A cross-sectional study of brucellosis-related characteristics of smallholder cattle herds in Gauteng Province

by

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Submitted in partial fulfilment of the requirements for the degree of
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at the

Department of Veterinary Tropical Disease
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Dedication

This mini-dissertation is dedicated to my family for their support.

Declaration

I, Dumakude Mpofu, declare that **A cross-sectional study of brucellosis-related characteristics of smallholder cattle herds in Gauteng Province** is my own work and that all the sources that I have used or quoted have been indicated and acknowledged by means of complete references.

……

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Date: **12 November 2018**

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Abstract

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Supervisor: **Prof D Abernethy**

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Department: **Veterinary Tropical Diseases**

There has been an increase in the herd prevalence of brucellosis in cattle in Gauteng, especially among smallholder herds. This study was undertaken to provide information on the distribution, nature and farm behavior of smallholder cattle herds as well as the knowledge and practices of the smallholder cattle keepers in relation to brucellosis. A cross sectional study was conducted on randomly selected herds that met a pre-determined criterion of herd size (between one and 30 cattle), using a standardized questionnaire. The data were analyzed using SPSS 25. Fourteen herds had between one and five cattle whilst the highest number of herds (20) had between 25 and 30 cattle. A total of 72 herds had direct contact with other herds, most (80.5%) contacts occurring at grazing or at watering points. Herds belonging to 70% of the interviewees were reportedly vaccinated as part of health management, however only 47.7% were correctly vaccinated. Seventy-nine interviewees stated that they were aware of brucellosis in humans, 32.8% them of could provide a list of symptoms possibly caused by brucellosis; of these 88.1% provided at least one correct symptom. Of the interviewees that reported dystocia, 59% indicated gloves were used during the obstetric interventions. Some of the smallholder herds in this study engaged in commercial activity. The amount of contact among some herds is a risk for the spread of brucellosis. Inadequate knowledge among some cattle keepers presents an opportunity for education and policy development for the control of brucellosis.

Key words: brucellosis, smallholder cattle herds, contact patterns, farmers' knowledge, education

Acronyms used

DAFF	Department of Agriculture, Forestry and Fisheries
GDARD	Gauteng Department of Agriculture and Rural Development
BB	Bovine Brucellosis
SA	South Africa
GP	Gauteng Province

Introduction

There has been an increase in the herd prevalence of bovine brucellosis (BB) in Gauteng Province, particularly among smallholder herds where it increased from 16.6% to 24.8% over a period of four years (P. Geertsma, pers com.). However, this conclusion was based on GDARD laboratory test results and using test data collected as part of the BB schemes in the province and not on structured surveys (P. Geertsma, pers com.). The reasons for the increase are unknown and a series of epidemiological studies are planned to investigate this trend and to identify remedial measures. However, a major obstacle to commencing these studies is the dearth of knowledge regarding the distribution, characteristics, contact patterns and management of the smallholder herds. Similarly, the level of knowledge about brucellosis among smallholders is unknown. The World Health Organisation (WHO) has declared brucellosis a neglected zoonosis and sees appropriate needs analysis, integrated approaches (One Health) and evidence-based advocacy as essential to its successful control (McDermott, Arimi, 2002).

Smallholder farmers constitute an important sector of cattle farming in Gauteng Province (GP). They are made up of mainly previously disadvantaged black farmers with a sizeable number of resource-poor white farmers, particularly in small agricultural holdings in the peri-urban areas. Yet some cattle keepers are not necessarily resource poor but keep cattle for emotional fulfilment or as pets. The black farmers are made up of beneficiaries of the land restitution programme, some buying the land outright and others farming with livestock on the edges of townships or informal settlements.

The main reasons for smallholder farming is food production, income generation, employment creation, provision of a social safety net, capital formation and for various cultural reasons. Farming is not always the main source of income; other non-farm sources of income exist to sustain families [Department of Agriculture, Forestry and Fisheries (DAFF) 2011, unpublished].

