when accessing higher value markets. • Abattoirs to pay producers in a timely manner as delays disenfranchise them, affecting their ability to invest in their production system & participate in the formal market. • Consider undertaking an assessment, in consultation with producers, into the introduction of a grading system to encourage weaner production & provide incentive through increased prices.
	Potentially unsafe disposal of waste & condemned material *The project team observed that solid waste from abattoirs was disposed of at the unprotected municipal dump. While the local council has since taken steps to manage the situation, implementing waste disposal law & forcing abattoirs to comply, this still needs to be monitored.*	• Transform as much of the solid waste as possible on site into safe products or destroy it (condemned material). • GoB/DVS to review existing legislation on meat safety to ensure that legislation relating to handling & disposal of solid waste from abattoirs clearly specifies what is necessary for safe disposal. • Monitor abattoir waste disposal to ensure compliance with waste disposal law. • Over time review waste management plans to ensure they keep up with global environmental and social trends to ensure sustainability.
FURTHER PROCESSING & VALUE ADDITION	**Use of animal by-products is limited, leading to unrealised potential for the development of associated enterprises** *The development of industries around animal by-products (currently lacking in Ngamiland) could improve income along the value chain, reduce waste being deposited in the Maun landfill & contribute towards GoB's priority of job creation & economic diversification, particularly among women & youth.*	• Engage institutes with the requisite skills & expertise such as LEA's Leather Incubation Programme & Zimbabwe's University of Science & Technology. • For leather production, emphasise use of vegetable tanning agents (versus chrome tanning agents), which are more environmentally friendly & review the Branding of Cattle Act (once BAITS is fully functional) as branding reduces leather quality. • LEA/NGOs to explore SMME development centred on leather goods, soap & other tallow-related products, either for sale to wholesale markets or for production in smaller quantities aimed at high-end tourist lodges in northern Botswana.
PACKAGING & TRANSIT	**Insufficient mechanisms exist to ensure transit issues do not disrupt trade** *The transit of beef from areas of production in Ngamiland to current export markets is not at present a challenge, but potential challenges may depend on both the product type & requirements of the country of transit.*	• GoB to put in place mechanisms to avoid potential trade disruptions in the future through a process of bi-lateral negotiations with countries of transit & protocol development.

	GAPS	RECOMMENDATIONS
MARKETS	**Government run/fed institutions in Ngamiland should be encouraged/ incentivized to increase proportion of beef that is locally sourced** *Anything that can be done to augment local sourcing of beef from within Ngamiland merits consideration.*	• GoB to revisit procedures for sourcing of beef for government run institutions in Ngamiland, (schools, prisons, military, etc.).
	Lack of SMS-based market information system inhibits producers from effectively participating in formal trade *Market information systems based on simple text messaging services (SMS) which do not require internet connectivity are commonly used elsewhere in Africa to provide real time information on market prices & alerts on market channels (e.g. buying points, closures of abattoirs, appeals for cattle, etc.). This ensures that the information reaching producers is accurate & consistent & leads to a sense of empowerment.*	• MoA/BMC to develop a simple text based (or similar) system for Ngamiland that does not require either internet connectivity or smart phone technology for ease of use & maximum coverage of producers. Information to include all relevant aspects of the beef industry such as available capacity & pricing at abattoirs; buying points; vaccination campaign dates; outbreak alerts & requisite procedures; etc.
STAKEHOLDER COORDINATION, COMMUNICATION & OUTREACH	**Inadequate understanding of how pricing is determined (live weight vs carcass weight) is leading to disputes between BMC and farmers over future pricing once quarantine is established, and reluctance to sell to abattoirs in the interim** *The determination of live weight versus carcass weight pricing involves a series of concepts (age, quality, bruising, point of sale, transport & other additional costs/risks borne by farmers) which may not be well understood by producers & therefore affect their ability to make an informed decision.*	• Arrange farmer workshops in order to address this topic specifically. • Farmers to consider investing in scales (collectively at village level) or weight bands to estimate live weight before sale. • Farmers associations to communicate more widely to farmers about how prices compare.
	Inadequate understanding of FMD & its characteristics in the region affects outbreak & farmer response *Recent capacity building workshops have highlighted the need for further efforts targeting vaccination campaign staff & farmers on the basics of FMD in the field & relevance of vaccination.*	• Vaccination campaigns offer an important opportunity to refresh the minds of both farmers & technical staff on the basics of FMD & relevance of vaccination in FMD management. Other mechanisms such as regular crush meetings, use of crush leaders & farmers associations should be utilised to disseminate information on a periodic basis as opposed to once-off trainings.
	Distrust & inadequate communication has damaged the relationship between farmers & DVS, resulting in poor compliance *The current relationship between DVS & farmers has deteriorated to the point where it is becoming a factor inhibiting the successful implementation of CBT, primarily due to a lack of trust as accusations of non-compliance run in both directions. The rebuilding of trust will take time, and will require both parties fulfilling their roles & responsibilities to the best of their abilities.*	• Farmers' associations & DVS to establish mechanisms for periodic, open, honest & transparent communication between the parties where issues & challenges are constructively discussed. • Plan interventions (beyond just consultation) related to the challenges in the beef industry in Ngamiland with the relevant stakeholders, particularly the farmers, so that there is adequate ownership & participation in the uptake of interventions.

14. CONCLUSIONS

The list of recommendations in Section 13 may seem daunting, but it is important to remember that firstly, not all actions fall under the responsibility of DVS. As identified in the report, there are a host of stakeholders relevant in the wildlife friendly beef CBT landscape. One of the most critical roles of DVS and government as a whole is to establish a truly transparent an enabling environment that allows different stakeholders to identify and fulfil their particular role(s) in ensuring that the value chain functions successfully. This enabling environment must encourage and invite the participation of these stakeholders, rather than prohibit or limit such participation. As an immediate way forward, a stakeholder meeting was convened in July 2019 by the GoB in collaboration with AHEAD, with invitations to all key stakeholders (from development partners to NGOs, from farmers to academic institutions, and of course the private sector) to take responsibility for different actions to address the various gaps, individually or collaboratively, depending on their respective mandates (see Annex D).

Secondly, not all actions require monetary resources, but they do require coordination, synergy and partnerships. DVS has already established a FMD unit to be based in Maun, with an approved operational budget from Cabinet, which has been tasked with championing CBT. These functions of coordination and nurturing of partnerships ideally should be a function of this unit. Therefore, it is strongly advised that the Terms of Reference for the unit be reviewed and modified to capture and reflect the relevant recommendations of this report, and that the unit's operational plans reflect the same.

Thirdly, there are existing opportunities for synergy that could potentially be tapped into. For instance, the current focus area for the European Union's bilateral relationship with Botswana is capacity and skills development in the livestock value chain. The need for capacity development has come out strongly in our recommendations for addressing various gaps. Ngamiland also forms part of the KAZA TFCA. Engagement by DVS or the FMD Unit with the TFCA Unit in the Ministry of Environment, Natural Resources Conservation and Tourism can assist in ensuring that agreed priorities find their way into the various planning processes of KAZA, and that potential funding sources are explored.

Finally, as mentioned above, not everything can be resolved or needs to be resolved at the same time. A distinction has been made between those obstacles that threaten the entire value chain and therefore must be addressed as a matter of urgency, and those that offer "low-hanging fruit" in terms of being relatively easily addressed.

The implementation of a CBT value chain approach to support the production of WFB carries with it the potential for marrying the distinct competitive advantage of Ngamiland's wildlife-based economy with the needs of local communities to improve their food security and livelihoods through the age-old tradition of livestock rearing. Therefore, the work at hand is not just about improving and increasing agricultural output, but is also about securing the natural resource base and restoring and maintaining ecosystem health. The current pilot project at Habu village (as described in Section 12 of the report) exemplifies how communities can achieve this by sustainably benefiting from the natural resource base, rather than only bearing the cost of living adjacent to wildlife. In Habu, the community's decisions to move their cattle further away from the delta and adopt better husbandry practices whilst establishing wildlife-based enterprises serve to demonstrate the inherent value that most of Ngamiland's population places on wildlife and wild habitats. It is only years of hardship and a dearth of solutions to very real conflicts arising at the livestock-wildlife interface that have contributed to a negative attitude towards wildlife.

The GoB has committed to implementing CBT approaches to beef trade in Ngamiland. It is hoped that the recommendations in this report provide a platform to help guide such efforts, in collaboration with a host of other key stakeholders, in order to sustainably improve market access for Ngamiland farmers, diversify economic opportunities, enhance system resilience and enable greater coexistence between the livestock and wildlife sectors.

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ANNEX A: THE USE OF FENCES AS PART OF DISEASE CONTROL POLICY

Botswana, along with other southern African countries, has employed geographically-based measures, and in particular fencing, to control animal disease spread. Over 50 years ago, European Union (EU) treaties provided preferential market access agreements to southern African countries, aimed at promoting economic development. The commercial livestock sector, in particular, was a major benefactor of these agreements, with participating countries receiving lucrative returns for livestock products exported to recipient EU markets (Taylor, 2012; Barnes, 2013). Many traditional agro-pastoral livestock producers, however, being located outside veterinary cordon fenced zones in FMD-endemic areas like Ngamiland, were not beneficiaries of these agreements.

Engagement in these trade agreements required participating countries to comply with stringent animal health standards, and this resulted in significant negative consequences for wildlife populations and their associated dispersal or movement routes (Cumming et al., 2015; R. Taylor, 2010, unpublished report). The eradication of targeted wildlife species in some areas was followed by the establishment of FMD-free livestock export zones and adjacent FMD surveillance areas through the construction of thousands of kilometres of wildlife-proof fencing aimed at separating wildlife from livestock.

In Botswana, more than 10,000 km of fencing (including border fences) has been constructed over the years for animal disease control purposes in order to protect the cattle industry. The first FMD fences were constructed in 1954/55 (Botswana/Namibia border) and in 1958 (300 km Kuke fence) to separate buffalo populations in the higher rainfall areas in the north of the country from livestock populations in the drier regions to the south (Perkins, 2010). Further waves of fence construction took place in the 1980s and 1990s, including the buffalo fences surrounding the Okavango Delta. In addition, the 1995 CBPP outbreak in cattle in the extreme north-west of Ngamiland precipitated emergency construction of three east-west control fences (Samuchima, Ikoga and Setata), as well as the Caprivi Border fence, to try to limit the spread through cattle movement. Despite these control measures, the disease quickly spread, and the district's entire cattle population was culled to prevent further spread to the export zone[12]. Following this, the GoB extended the Northern Buffalo fence (1996/1997) to join the newly upgraded Caprivi Border fence (Albertson, 2010; Gadd, 2012).

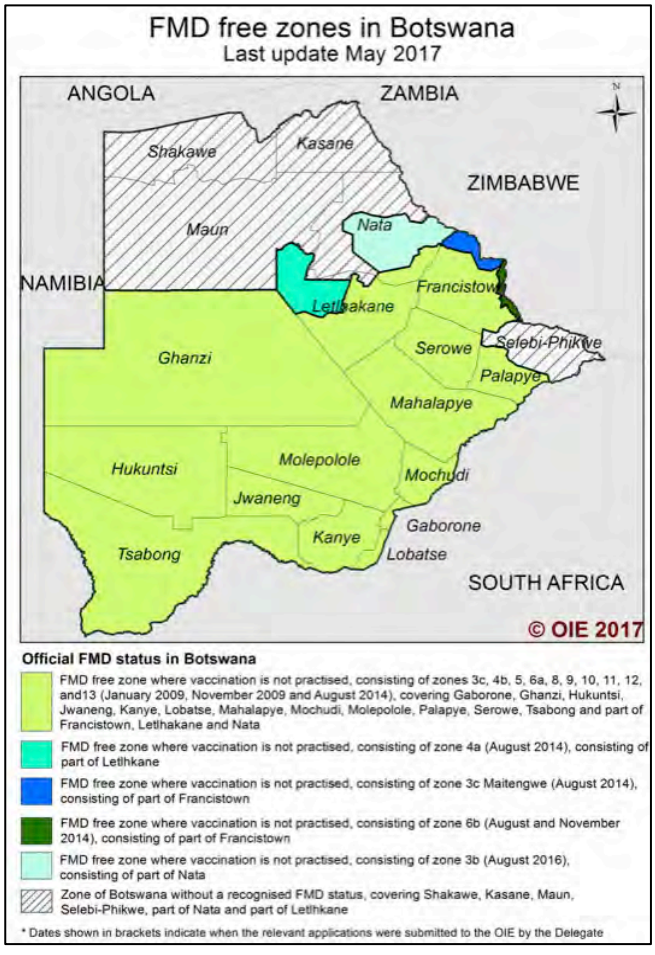

Figure A1. FMD-free zones in Botswana. Source: OIE.

Today, in order to meet international trade standards related to FMD set by the OIE, Botswana is divided into a number of veterinary zones containing livestock of different FMD health status (Figure A1). The FMD-free zones, or green zones, are located in the south while the FMD-infected zones, or red zones (grey-shaded areas in Figure A1), are located primarily in the

[12] CBPP has no wildlife reservoir and does not affect trade in beef but, unlike FMD, it can cause high mortality in naïve cattle populations.

north. Beef produced within the FMD-free zones can be sold for export to premium markets, while markets for beef in the red zones are currently limited.

DVS also maintains additional fences in the north, particularly within Ngamiland, to control the movement of cattle within zones. Thus, Ngamiland (Zone 2) is further divided into six sub-zones (2a-f – Figure A2). Sub-zones 2a-2d are FMD-infected zones with vaccination and sub-zones 2e and 2f are considered buffer zones. Vaccination was discontinued in sub-zone 2e in 2014 and DVS anticipates doing the same in 2f at a later date.

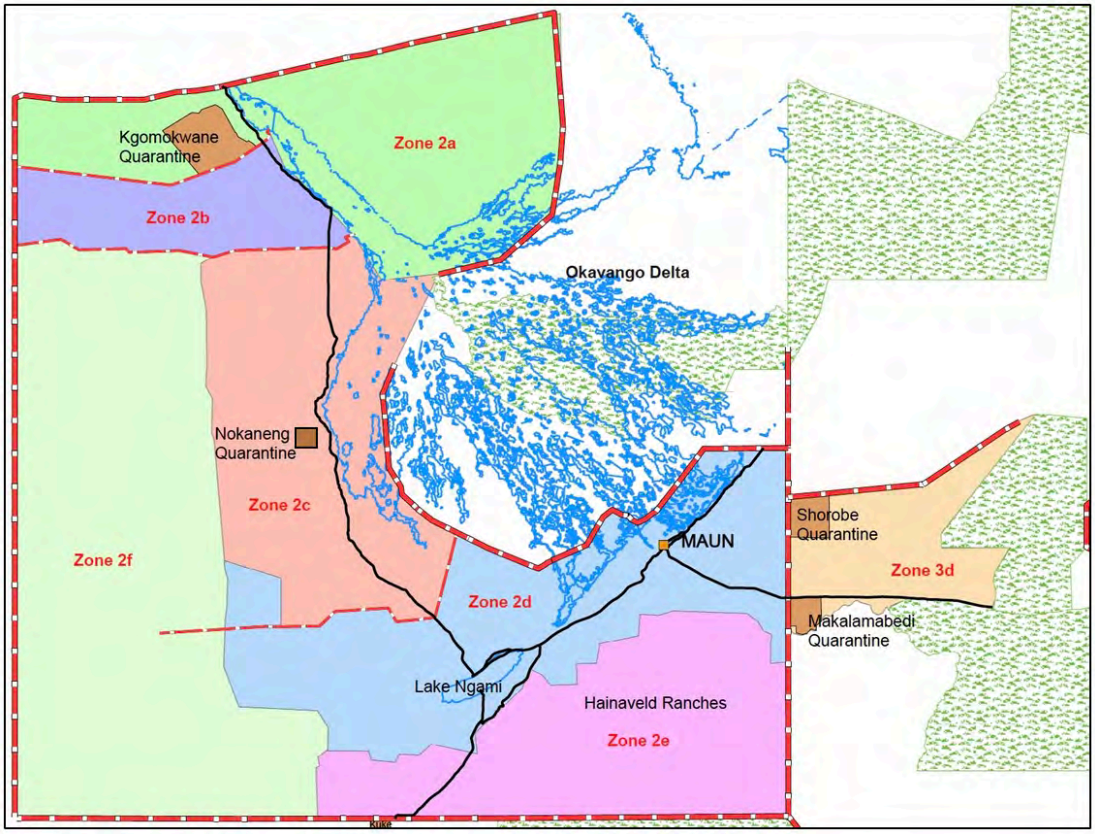

Figure A2. Ngamiland indicating FMD sub-zones, veterinary fences (red dotted lines) and quarantine stations. Source: adapted from DVS, 2018.

Impact of fences on wildlife and habitat connectivity

All the above fences were built without assessment of the impacts on wildlife populations. Whilst meeting the requirements of the commercial beef industry in the south of the country, the fences have contributed to the collapse of populations of wild ungulates by interfering with their seasonal movements relating to grazing and nutrient needs and blocking access to water in dry years (Cumming et al., 2015; Gadd, 2012; Osofsky et al., 2008). For example, the Kuke fence that runs in a linear fashion from east to west effectively separated Kalahari wildlife populations in western Botswana from the Okavango Delta. As a result, between 1978 and 2003, formerly abundant mobile populations of wildebeest (*Connochaetes taurinus*) and red hartebeest (*Alcelaphus buselaphus*) in the Kalahari system declined by an order of magnitude (Perkins, 2010). Wildebeest declined from 315,000 to 16,000 and hartebeest from 293,000 to 45,000 as a result of fragmentation of their range by fences (Cumming et al., 2015; Perkins, 2010).