Decisions regarding disease control have changed radically due to a combination of improved knowledge about infectious diseases and of the need to take into account a whole range of socioeconomic considerations that were not previously considered. Epidemiological studies require baseline data to inform their size, design and nature. For example, disease prevalence will determine the power and size of a study; contact patterns between herds will affect the unit of study (herd or communal grazing area) while the level of farmer knowledge will influence how data are collected from livestock owners. There are no published studies on smallholder herds in Gauteng Province and information regarding their number, geographical distribution and trading patterns is very scant. A survey of such herds is therefore essential before more formal epidemiological studies are undertaken. Consequently, three objectives were set for the study:

1. To collect baseline and descriptive data that will inform epidemiological studies on bovine brucellosis.
2. To describe the distribution, contact patterns, nature and farm behavior of smallholder bovine herds in Gauteng.
3. To assess the knowledge and practices of smallholder cattle herd owners in relation to BB.

Literature Review

Brucellosis in cattle

Brucellosis is a contagious bacterial disease that causes reproductive inefficiency and is a zoonosis (http://www.oie.int/en/animal-health-in-the-world/animal-diseases/Brucellosis/). In cattle, *Brucella abortus* is the usual cause of brucellosis, but other *Brucella species*, such as *Brucella melitensis* and *Brucella suis* are sometimes involved. The bacteria is transmitted mainly by the ingestion of feed or drinking of water that is contaminated with discharges from infected cows. Cows may be infected after licking genital discharges or the genital areas of infected cows. Brucellosis is generally carried from one herd to another by an infected animal; especially when female cattle are added onto an existing herd. Brucellosis may also be spread when some wildlife or animals from an affected herd mix with herds that are free of brucellosis [http://www.oie.int/en/animal-health-in-the-world/animal-diseases/Brucellosis/ (Matope et al., 2010a)].

Brucella infection in cattle causes significant economic losses as a result of clinical disease: abortion, neonatal losses, increased inter-calving periods, low fertility, reduction in milk produced, and high rates of culling because of the emergency culling of infected animals (Coelho et al., 2007). In South Africa, valuable (genetic or breeding) cows are culled at slaughter value when they are identified as infected as per the Animal Diseases Act 35 of 1984.

In South Africa (SA), brucellosis is controlled using a combination of measures such as vaccination and test and slaughter of infected cattle. A national surveillance programme is also in place and is used to measure the amount of disease and identify infected herds from which positive cattle are culled. The Animal Diseases Act 35 of 1984 and the Bovine Brucellosis Scheme regulations 2483 are the enabling legislation; underpinning heifer vaccination and slaughter of infected cattle as well as other acts to facilitate management of the disease including surveillance (Interim Brucellosis Manual 2016).

Common risk factors for cattle brucellosis prevalence in pastoral livestock systems include age of cattle, herd size (Nuraddis et al., 2010), contact patterns and the type of livestock production system(Diez, Coelho, 2013a), while drinking of raw milk and lack of biosecurity knowledge increase the zoonotic risk (Mai et al., 2013, Mai et al., 2012).

In an earlier study in Zimbabwe, the BB sero-prevalence was found to be between 10% and 53% in large cattle herds in different agro-ecological regions of the country compared to 0–16% in smallholder cattle (Mohan et al., 1996). Intensive management practices in commercial farms promote the spread and maintenance of BB, especially after abortions (Nicoletti, 1980), while extensive cattle management in smallholder farms tends to limit the spread of infection. The intensity of contact between naive herds and contaminated environmental sources plays a major role in the spread of *Brucella* infections (Bekele et al., 2011). Stocking density is important for brucellosis infection among susceptible cattle (Omer et al., 2000a, 2000b). The risks for the spread and transmission of brucellosis, such as the movement of herds with frequent contact with other herds at communal grazing grounds and at water sources, are significant in pastoral systems (Smits, 2013).

Brucellosis in humans

Human infection can occur through direct contact with infected cattle e.g. at parturition or abortions, or through the consumption of raw milk, commonly practiced in sub-Saharan Africa (McDermott & Arimi, 2002). The latter increases the risk even among urban and peri-urban consumers in sub-Saharan Africa (Hendricks et al., 1995). Apart from consumers, brucellosis is regarded as an occupational disease – with animal health workers, farmers and abattoir workers at risk of infection (McDermott & Arimi, 2002). Brucellosis affects up to 500 000 persons annually (Pappas et al., 2006).

The common symptom in all patients is an intermittent fever of variable duration. Influenza-like symptoms, such as fever, malaise, lack of appetite, headache, muscle and back pain are reported. Intense sweating can occur, especially at night (McDermott & Arimi, 2002). The nonspecific presentation poses a challenge with clinical diagnosis of brucellosis in sub-Saharan Africa, where it is usually confused with the highly prevalent and

clinically similar malaria (McDermott, Arimi, 2002). Public awareness of brucellosis in Southern Africa is very low. A lack of adequate knowledge of the disease among human health workers, in addition to the lack of effective prevention and management strategies, have led to the wide spread of the disease, though the actual amount of the disease in humans is unknown (Godfroid et al., 2011).

Smallholder cattle herds

The smallholder cattle farmers produce for household consumption and markets. Cattle are also kept for noncommercial reasons. According to DAFF (2012), 40% of the livestock in South Africa is owned by smallholder black farmers. There are about 38 500 commercial farms and intensive units and an estimated two million smallholder farmers involved in livestock production (Aliber, Hall, 2012; Aliber, Cousins, 2013) and (Meissner et al., 2013) in SA. It has been estimated that livestock form a significant component of the livelihoods of 70% of the world's poor [Livestock in development (LID), 1999. Livestock on Poverty-Focused Development. Livestock in Development: Crewkerne, Somerset, UK].

There is no universally accepted definition of smallholder cattle herds [http://www.fao.org/tempref/AG/Reserved/PPLPF/Docs/Reports%20&%20Papers/PAP_RL_GL_JO_99_Livestock%20and%20Development_LID.pdf]. Attributes that may be considered in a definition of smallholder livestock keepers include their tendency to operate with limited resources relative to other producers in the sector, and the fact that, in general, smallholder livestock keepers have relatively low-levels of formal education and training. Communal grazing is a characteristic of smallholders (Aliber, Hall, 2012). Herdsmen are a necessary feature in communally grazed herds as well as in herds on small holdings that need to be corralled at night for security reasons. This is especially significant in GP because of the prevalence of livestock theft. Some cattle owners combine their resources to secure the services of a herdsman who then mixes their herds and looks after them at grazing and corrals them at night. This leads to increased head to head contact among cattle as well as mixing of different herds.

Risk factors for brucellosis in cattle

Risk of prevalence

Several factors, such as the sex, breed, age, herd size and management play an important role in the epidemiology of brucellosis (Diez & Coelho, 2013a). Production systems, husbandry practices, and contact with wildlife also influence the prevalence (Matope et al., 2010a; Godfroid et al., 2011) of brucellosis. 'Bovine brucellosis is present in all the major livestock production systems, but its prevalence and incidence are variable; usually greater in systems in which large numbers of cattle mingle and lowest for small confined herds. In pastoral systems and livestock-subsistence crop systems in semi-arid areas, serological prevalence is almost always greater than 5%' (McDermott & Arimi, 2002).

In pastoral systems, Brucellosis prevalence increases with age indicating that infection pressure is sustained (Omer et al., 2000b). This high prevalence is commonly associated with multiple abortions and provides a steady supply of infectious organisms to maintain transmission and a constant supply of new infections (McDermott & Arimi, 2002).

Large herds are also at higher risk of being infected because of the increased possibility of each cow coming into direct contact with other cattle (Nuraddis et al., 2010) and (Lindstrom, T. et al., 2012). An increase in herd size may be associated with poor hygiene on the farm especially if the farm is small. A high stocking density is an important determinant of brucellosis infection in cattle (Omer et al., 2000b).

Herd immunity and type of cattle breed (dairy or beef) play a role in the incidence and prevalence of brucellosis (Matope et al., 2011). Contact between cattle and wildlife has also been incriminated in the epidemiology of brucellosis (Matope et al., 2010a). Herd immunity can be improved by vaccination (McDermott et al., 2013). Two vaccines are available for use in cattle in South Africa; *Brucella abortus* RB51 and *Brucella abortus* strain 19 vaccines. The Animal Diseases Act (Act 35 of 1984) prescribes vaccination of heifers as mandatory in the country, using a registered product. However, these vaccines are only effective in preventing the transmission of the bacteria from an infected animal to susceptible ones as well as preventing abortions in infected cattle. They have little effect in

preventing infection (Olsen, 2013). When RB51 is used in pregnant cattle, abortions may follow, making it difficult for farmers to adopt the vaccine. In GP, some farmers do not like to use the S19 vaccine because it causes false-positive reactions especially when used outside the prescribed age range of 4 to 8 months.