The three CBPP fences, constructed through mostly cattle-free wildlife habitat, fragmented much of western Ngamiland and led to large mortalities of ungulates, particularly along the southern side of the Setata fence, as did the Northern Buffalo and Caprivi Border fences (Conservation International, 1998). Similar impacts

occurred in the Makgadikgadi system where cordon fencing separated the Makgadikgadi Pans ecosystem from the Kalahari ecosystem (Perkins, 2010), and cut off wildlife migration routes from the Okavango Delta to the Kalahari grasslands around Nxai Pan (Bartlam-Brooks et al., 2011). In addition, the adjoining Northern Buffalo and Caprivi Border fences entrapped wildlife in the Okavango Panhandle triangle, including large numbers of elephants (estimated at ~16,000 today - EcoExist pers. comm., Aug 2018); and effectively cut off north-south wildlife movement between Botswana and key habitats to the north – critical for long-term wildlife population viability within the larger KAZA TFCA.

Today, some of these fences are in a state of disrepair, which leads to additional negative impacts related to entrapment, not only of wildlife but also of cattle. In addition, the Southern Buffalo fence has proved expensive and logistically challenging to maintain. Breakages in the fence have allowed movements of cattle from the surrounding communal lands into the Okavango Delta during the dry season: it is estimated that more than 5,000 cattle are present in the western delta during the dry months (M. Hofmeyr, pers. comm., Nov 2018).

The negative impacts of fences on wildlife can, in some cases, be reversed once the physical barrier is removed. The retrospective Ngamiland Fences Environmental Impact Assessment (EIA) conducted by Scott Wilson (2000) recommended removal of the Setata and Nxai Pan fences. These were subsequently dismantled in 2003 and 2004. A study by the Kalahari Conservation Society concluded that "removal of the 210 km Setata fence and the 66 km portion of the Nxai Pan fence resulted in an immediate end to the negative effects on wildlife populations in the affected areas" (Mbaiwa and Mbaiwa, 2006). Bartlam-Brooks et al. (2011) also recorded the re-establishment of an historical zebra migration from the Okavango Delta to the Makgadikgadi grasslands shortly after the Nxai Pan fence was removed – one which is now the second longest ungulate migration in Africa, after that of the Serengeti. Despite these successes, in 2007, a decision was made by the then Department of Animal Health and Production to rebuild the Setata fence. However, in in 2008 the GoB agreed to leave a 100 km section of the fence open for wildlife movement (Gadd, 2012).

Ngamiland is a central part of the regional elephant range and a key part of two of KAZA's six core Wildlife Dispersal Areas (WDAs), namely the Kwando River and Khaudum-Ngamiland WDAs. As KAZA considers how to ensure habitat connectivity across the landscape and across borders, an important consideration is the position of cordon fences, e.g. the Northern Buffalo fence and the Namibia-Botswana Border fences – and their impact in terms of impeding wildlife movement and exacerbating human-wildlife conflict. In the case of Kwando River WDA, discussions between the Governments of Botswana and Namibia have yet to lead to concrete plans for removal or realignment of the fence despite several pieces of research highlighting the potential to reduce the impact of the fence without causing an increase in wildlife-livestock disease transmission (KAZA TFCA, 2014). Further, in Khaudum-Ngamiland WDA - the most westerly of KAZA's six WDAs - realignment of the partially dilapidated border fence would connect Khaudum National Park, and potentially some of the Namibian conservancies to the south, with western Ngamiland. This would re-establish wildlife connectivity between the Okavango Delta and important resource areas historically functioning as summer wildlife calving areas such as the Nyae-Nyae pans, and dramatically improve wildlife population abundance and resilience on both sides of the border, creating more economically-viable wildlife tourism development opportunities for both countries (Kalahari Wildlands Trust - https://www.kalahariwildlandstrust.com/wildlife-habitat-conservation.html).

The Caprivi Border fence and Northern Buffalo fence are clearly barriers to wildlife movements within Botswana and between the Okavango Delta and Namibia. In the 1990s, a 35 km gap in the Caprivi Border fence (west of the Kwando River) was created through the Government of Botswana's (GoB) Ad Hoc Committee on Fences. This now serves as one of the most critical wildlife corridors within KAZA, allowing elephants and other wildlife to move from northern Botswana through the Caprivi (now Zambezi Region) into southeast Angola (Chase and Griffin, 2009). However, the trapped Okavango Panhandle elephant population continues to pose challenges. Research suggests that re-alignment of the Northern Buffalo fence to include NG13 (a designated Wildlife Management Area), together with removal of an additional 100 km of the Caprivi border fence, would widen the wildlife movement corridor between Botswana and the Zambezi Region. It would also relieve elephant population pressure in the Panhandle (Songhurst et al.,

2015), and improve connectivity within KAZA's Kwando River WDA. More recently, it has been recommended (EcoExist pers. comm., Aug 2018) that consideration be given to the near-total removal of the Northern Buffalo fence, with just the lowest section remaining to demarcate the non-cattle zone in the delta to control cattle incursions. Additional bottlenecks of fences of "most concern" in western Ngamiland have also been identified by researchers (Figure A3).

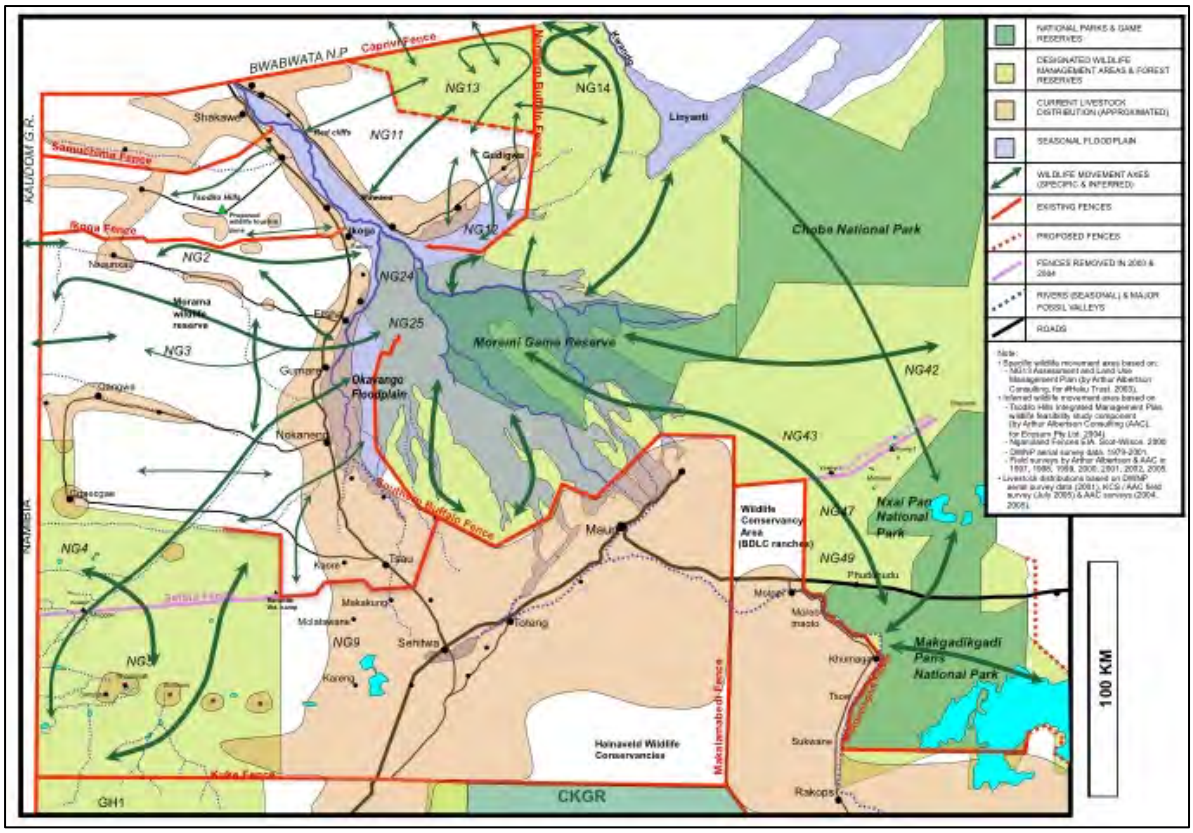

Figure A3. North-west Botswana: fences and wildlife movements (updated 2016). Source: A. Albertson.

Fence maintenance

DVS recently noted a number of challenges to maintaining fences in Ngamiland including: (i) lack of resources, especially transport, (ii) increased fence breakages by elephants and people, (iii) reduced accessibility due to flooding around the delta, and (iv) theft of fencing materials, especially gum poles. This has resulted in increased buffalo incursions (DVS, unpublished status report, 2017). As a result, today some of the fences are in a state of disrepair and therefore do not adequately serve their intended purpose.

While accurate estimates are often difficult to obtain because disaggregated government budgets are unavailable in the public domain (Thomson et al., 2013a), in 2015 DVS estimated maintenance costs at P36,680 per km, based on the MoA Fence Maintenance Cost Bill of Quantities. At a meeting with DVS (August 2018), Mr. Gaobatwe (Chief Scientific Officer, Veterinary Services Extension Coordinator) said that today's costs were more likely estimated at P47,000 per km.