Keeping mixed breeds, was found to be independently associated with increased odds of herd *Brucella* seropositivity of smallholder dairy cattle in a study in Zimbabwe (Matope et al., 2010a).

Risk of spread

Public livestock markets like auctions play a major role in disease spread because cattle from different herds converge on the node and disperse in different directions to mix with different herds at their new homes (Robinson et al., 2002). Cattle migration increases the possibility of spread of infection (Omer et al., 2000c; Berhe et al., 2007). This has become important in South Africa because the deregulation of the red meat industry in 1997 led to the removal of most movement controls as well as the entry of new players into the cattle industry. The new players feed the informal cattle market whose demands (in relation to quality of stock) are less stringent than those of the long established formal market. Because of this network, infected herds may rapidly infect a large number of other herds (Robinson et al., 2007).

The intensity of contact with infected herds and with contaminated environmental sources play a major role in the spread of *Brucella* infections. Communally managed herds generally have an increased possibility of contacts because they share grazing and water resources (Omer et al., 2000b) (Omer et al., 2000b) (Omer et al., 2000b). In communal grazing systems, calving occurs at any place hence serving as a source of infection for all herds that share resources (Smits, 2013).

A biosecurity plan for each herd is essential to prevent and control BB. Elements of this plan include measures to prevent the entry of the disease into the herd and to prevent spread from animal to animal in the herd once some cattle are infected. Vaccination, as

described above, is one of the pillars of the biosecurity plan. The buying in of cattle must be managed to ensure that before they are introduced into the herd, the new cattle are tested and kept in isolation until negative serological test results are returned. Farm hygiene also plays a major role as when aborted materials as well as other birth membranes and fluids are collected and safely disposed of, the amount of infective material in the cattle environment is reduced. Cows should calve in isolation and the calving stalls disinfected after each calving. Infected cows should be isolated from negative cows immediately and not allowed to calve down on the farm as this increases the risk of spread of the disease. Colostrum from positive cows should not be collected and used for calves from negative cows. The colostrum contains millions of bacteria that can infect the calf that will become a latent carrier and become a source of infection when she aborts or calves (Wolff et al,. 2017).

Risk factors for human infection

In sub-Saharan Africa, transmission to humans is primarily from livestock reservoirs of brucellosis. The risk to humans is a function of the effective contacts at the livestock and the human–livestock interface. Contacts are both direct, often through contamination with infected animals, particularly when they are aborting or calving, and indirect, mainly through the consumption of raw milk (McDermott & Arimi, 2002). Soured or fermented milk ("maas") is commonly produced and consumed in South Africa and unless pasteurized, such fermentation does not eliminate the zoonotic risk (Estrada et al., 2005).

Consumer movements advocate the consumption of natural foods including raw milk. Urban consumers are thus at risk of infection because of the consumption of raw milk and other infected animal products (Corbel, 1997).

Accidental self-injection may occur and lead to infection. Infection due to use of live *Brucella* vaccines can be acquired from mucosal membrane splashes, skin cuts or, occasionally, infectious aerosols, and generally occurs in individuals involved in animal vaccination (http://www.who.int/csr/resources/publications/Brucellosis.pdf).

Knowledge of brucellosis

Livestock owners' knowledge and behaviour regarding brucellosis must be taken into account if sustainable control programs are to be implemented. The lack of sufficient knowledge of the disease in conjunction with high-risk practices and the absence of effective prevention and management strategies, result in continuous disease circulation in the population (Musallam et al 2015).

Previous Knowledge, Attitude and Practice studies regarding brucellosis among people with high effective interface with livestock in different endemic settings revealed variable results. In Kenya (Obonyo et al., 2013), it was found that there was poor awareness of the transmission routes of brucellosis from animals to humans. Similarly, lack of knowledge and high-risk behaviours regarding brucellosis were observed in a study of small-scale dairy farms in Tajikistan (Lindahl et al., 2015). However, a high level of knowledge of the disease was found in a study conducted in a village in the Nile Delta (Holt et al., 2011) region of Egypt. Despite the high level of awareness and detailed knowledge of disease transmission, high-risk practices were common.

Ignorance of risk of *Brucella* infection was found by Marcotty et al. (2009) to be a factor contributing to human exposure. In Zimbabwe, (Matope et al., 2010b) and in Zambia, (Muma et al., 2007) researchers found that people with no knowledge of brucellosis were more likely to be exposed to brucellosis compared to those with knowledge. Farmers with knowledge of brucellosis are more likely to be cautious of introducing the diseases into their herds or have some *Brucella* disease control measures on the farm compared to those not aware of the disease. They are likely to take precautions during obstetric interventions and when handling aborted material as well as avoid consumption of raw milk and its products (Marcotty et al., 2009).

Methodology

Study herds were recruited from cattle herds of one to 30 cattle in Gauteng Province (GP). This population is distributed across the province on land that is either designated as agricultural land by land use planners or for other purposes. The size and location of the herds were unknown. An incomplete database of the Gauteng Department of Agriculture and Rural Development (GDARD) veterinary services was used to estimate the population size.

The sample size was determined using StatsCal in Epi-Info (CDC Version 7); 192 herds were needed based on a herd prevalence in GP smallholder herds of 25% (GDARD, 2013) ± 6%; ß = 95%; α = 80%. A map of GP with a polygon layer of 666 polygons, each one being 5 km^2 (Annexure 1), was generated in ArcGIS 10.4 (ESRI, Redlands, CA, USA) using customised script. Each polygon was assigned a unique number (ID) and all herds were associated with a polygon. The centroid of each selected polygon was identified and its geographic coordinates determined. A sample of 192 polygons was randomly selected using Research Randomiser (Urbaniak, Plous, 2013). Polygons wholly or partially in GP were used in the sampling frame.

A structured questionnaire (Annexure 2) was designed to capture data on the demography, trading patterns, contact patterns and management of smallholder cattle herds as well as the knowledge and practices of respondents in relation to bovine brucellosis. The questionnaire was tested among animal health technicians (AHTs) and state veterinarians employed by GDARD before being trialled on five smallholder farms, further fine-tuned and finalised. A team of volunteer AHTs was trained on the administration of the questionnaire.

The coordinates of each polygon's centroid were used as the point of departure in the search for a herd that met the criteria of herd size between one and 30 cattle. Starting from the location on the ground, a systematic search for respondents was conducted in the following manner: a visual scan for herds with cattle was conducted starting from a northerly direction sweeping 360 degrees. If a suitable herd was identified it was

approached and invited to participate in the survey. If no suitable herd was identified, then the search was expanded throughout the polygon in a systematic fashion – northerly direction then in a clockwise manner. If no suitable herd was identified in a given selected polygon, then another polygon was randomly selected from the remaining polygons. For practical purposes, the second set of random polygons was proactively selected and provided in reserve. The process of searching for suitable herds was repeated in each selected polygon.

Each questionnaire was number coded to correspond with the polygon number. The selected respondents provided informed consent (Annexure 3) before commencing the interview, which were conducted between June and October 2016. The questionnaire was administered in two ways; literate and confident respondents read and completed the questionnaire or the interviewer read out the questionnaire. Responses from each questionnaire were captured onto an Excel spreadsheet using a predesigned form. Whilst the names and contact details of interviewees were captured during interviews, these were not transferred onto the dataset on the Excel spreadsheet to protect their privacy.

The data were analysed in Excel and SPSS (Version 25; IBM).

Results

Demography of smallholder herds

One hundred and eighty herds were involved in the study, distributed across GP (Figure 1). 81.3% of interviewees were owners while 13.1% were family members. Twenty-five herds had between one and five cattle while the highest number of herds (n = 35) had between 25 and 30 cattle (Figure 2).