No condensed review of the "State of Ngamiland Fences" exists; however, data on fence condition and breakages are being analysed for the Setata fence (A. Albertson, pers. comm., Aug 2018), and EcoExist expects to have estimates of breakages along the Northern Buffalo and Caprivi Border fences in the near future (EcoExist pers. comm., Aug 2018). Preliminary observations by both research groups indicate extensive elephant breakages along these and other fences, and with the expanding elephant population, this is likely to remain a persistent challenge. Indications of the extent of elephant breakages could mean an

annual bill of fences maintenance in Ngamiland exceeding P20 million. Any reduction in the number of fences needing to be maintained would therefore be a cost saving to the treasury; and materials salvaged where fences are decommissioned could further offset maintenance costs elsewhere.

Ad Hoc Committee on Fences

In response to negative publicity over the proliferation of veterinary fences in Ngamiland, including those constructed in response to the 1995 CBPP outbreak, a multi-sectoral gathering was convened in early 1997, initially called the Fences Committee, later called the "Ad Hoc Committee on Fences" (AHCOF) under the leadership of the then Department of Animal Health and Production. The objective was to create a forum where the Department of Animal Health and Production, DWNP and conservation NGOs could deliberate on issues related to cordon fences in Botswana in a positive and constructive manner. The committee proved to be a highly effective technical tool that offered key recommendations that were taken by government up to Cabinet level. As a result of the committee, critical decisions were taken such as creation of the 35 km wildlife corridor at the Kwando River on the Caprivi Border fence. Unfortunately, the momentum established by AHCOF in 1997 was not maintained, and by mid 1998 the Committee did not meet further. During the Scott Wilson Ngamiland Fences EIA work in 2000, a "Fences Reference Group" was also formed to deliberate on findings, and this later became the Fences Task Force. However, the task force did not remain functional.

The need for a forum such as the AHCOF remains extremely relevant today, in view of current CBT developments and the opportunities for land-use harmonization that CBT represents. Botswana stakeholders highlighted the need to resurrect the AHCOF at the KAZA-AHEAD-FAO CBT workshop in Victoria Falls in 2016 (http://www.wcs-ahead.org/kaza_ahead_fao_workshop_2016/kaza_ahead_fao_workshop_2016.html), and the Directors of DVS, DWNP, DAP, DEA and Department of Lands are currently in the process of reconstituting and reviving the AHCOF. Part of the role of this committee would be to review the functions of the various fences and weigh these against the ecosystem costs such as loss of habitat connectivity and wildlife migration routes. Those fences that continue to play an invaluable role in the management of disease risk from a livestock perspective must be identified and confirmed. However, the advent of innovations such as CBT, when applied to beef, offer alternatives to the traditional geographic-based approach to FMD-risk management that has been so reliant on fences.

ANNEX B: FOOT AND MOUTH DISEASE IN NGAMILAND, PAST AND PRESENT

Outbreaks of FMD in cattle in Botswana, as was the case in other southern African countries, occurred repeatedly between 1933 and 1981 (i.e. after the buffalo and cattle populations of southern Africa recovered from the Great Rinderpest Pandemic of 1896-1904). During the following 20 years (1982 – 2001) no FMD outbreaks were diagnosed in Botswana, including in Chobe and Ngamiland Districts where large concentrations of buffalo have historically been present. This FMD-free period coincided with the introduction of improved FMD vaccines manufactured locally by BVI. Since 2002, however, the incidence of FMD in cattle increased remarkably in Botswana despite regular vaccination campaigns against FMD being conducted two to three times a year in the north-west of the country (Table B1). The reason(s) for the resurgence of FMD is unclear and probably multifactorial. It needs to be appreciated, however, that the increase in cattle-associated FMD incidence since 2002 is not unique; other countries of the region have had the same experience in areas where wildlife and cattle populations interface (Thomson et al., 2013a).

The SAT types of FMD virus evolved in association with African buffalo over approximately the last millennium (Knowles, 2008). Furthermore, evidence that buffalo sometimes transmit SAT viruses to nearby cattle is irrefutable although the precise mechanisms of transmission are not fully understood (Vosloo & Thomson, 2017). SAT viruses, moreover, differ in a number of fundamental respects from Eurasian types (O, A and Asia 1), the other branch of the FMD virus species (*Aphthovirus* genus) that causes FMD in most other parts of the world and on which standards and recommendations for the control of FMD are predominantly based.

Viruses causing FMD in cattle in Botswana were, until 1977, exclusively SAT types 1 and 3; after 1977 SAT 2 outbreaks have predominated, as is the case in southern Africa generally (Derah & Mokopasetso, 2005; Thomson, 1994). Furthermore, almost all SAT 1 and SAT 2 viruses recovered from cattle in Ngamiland since 2007 have been shown by genome sequencing to be topotype III, i.e. the historical topotypes associated with western Zimbabwe and northern Botswana. There is consequently no reason to believe that the FMD problem in Ngamiland is not indigenous in origin.

Between 2002 and 2011 outbreaks of FMD occurred at various places in Botswana close to the Zimbabwean border (e.g. in the vicinities of Pandamatenga, Lesoma, Selibe Phikwe twice and Francistown). That led to the supposition that they originated from Zimbabwe and that was supported by the fact that FMD outbreaks in cattle in Zimbabwe increased dramatically after 2000; between 1996 and 2000 (5 years) only three FMD outbreaks were reported by Zimbabwe to the OIE, whereas in the following 5-year period 314 outbreaks were reported. In 2003 alone, 202 outbreaks occurred in Zimbabwe (OIE/Handistatus II, 2018 – accessed via www.oie.int). Phylogenetic analysis provided by the OIE and FAO World Reference Laboratory for FMD (WRLFMD – Pirbright, UK) also showed that at Selibe Phikwe in 2006 and 2011 and Francistown in 2011, SAT 2 topotypes II and I viruses were involved, respectively. Topotype I is foreign to Botswana but indigenous to south-eastern Zimbabwe/north-east South Africa. Similarly, topotype II has been rare in cattle in Botswana, an exception being at Mohembo West (Shakawe) in 2008. The outbreaks at Pandamatenga and Lesoma in the Chobe District were both caused by SAT 2/topotype III viruses which are indigenous to that area. A further useful piece of information provided by genome sequencing is that the viruses involved in FMD events in cattle in Chobe and Ngamiland districts have so far been caused by different viral sub-lineages, i.e. indicating that FMD in cattle in these two districts have so far been unconnected.

Conversely, close relationships were found to exist between viruses derived from cattle in the Zambezi Region of Namibia, southern Zambia and the Chobe District. For example, in 2008 a SAT 2/topotype III virus caused FMD at Satau, Chobe; that virus was closely related to viruses that occurred in cattle in southern Zambia in 2007 and also in the Zambezi Region of Namibia in 2008. It was revealed by a project conducted in the Zambezi Region of Namibia that unofficial cross-border trade in cattle occurs commonly in the border areas between the three countries (Meat Board of Namibia, 2014).

Table B1 summarises data reported to the OIE (World Organisation for Animal Health) for 11 FMD events[13] and 51 associated outbreaks in Ngamiland that began in October 2007 and have continued to the present (July 2018). These events were almost all (9/11) caused by SAT 2 viruses and, where the topotype could be identified, all were topotype III. The exceptions were short-duration (4 month) events caused by SAT 1 viruses at Mahembo East (Zone 2a) and at Tubu in the Gumare area (Zone 2c) in 2014/15 (Events 5 & 6, Table B1). These two events resulted from infection with two different lineages of SAT 1/topotype III viruses as shown by genome sequencing (data not shown).

On average, FMD events in Ngamiland have lasted 9 months (range 4–25.5 months) and consequently Ngamiland has been more or less continuously afflicted by FMD in cattle for all but 22% of the time between October 2007 and July 2018, i.e. a period of 10 years 7 months. This provides a measure of the extent of disruption to cattle production and trade in animal commodities over that decade. On the other hand, the direct effects of FMD on cattle over this period were limited, evidenced by apparent morbidity rates)[14] reported to the OIE. In 6/11 events the apparent morbidity rate was below 5%; the two highest were 31.6 and 32.7% for events 8 and 13 (Table B1). It needs also to be recognised that, as is the case with SAT viruses in southern Africa generally, FMD in cattle in Ngamiland is a mild disease with very low mortality (Vosloo & Thomson, 2017). So FMD in cattle in Ngamiland, like SAT-type FMD in southern Africa generally, is characterised by low morbidity, which contrasts with the FMD situation in most other parts of the world (OIE/WAHID, 2018; Vosloo & Thomson, 2017).

A difficulty related to FMD events and outbreaks summarised in Table B1 is that the beginning and end of events, and therefore their duration – as reported to the OIE by DVS – was based on the appearance and subsequent cessation of clinical cases of FMD and their geographic and temporal associations. However, genome sequencing data that subsequently became available showed that lineages of SAT 2/topotype III viruses found in Ngamiland over the period 2007–2018 are not always reconcilable with events and outbreaks as reported to the OIE. For example, some viral lineages were apparently associated with more than one reported event (e.g. Event 1, Table B1) while, conversely, some events involved more than a single virus lineage. Perhaps the best example of this phenomenon is SAT 2 viruses isolated in Ngamiland between 2012 and 2018; these appear to be members of a distinct lineage (labelled B), separate from another that was also prevalent in 2012. The latter lineage, in turn, is related to the viruses that caused the original FMD event (Event 1 – Table B1) detected at Habu in 2007 (Figure B1). It is possible that only two lineages of SAT 2 virus (labelled A and B) were involved in FMD events in Ngamiland between 2007 and 2018 (Figure B1).

[13] A FMD event comprises one or more epidemiologically related outbreaks of FMD.

[14] Apparent morbidity rate – the number of diseased animals as a percentage of the susceptible cattle population.

Table B1. FMD events in cattle recorded in Ngamiland between 2007 and July 2018.

FMD event number	Date (duration)	Initial location (& areas of spread)	Virus type/ topotype	No. outbreaks reported	Apparent morbidity rate (%)	Comment
1	17/10/07 – 30/11/09 (25.5 mths.)	Initially Habu Extension Area (EA). In April 2008: Kareng EA, Bodibeng EA, Toteng EA, Semboyo EA, Nokaneng EA, Sehitwa EA, Mohembo West)	SAT 2/ topotype III[15]	9	14.3 initially at Habu 0.7 in outbreak of April 2008	Initially the event was restricted to the Habu vicinity. In April 2008 cases occurred at other locations of Zones 2c and 2d. Two different lineages of SAT 2/topotype III virus were obtained from cattle early and late in the event. This indicates that two separate events were actually occurred.
2	4/2/11 – 6/6/11 (4 mths.)	Kaepe Crush, Maun (Zone 2d)	SAT 2/ topotype III	1	5.5	The event involved only 14/250 cattle and clinical cases occurred over less than one month.
3	17/9/11 – 15/5/12 (8 mths.)	Itoto, Maun (Zone 2d)	SAT 2/ topotype III	1	1.25	Only 15/1200 cattle were diseased and the event did not spread. Therefore, the official duration of the event seems unnecessarily long. Virus involved was a different lineage from the virus involved in Event 1.
4	23/5/12 – 20/5/14 (24 mths.)	Tam, Bodubatau, Sibanda, Gumare, Mphapha, Mhapo, Maila 1, Katoo, Mmamotaung & Namanyone crushes (Zone 2d). Subsequently cases also occurred to Zone 2c.	SAT 2	2	Not accurately determined	Event followed flooding which made access to cattle for vaccination in April 2012 difficult; flooding also damaged the buffalo fence enabling buffalo/cattle contact. Only 148 clinical cases were identified during the two-year event.
5	19/06/14 – 31/10/14 (4.5 mths.)	Mohembo East & Xaukwe Crushes (Zone 2a)	SAT 1/ topotype III	2	3.1	Event did not spread beyond the two crushes. Clinical end-point reached within a week. Two lineages of SAT 1/topotype III identified in samples from the event (one from Mohembo East, Shakawe - Zone 2a). Therefore, the second outbreak actually represented a separate event.

[15] The virus type was initially shown as SAT 1 but later changed to SAT 2.

FMD event number	Date (duration)	Initial location (& areas of spread)	Virus type/ topotype	No. outbreaks reported	Apparent morbidity rate (%)	Comment
6	27/10/14 – 28/2/15 (4 mths.)	Tjaa Crush, Tubu, Gumare (Zone 2c)	SAT 1	2	Initially 3.1	Event did not spread although 1 case occurred about 6 weeks after the initial 44 cases.
7	9/3/15 – 31/8/15 (5.5. mths.)	Initial occurrence at Maxebo Crush, Kareng (Zone 2d); later outbreaks at Magato/Motopi II, Kaepe/Moagi, Maego/Itoto/Dentshaa/Xharaxhe & Hallelujah	SAT 2	5	Initially 4.0, later 1.7, 2.1, 0.4 & 4.2	Event first detected at pre-loading inspection of cattle destined for a local abattoir. Last case detected on 17 April 2015.
8	26/7/15 – 31/3/16 (8 mths.)	Initial occurrence at Segongwana Crush, Hainaveld Ranches (Zone 2e); later outbreaks at Nametsapelo, Morula, Boitapoloso, Pelotshetlha, Matabologa 2, Matabologa 1, Kuke Quary/Thapolathari & Malalakgakana (all Zone 2e)	SAT 2	9	Initially 31.6; later outbreaks collectively 1.3	Last case identified at Malalakgakana on 20 August 2015.
9	3/8/15 – 30/3/16 (8 mths.)	First cases at Gubago Crush, Shorobe EA (Zone 2d). Later outbreaks at Xhoxao, Mabudisa & Mazumbi	SAT 2	4	Initially 15.3; later outbreaks 0.5, 0.8 & 0.4 respectively	Last case detected on 4 September 2015.
10	19/09/17 – 19/3/18 (6 mths.)	Namanyane Crush (Zone 2d)	SAT 2	1	32.7	Event did not spread from the only crush area affected.
11	9/6/18 - ?	Naune Crush in Zone 2d initially; subsequent spread to Sehitwa Tanks, MaMotaung, Kgomotshetlhana 1, Xushe, Hengari, Mapute II, Moruleng East in Zone 2d and Tsau, Setata, Mokuchoma, Tsua Borehole & Habu – all in Zone 2c	SAT 2	15	1.3 initially; later outbreaks 0.5	Event apparently spread from Zone 2d to 2c.

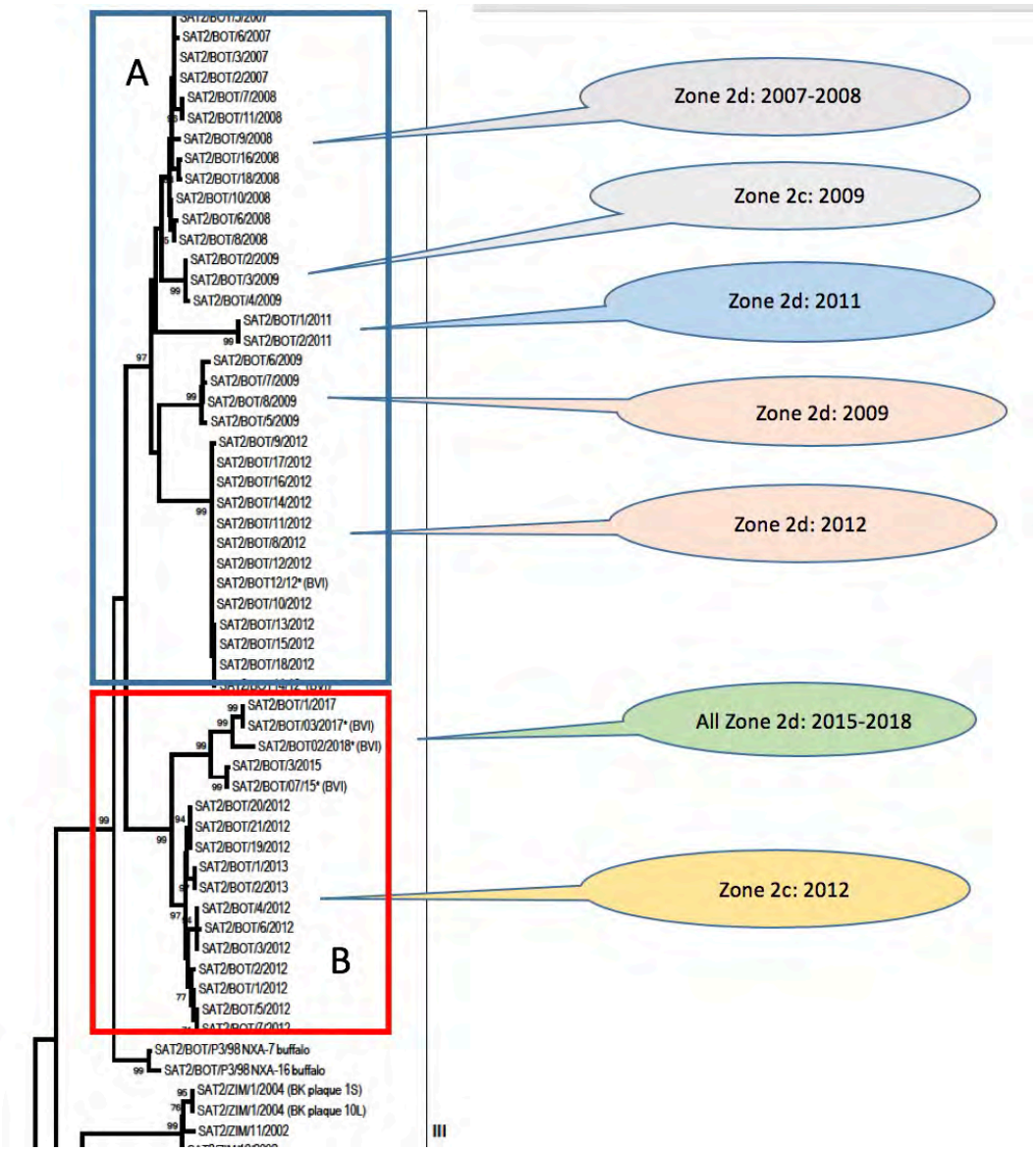

Figure B1. Phylogenetic tree (lower non-relevant part truncated to fit on page) of SAT 2 topotype III viruses showing relationship between viruses and cattle outbreaks in Ngamiland.