Figure 1 Distribution of smallholder herds participating in the study

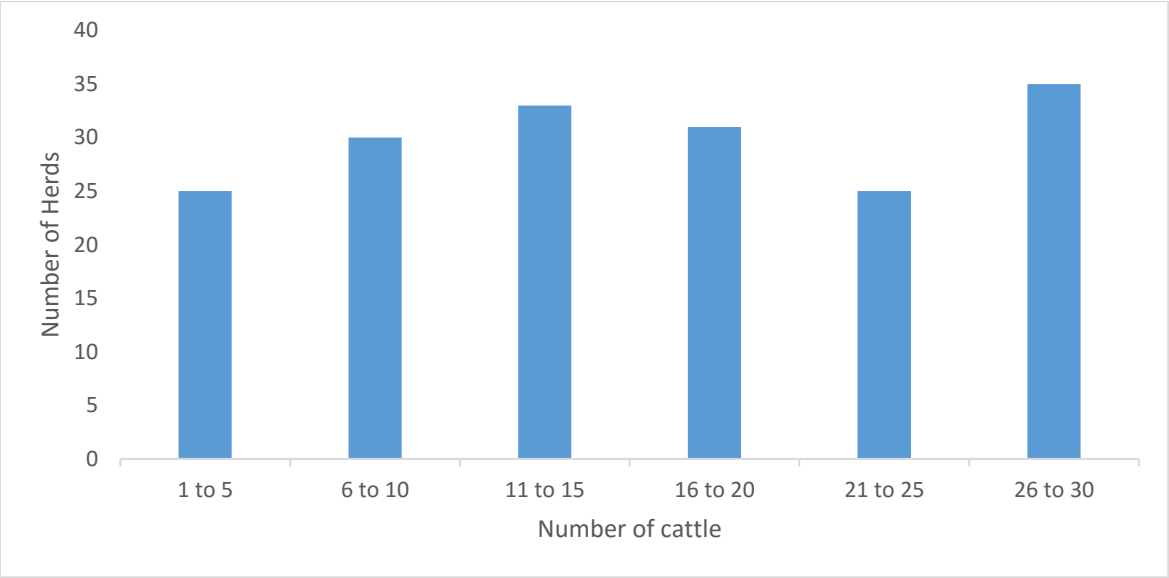

Figure 2 Frequency distribution of herd size

The proportion of female cattle in the herds ranged from 0.62-0.67, dependent on herd size, but these differences were not significant (chi-squared test, $p > 0.05$ for all groups). Crossbred cattle were the most common breed represented (31%), followed by Brahman and Nguni (Figure 3).

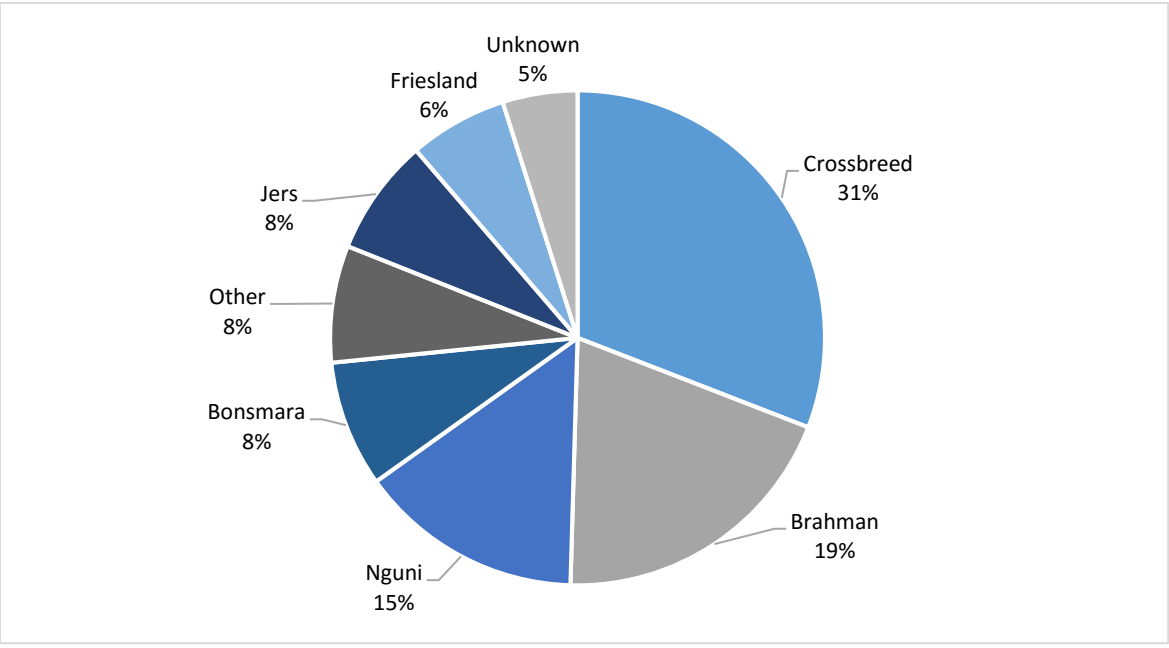

Figure 3 Distribution of breeds by herd

Trading patterns, contact patterns and management of smallholder cattle herds

Almost two thirds (62.0%) of herds used their own land for grazing whilst 22.9% utilised communal grazing. Most herds (61.1%) remain on the same grazing land throughout the year. Cattle from the remaining herds had been moved to at least one other grazing area in the previous 12 months, almost all (98.5%) of which were within 25 km radius of the home premises. Over half (58.6%) utilised communal land and 40% used private land at these extra grazing lands.