There are three possible interpretations for the broad picture outlined above, reflected in Table B1 and Figure B1. (1) Regular introduction of the viruses into the cattle population through contact with buffalo herds. It is known that introduction of FMD viruses into the cattle population occurs at the interface, but many parts of Ngamiland are not interface areas yet they report outbreaks, whereas we know that the interface can at times be quite large in the delta, yet no outbreaks are reported. (2) Recrudescence of shedding of virus in recovered cattle from which FMD virus can be retrieved from the pharynx for months or years after infection, i.e. 'carrier' cattle. Considerable research over many decades has been unable to provide evidence of recrudescence of shedding or potential to transmit the virus by natural means in such cattle (Bronsvoort et al., 2016), so for all practical purposes this scenario is not favoured as an explanation for maintenance and circulation of FMD in cattle in Ngamiland. (3) Endemic circulation of FMD in cattle populations after relatively infrequent introductions from buffalo contact, with only periodic occurrence of clinical FMD. The level of contact within the cattle population of Ngamiland is probably high enough to

sustain such circulation, even though individual cattle are only infectious for a maximum period of about a month, because, particularly during drier periods, cattle herds will mingle at places where water and grazing are available. Transmission of virus by acutely infected cattle showing no clinical signs has been reported (Charleston et al., 2011; Sutmoller & Olascoaga, 2002), and it is probable that cattle with mild clinical signs will escape observation, particularly as the level of observation by owners or herders is reportedly low. Endemic circulation of FMD virus in unvaccinated or inadequately vaccinated cattle populations is well described, and vaccination coverage in Ngamiland is believed to be inadequate at certain times of the year. Furthermore, protection is of short duration, with the recommended frequency of vaccination for the area being three times per year, and a proportion of the vaccinated cattle may no longer be protected by the time revaccination occurs.

In other words, it may be that SAT 2 viruses have become endemic to the cattle population of Ngamiland and are only periodically evident through the occurrence of clinical FMD. This is analogous to the situation with respect to SAT viruses in East Africa. Such circulation does not depend on the presence of long-term carriers and has been recognised for a number of viral diseases. The classic example is rinderpest, now eradicated globally, which spread to and persisted in most parts of the world in the absence of a carrier state. Avian influenza is a further well known and important example.

Sub-clinical infection with SAT types of FMD viruses occurs commonly in African wildlife, buffalo especially (Thomson et al., 2003; Vosloo et al., 2009), and has been reported in cattle from other parts of the world (Henderson 1985; Sutmoller & Cassas Olascoaga, 2002). There is also good evidence for this phenomenon in cattle infected with SAT viruses in other parts of southern Africa (Vosloo & Thomson, 2017).

Progress on better understanding of the epidemiology of FMD in Ngamiland, i.e. differentiation between the three possible scenarios outlined above, will depend on systematic sampling of the buffalo populations in and around Ngamiland and more systematic studies on Ngamiland cattle in future. Limited sequencing data on virus isolates obtained from buffalo in Botswana are available, with almost none from Ngamiland in recent times.

Control of FMD in Ngamiland

Control of FMD in Botswana in modern times has had two objectives: (1) keeping the disease out of the 'green (FMD-free) zones', thereby enabling beef exports to the EU and other high value beef markets, and (2) controlling the disease as effectively as possible in endemic areas of the country. In the latter respect control of FMD in Ngamiland has, as is the case in other southern African countries such as Namibia and South Africa, been founded on a combination comprising mass prophylactic cattle-vaccination programmes and separation of cattle and buffalo populations through cordon fences, e.g. the Northern and Southern Buffalo fences.

The integrity of the buffalo fences for achieving separation between cattle and buffalo populations is widely recognised as being inadequate, primarily because maintenance of extensive fencing systems subject to on-going elephant and human damage and periodic flooding is tedious, difficult and expensive (see also Annex A). During the course of the WFB project, anecdotal reports came to the team's attention concerning the periodic large-scale ingress of cattle to the Delta through the buffalo fences during the driest months of the year, as well as occasional egress of buffalo to cattle-raising areas of Ngamiland during wet seasons. However, it appears that the extent of this problem has never been accurately measured.

The vaccination issue is covered in Section 3.4 of this report, which concludes that there is *prima facie* evidence for the current vaccination programme being inadequate.

Knowledge gaps - possibility of eradicating FMD from Ngamiland

It was evident during workshops and other interactions associated with the WFB Project that there is belief in Botswana among both livestock owners and animal health professionals that FMD can be eradicated from Ngamiland. This idea is reinforced by the fact that in other parts of the world, such as the European Union and large parts of South America, FMD has been eliminated, principally through mass vaccination programmes (Leforban & Gerbier, 2002). On the other hand, based on purely technical considerations, including the presence of wildlife species such as buffalo and other major differences between features of SAT and Eurasian FMD viruses, eradication of SAT infections in the context of southern Africa has been shown to be unlikely (Thomson & Penrith, 2017).

With that in mind, together with the unequivocally high incidence of FMD events in Ngamiland cattle over the last decade, it needs to be recognised that elimination of FMD from Ngamiland within the foreseeable future is highly improbable unless new technologies and/or approaches become available. It is suggested that this issue be addressed more objectively in future because it has wide-ranging implications and influence over the expectations of a large section of Botswana's civil society. Moreover, the FMD problem in Botswana generally and Ngamiland specifically will not be satisfactorily addressed until the local epidemiology of FMD is better understood. That can only be achieved by appropriate investigation/research conducted during both FMD events/outbreaks and inter-epidemic periods. Apart from limited exercises based on sequencing of viruses isolated during cattle outbreaks, there is no evidence of such research. Consequently, a difficult, complex and evolving problem is being addressed on the basis of historical understanding founded mainly on international recommendations which do not even pay passing reference to the specific SAT virus/wildlife challenges confronting southern Africa.

A specific knowledge gap also exists in relation to the FMD viruses maintained by buffalo populations in Ngamiland and Chobe. As a result, the genome sequencing data available on SAT viruses involved in cattle events in Ngamiland, while informative, does not enable investigation of the precise role of buffalo. Currently available data shows that several SAT 2/topotype III virus lineages have circulated in Ngamiland cattle in recent years. However, whether this is evidence of frequent buffalo virus introduction into the cattle population or whether some lineages are circulating in the cattle population undetected is still open to speculation.

Another fundamental question is whether the majority of cattle involved in FMD outbreaks do not become infected or whether only a proportion of infected animals develop disease. This is a crucial issue if FMD in places like Ngamiland is to be better understood.

Unless and until these areas of uncertainty are satisfactorily addressed, together with ways of enhancing the efficacy of the vaccination programmes against SAT viruses, improved management of FMD in Ngamiland and similar locations in southern Africa will remain extremely challenging.

ANNEX C: RESEARCH AREAS IN RESPECT TO SAT-SEROTYPE FMD IN SOUTHERN AFRICA

This outline of potential research topics is meant to be illustrative, not exhaustive.

1. Investigation into possibilities for improvement in the performance of vaccination as a control strategy against SAT serotype FMD in southern Africa.
    a. A system for establishment of FMD topotypes circulating in wildlife in specific locations, e.g. Ngamiland (previous attempts seemingly provided no worthwhile results). That will enable practical investigation into 'matching' of available vaccine strains and SAT viruses circulating in wildlife populations.
    b. Investigation into the differences between SAT viruses involved in outbreaks in the SADC region before and after 2000 (i.e. to establish whether continual routine vaccination with the same vaccine strains is responsible for the apparent increase in SAT outbreaks in cattle in southern Africa since 2000).
    c. Possible use of high potency vaccines to modify susceptibility to infection of both buffalo and cattle.
    d. Renew attempts to identify ways to broaden vaccine-induced immune responses of cattle to the wide antigenic diversity of SAT virus variants in circulation in the field in southern Africa.

2. Development of scientifically-based best practice associated with trading of livestock and livestock products in endemic zones while FMD outbreaks are on-going.
    a. Development of a draft SADC approach for management of SAT outbreaks in areas outside FMD-free zones, including principles for integrating FMD management and trade so that periodic FMD outbreaks of limited geographic extent do not bring livestock production and trade to an abrupt and long-lasting halt.
    b. Work towards incorporation of this aspect into the Regional FMD Control Strategy.

3. Further investigation into the apparent epidemiological differences between SAT- and Eurasian-type FMD described by Vosloo & Thomson (2017); these differences have fundamental implications for management of FMD in southern Africa and the relevance of international recommendations for FMD control as well as sanitary standards associated with trade (e.g. the FAO/OIE Progressive Control Pathway for FMD, and OIE Terrestrial Animal Health Code).
    a. Mechanisms and dynamics of SAT virus transmission between buffalo and other commonly infected species, cattle especially.
    b. Evaluation of the reasons for the apparently slow horizontal spread of mild and unapparent SAT infections of cattle populations in southern Africa.
    c. Investigation into excretion rates of SAT viruses with apparently reduced pathogenicity for cattle.
    d. Analysis of the deficiencies and consequent possible amendments to render the PCP-FMD more relevant to management of SAT-type FMD in southern Africa.