The most important reason for keeping cattle was financial security (41.3%) whist the second (29.6%) most important was as a primary source of income. Cultural and spiritual reasons were cited in 26.1% of herds. Eighty herds (44.4%) were milked; and of these, 85% were milked by hand. There was no significant difference in herd size between those that milked and those that did not (mean of 17.3 versus 15.4 cattle respectively; $p > 0.05$).

A quarter (25%) of the herds surveyed utilised the services of a herdsman. Most of the herdsmen (84.4%) worked with more than one herd. Twenty nine (70.7%) of the communal herds were looked after in combination with other herds by sharing the same herdsman. Of the herds surveyed, 40% had direct contact with other herds with the most contact (80%) at grazing grounds or at watering points, while 16.7% occurred in kraals (Figure 4). Communal herds were significantly likely to have more contact than private herds (77.5% vs 2.5%; Chi-Squared Test = 74.1; $p < 0.001$).

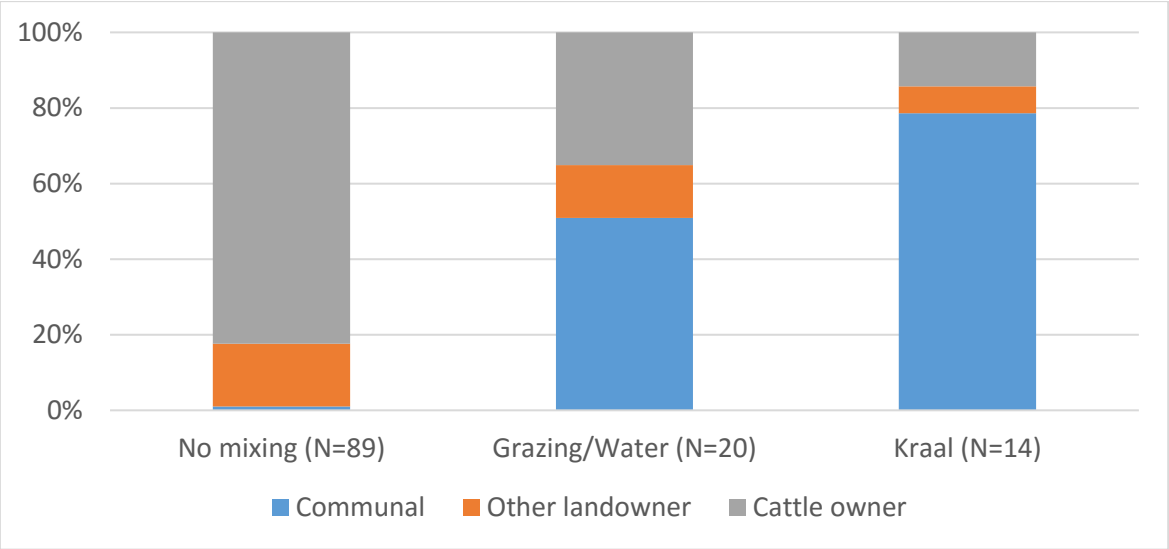

Figure 4 Distribution of cattle mixing by contact type

Just over half (52.8%) the herds added cattle and 64.4% moved animals out in the previous 12 months. Of those that added cattle to their herds, 71.6% did so to grow the herd whilst 16.8% did so for commercial reasons. The rest did so for replacement purposes. Among those that did not add to their herds, the most common reasons given were insufficient land carrying capacity (50%) and insufficient funds (32.3%). The price of cattle was the most important (71.3%) factor that guided the buying patterns. Other factors such as quality of stock (20.8%) and accessibility of market (6.2%) were second and third respectively. Buyers were mostly (91.5%) guided by the price of stock on offer. Female cattle dominated the live cattle buying market: of 434 cattle purchased by the study herds, 62.4% were females and 55.4% of these were bought at auctions (compared to 50.3% of males). Males dominated the sales market, commanding 51.7% compared to 48.3% females; of the cattle were sold at auctions, 48.1% were females and 51.9% were males.