4. Evaluation of CBT approaches for production and marketing of small stock and products derived from them in FMD endemic areas.

5. Investigation into the prevalence of virus circulation in cattle and other animals sub-clinically infected with SAT viruses, SAT 3 in particular, in and around transfrontier conservation areas.

6. Investigation into the advantages and disadvantages of using mobile abattoirs and quarantine systems for managing trade associated FMD risk.

7. Evaluation of the diagnostic potential (i.e. sensitivity and specificity) of laboratory tests for SAT-type infection in African wildlife species, e.g. buffalo, impala and kudu. Without this information trade and/or translocation of wildlife is rendered problematic.

8. Evaluation of selected higher value processed beef products, e.g. smoked beef, salami, various sausages, and perhaps biltong with a higher moisture level than specified, for persistence of FMD virus with a view to expanding the range of acceptable products for export.

9. Comparison of the economics of the current cattle production, marketing and pricing systems in Ngamiland with a modern weaner-based production system that includes price differentiation through carcass grading.

ANNEX D: SUMMARY OF STAKEHOLDER VALIDATION WORKSHOP

Prior to finalising the gap analysis, Botswana's Department of Veterinary Services (DVS), in partnership with Cornell University's AHEAD programme, hosted a stakeholder validation workshop in Maun from 30 July to 1 August 2019. The Rockefeller Foundation, Cornell's David R. Atkinson Centre for a Sustainable Future and the European Union provided additional support.

The forum, officially opened by Paramount Chief of the Batawana, Her Majesty K. Moremi and the Minister of Agricultural Development and Food Security Hon. Fidelis M. Molao, emphasized the bringing together of key stakeholders within Ngamiland to:

- Establish a common understanding of CBT approaches to beef production,
- Review and evaluate the identified gaps along the value chain, as well as potentially identify additional ones, and
- Identify, through a participatory process, where and how stakeholders might play roles in filling those gaps.

Over the three day period, 105 participants attended the workshop, including technical experts from both the livestock and wildlife sectors, representatives from Ngamiland farming communities, traditional and local government authorities, as well as stakeholders from the private sector (including the beef and tourism sectors), development partners, NGOs, diverse government departments, and academia. A full participant list can be found in Table D2.

Paramount Chief Moremi and Hon. Minister Malao at the official opening.

The workshop was designed such that members of the gap analysis team presented the main findings of the report, focusing specifically on the gaps (or challenges) identified as potentially hindering the successful implementation of CBT in Ngamiland, together with corresponding recommendations. After a series of presentations on Days 1 and 2, participants broke into groups each afternoon to verify the presented gaps, to suggest modifications and/or to enumerate additional ones, where necessary. These were then discussed during plenary sessions and agreed submissions have been incorporated directly into the final gap analysis. Additional presentations were made by the OIE and several conservation organisations, which together provided context from international animal health and human-wildlife conflict perspectives.

On Day 3, participants divided up by sector, specifically (i) government; (ii) farmers; (iii) NGOs and academia; and (iv) private sector and development partners to consider how they could contribute towards addressing the identified gaps. The session was designed to allow for discussion and engagement, initially amongst members of the same sector, and subsequently between sectors. While the different groups were not able to go through all of the gaps listed in the report during the limited time available in a workshop setting, and acknowledging that not all role players were present, illustrative initial thoughts were captured and are presented in Table D1. This starting point can hopefully serve to stimulate further discussion and consideration by CBT role players as to how they can best support implementation of CBT in the district.

Notably, during this process participants recognised that stakeholders other than government and farmers have significant roles to play in order for CBT of beef to be successfully rolled out. Farmers themselves identified the need for a change in their mindset and recognised the need to take greater responsibility in complying with risk mitigation strategies along the value chain. Government reaffirmed that in order for farmers to comply with the animal production systems in place, those systems must be fully functional, with

increased accountability and transparency on the part of government. And both farmers and government officials noted the value of collaborating with conservation NGOs supporting improved livestock husbandry practices and mitigation of human-wildlife conflict within farming communities. The private sector expressed the need for a review and improvement of the enabling environment so as to foster business investment and innovation in the district. Overall, while some participants expressed that the complexity of how the various components and players of the value chain fit together was somewhat overwhelming, virtually all stakeholders indicated they felt hopeful that the challenges were surmountable through increased collaboration.

Going forward, the Director of Veterinary Services, Dr L. Modisa, invited stakeholders to embrace the CBT approach for beef production in the district, welcomed their participation and committed his department to addressing key operational shortcomings identified within the gap analysis.

Workshop participants on Day 1 (top); plenary report back of group discussions (middle); sectoral input into filling the gaps on Day 3 (bottom).

Table D1. Sector groups identify ways to contribute towards addressing identified gaps for the successful implementation of CBT of beef in Ngamiland (illustrative, not exhaustive).

Key:

 Government  Farmers  NGOs/ Academia  Business/ Private sector  Development partners

	Gaps	Example of who could help address this gap	By doing what?
FIELD	Good animal husbandry and livestock management practices not being implemented sufficiently	 • DAP, Agribusiness • DVS	• Farmer training • Ensure compliance
			• Improve breeding stock & quality – government could consider bull subsidy • Improve rangeland management (with NGOs) • Improve record keeping, herding etc. (with NGOs) • Strengthen farmers associations (with NGOs & DVS) • Change of mindset on husbandry practices • Invest in infrastructure through government schemes – e.g. ablutions, etc. to prevent measles
			• Support farmers with: a. Kraaling & herding b. Health care c. Human-wildlife conflict mitigation • Monitor CBT compliance & implementation protocols • Put in place conservation agreements
			• Capacity building on animal husbandry & production (e.g. FAO) • Assist GoB in developing sound national & regional livestock strategies/policies (e.g. FAO, AU, SADC, etc.)
	Low offtake consisting of primarily larger, older animals has implications for quality of beef & consistency of supply		• Encourage & support weaner production
	Overstocking & overgrazing are leading to rangeland degradation		• Support farmers with: a. Group herding b. Kraaling c. Capacity development on good rangeland practices d. Planned grazing e. Mobile abattoirs • Establishment of local butcheries/slaughterhouses

	Gaps	Example of who could help address this gap	By doing what?
FIELD	Challenges surrounding BAITS are inhibiting its successful implementation in Ngamiland	 • DVS	• Ensure system functionality • Farmer training • Ensure compliance • Train BAITS Agents
			• Encourage more acceptance of BAITS - take greater ownership • Encourage compliance • Facilitate increased internet connectivity • Buy equipment like applicators • Increase interaction with system, including getting trained on its application
			• Support the establishment of clusters, aggregate herds, grazing committees & cooperatives for easier traceability • Facilitate increased internet capacity
			• Continue to develop internationally harmonised guidelines for animal identification & traceability, which can serve as a useful guide to member states • Capacity building on animal identification & traceability
QUARANTINE	In terms of the production of chilled or frozen beef, the requirement for pre-slaughter quarantine of cattle is currently resulting in a bottleneck due to producer reluctance to quarantine their animals		• Liaise with tourism companies operating in Ngamiland which offer a large market for beef for staff rations that do not have specific quality or cut requirements (& do not require quarantine)
			• Help develop value-added products whereby beef is considered safe without cattle quarantine • Encourage targeting markets that don't require quarantine
	The location, holding space & physical state of existing quarantine stations are factors limiting quarantine capacity		Where feasible/viable, consider: • On farm quarantine • Compartments, noting current regulatory limitations • Community quarantines
			• Provide capacity (expertise & experience) on mobile quarantines
	Lack of a comprehensive biosecurity plan for quarantine stations		• Provide capacity (expertise & experience) on biosecurity
	Lack of QS environmental management plan and inadequate grazing capacity to meet potential abattoir throughput demand		• Provide capacity (expertise & experience) on skilled herding & rangeland management

	Gaps	Example of who could help address this gap	By doing what?
ABATTOIR	Insufficient focus in some abattoirs on implementing Hazard Analysis Critical Control Points (HACCP) or HACCP-like systems to increase spectrum of available markets	 • DVS	• Ensure compliance • Monitoring & evaluation
			• Capacity building to improve understanding of veterinary public health concepts, such as HACCP & meat inspection to enhance good abattoir practices and market compliance
	Potentially unsafe disposal of waste & condemned material	 • DEA, Environmental Health, Waste Management, Police	• Ensure compliance
	Lack of consistent supply of cattle to meet slaughter capacity & fulfil export quotas		• Encourage & support weaner production • Dialogue with BMC & private abattoirs to do grading for value addition
FURTHER PROCESSING & VALUE ADDITION	Range of secondary beef products is limited		• Re-engage government on previous processed product recommendations/proposals
	Potential market for WFB offered by Ngamiland's tourism industry not being realised		• Support branding of organic grass fed beef from Ngamiland as WFB
			• Tourism companies operating in Ngamiland to liaise with NGOs working on WFB brand certification & communities on direct purchase of WFB beef
			• Support the establishment of model simple but compliant facilities for processing Ngamiland beef
MARKETS	Entities such as Ministry of Investment, Trade & Industry and the National Strategy Office have not been co-opted adequately in the exploration of markets for CBT beef	 • MoA (DVS)	• Identify & co-opt other important government stakeholders to participate in the value-chain
			To help elevate sanitary conditions and market access: • Continue to develop science-based, harmonised sanitary standards to enable fair & safe trade in animals & their products • Provide capacity (expertise) to facilitate compliance with market requirements

	Gaps	Example of who could help address this gap	By doing what?
FMD OUTBREAK CONTROL	Approaches to managing FMD outbreaks are not fully aligned to CBT, causing trade disruption & affecting investor confidence	 • DVS	• Develop & disseminate relevant SOPs
			Encourage & support: • Timely vaccination - encourage neighbours to vaccinate • Herding • Reporting of FMD incidents through use of toll-free number of the ministry
			• Engage communities on the ground during development of SOPs & protocols • Provide technical assistance to DVS, if requested, on SOP development
			• Continue to support national Veterinary Services in the control of FMD
FENCING	Lack of clear understanding of the state, impact, purpose & cost of the fencing inventory of Ngamiland		• Assist National Committee on Cordon Fencing, help source funds for fencing assessment • Assess & monitor fences & landscape connectivity
STAKEHOLDER COORDINATION, COMMUNICATION & OUTREACH	Inadequate understanding of how pricing is determined (live weight vs. carcass weight) is leading to disputes between BMC and farmers over future pricing once quarantine is established, and reluctance to sell to abattoirs in the interim		• Support efforts to better understand how pricing is determined
			• Capacitate communities & farmers through workshops on how pricing is determined
	Inadequate understanding of CBT & the role that different stakeholders need to play in its successful implementation		• Provide support for trainings/ workshops & translating documents into Setswana (e.g. CBT Guidelines)
	Ground level activities amongst farmers, NGOs & government entities need to be coordinated		• Strengthen collaboration, information sharing & coordination through existing working groups

Table D2. Validation workshop participant list.

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Table D3. Validation workshop programme agenda.

GAP ANALYSIS FOR IMPLEMENTATION OF CBT OF BEEF IN NGAMILAND: STAKEHOLDER VALIDATION WORKSHOP *Maun, Botswana – 30 July-1 August 2019*		
Arrival Day – 29 July 2019		
17:30	Registration	
Day One – 30 July 2019		
TIME	**SESSION/ACTIVITY/PRESENTATION TITLE [SESSION CHAIR]**	**PRESENTER**
07:30	Morning registration opens; tea & coffee available	
	OPENING SESSION [Chair: L. Modisa]	
08:30	Opening Prayer	Volunteer
08:35	Introduction of Dignitaries	District Commissioner Ngamiland, K. Leipego
08:40	Welcome Remarks: What do Cattle and Wildlife Mean to the People of Ngamiland?	Paramount Chief of the Batawana, K. Moremi
08:55	Opening Address: The Imperative to Make Livestock Agriculture Productive, Compatible with Wildlife and Profitable in Ngamiland – Commodity-Based Trade (CBT) of Beef as a Viable Option	Hon. Minister of Agricultural Development & Food Security, F. M. Molao
09:10	Purpose and Objectives of the Workshop	S. Osofsky
	SETTING THE SCENE [Chair: L. Modisa]	
09:15	Around the Room Introductions	All
09:30	Introduction & Context Laying	S. Atkinson
09:40	The Importance of a Diversified Economy for Ngamiland	T. McNutt, M. Masedi
09:55	Overview of Commodity-Based Trade (CBT) – Options for Achieving Wildlife-Friendly, FMD-free & Tasty Beef from Ngamiland	G. Thomson
10:10	Lessons Emerging from Implementation of CBT of Beef at Local & Regional Scales	S. Atkinson, S. Osofsky
10:25	Q&A	
11:15	GROUP PHOTO & TEA / COFFEE BREAK	
	FIELD REALITIES & NEEDS [Chair: M. Letshwenyo]	
12:00	Producer Protocols, Animal Husbandry & Rangeland Management Practices	J. van Rooyen
12:15	Animal Identification & Traceability	M-L. Penrith, M. Masedi
12:30	Q&A	
13:30	LUNCH	
	TRANSPORT, INFRASTRUCTURE [Chair: G. Matlho]	
14:30	Transport Challenges & Pricing Issues (e.g. Live Weight vs. Carcass Weight)	C. Marshall
14:45	Infrastructure & Operational Issues; Distribution of Abattoirs in Relation to Cattle, Markets & Quarantine Stations; Possible Alternatives	C. Marshall, J van Rooyen
15:00	Update on Quarantine Stations; Review of Options / Scenarios for Beef Export with or without Quarantine across a Range of Markets	O. Thololwane, C. Marshall
15:15	Environmental Management Plans	J. van Rooyen
15:25	Biosecurity & Compliance	M.-L. Penrith
15:35	Q&A	
15:50	TEA / COFFEE BREAK	

	STAKEHOLDER PERSPECTIVES I [Facilitator: S. Osofsky]	
16:15	Breakout Groups Session I: Reflecting on Day 1's discussions and using the Table "Constraints that hinder implementing a CBT approach along the value chain in Ngamiland" provided, what do participants think of the identified gaps? Are they accurate? Are there gaps missing (if so, list specifically)? *Guidance on breakout group objectives will be provided, and each group will have an assigned facilitator and volunteer scribe. Each Group will present their findings first thing tomorrow AM.*	
18:00	ADJOURN	
19:00	GROUP DINNER – All Participants	

Day Two – 31 July 2019		
	STAKEHOLDER PERSPECTIVES I (CONT.) [Facilitator: N. Ramsden]	
08:30	Day 1's Breakout Groups Present Findings, with Q&A, Discussion	
09:30	TEA / COFFEE BREAK	
	CROSS-CUTTING ISSUES ALONG THE VALUE CHAIN [Chair: G. Ntsepe]	
10:00	Packaging & Transit of Beef	M-L. Penrith
10:10	Response to FMD Outbreaks that Enable CBT Success	G. Thomson
10:20	Reflections from the OIE on the Challenges & Opportunities around CBT	M. Letshwenyo
10:30	Stakeholder Coordination, Communication & Outreach	N. Ramsden
10:40	Q&A	
	PROCESSING & VALUE ADDITION [Chair: K. Seisa]	
11:10	HACCP Compliance for CBT in Abattoirs; Biosafety	M.-L. Penrith
11:20	Use of By-Products; Further Processing & Value-Addition	S. Atkinson
11:35	Wildlife Friendly Beef Brand Development	T. McNutt
11:45	Habu Pilot Progress	M. Masedi
12:00	Q&A	
12:30	LUNCH	
	WILDLIFE, FENCES & LIVELIHOODS [Chair: C. Nkgowe]	
13:30	Potential Impacts of Strategic Fencing Realignments for Reducing Human-Wildlife Conflict and Enhancing Conservation Success	R. Taylor, on behalf of A. Songhurst, G. McCullough
13:15	Enabling Elephant Movements Lessens Conflict: Thinking through Fences & Other Infrastructure	R. Taylor
13:30	Mobile Kraals and Other Approaches to Human / Wildlife Conflict Mitigation	E. Mudongo
13:45	Ngamiland's Fences – Positive and Negative Impacts & the Role of the National Committee on Cordon Fences – Progress on Cross-Sectoral 'Win-Win' Solutions	L. Modisa
14:00	Q&A	
	STAKEHOLDER PERSPECTIVES II [Facilitator: S. Osofsky]	
15:00	Breakout Groups Session II: Reflecting on Day 2's discussions and using the Table "Constraints that hinder implementing a CBT approach along the value chain in Ngamiland" provided, what do participants think of the identified gaps? Are they accurate? Are there gaps missing (if so, list specifically)? *Guidance on breakout group objectives will be provided, and each group will have an assigned facilitator and volunteer scribe.*	
15:30	WORKING TEA / COFFEE BREAK	
16:00	Breakout Groups Session II (cont.)	
17:00	ADJOURN	

Day Three – 1 August 2019		
	STAKEHOLDER PERSPECTIVES II (CONT.) [Facilitator: N. Ramsden]	
08:30	Day 2's Breakout Groups Present Findings, with Q&A, Discussion	
	PLUGGING THE GAPS – A MULTISTAKEHOLDER RESPONSE [Chair: N. Ramsden]	
09:30	Breakout Groups Session III: Reflecting on the final list of gaps along the value chain discussed, and using the Table "Constraints that hinder implementing a CBT approach along the value chain in Ngamiland," what role(s) do participants feel different stakeholder groups can play in addressing these gaps, and how? How can they most effectively contribute to CBT success? *Guidance on rotating breakout groups and objectives will be provided, and each group will have an assigned facilitator and volunteer scribe.* [**Facilitator: N. Ramsden**]	
10:15	WORKING TEA / COFFEE BREAK	
10:45	Breakout Groups Session III (cont.)	
12:00	Next Steps in Supporting Implementation of CBT in Ngamiland	L. Modisa
12:10	Reflections & Feedback	Panel
12:30	Closing Remarks	District Commissioner, Ngamiland, K. Leipego
12.40	LUNCH & ADJOURN	