A high proportion (70%) of interviewees reported their herds were vaccinated as part of herd health management, however 47.7% of herds were actually vaccinated. Just over half (52.7%) of herds that vaccinated with the correct vaccine had experienced mortalities in the previous 12 months; this was not significantly different from the 48.7% that did not vaccinate (Chi-Squared test = 0.253; p = 0.615). Half of the herds reported mortalities in the previous 12 months with 86.7% of these reporting three or fewer deaths and 3.3%

reporting more than six animals dying. The mortalities reported in communally-grazed herds were significantly higher than those on private land (68.3% vs 44.9%; Chi-Squared Test = 6.885; $p \leq 0.05$). Of the herds that reported mortalities, 58.2% of the herds could provide the cause of death, and of these, starvation was the most common (69.2%) cause (Figure 5).

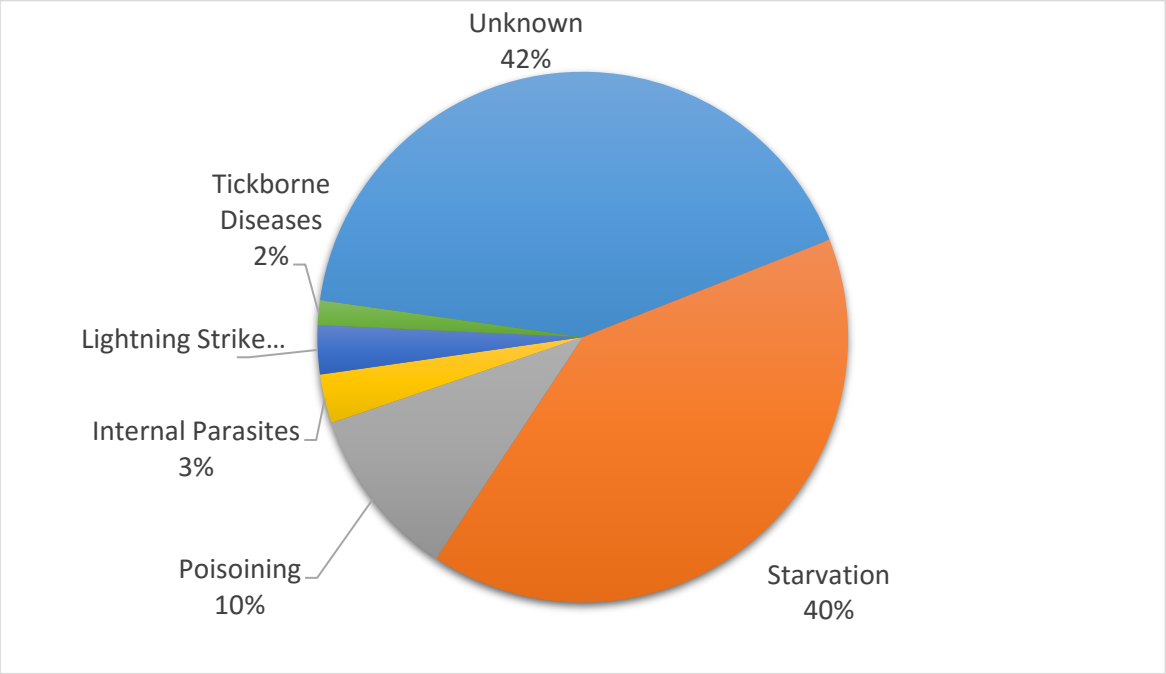

Figure 5 Cause of mortality in smallholder herds

Knowledge and practices of respondents regarding brucellosis

Ninety (50%) of the interviewees reported dystocia in their cattle in the 12 months prior; in 21.7% of such herds, the owner attempted to resolve the problem whilst friends or neighbours assisted in 47.8%. Private veterinarians were summoned in 14.1% and the state veterinarian in 2.2% of the herds. In 59% of the herds with dystocia, gloves were worn during the intervention. Less than half (46.1%) of the interviewees indicated they vaccinated their cattle against brucellosis; of these, 50.6% stated they used both *Brucella abortus* Strain RB51 and Strain 19 vaccines while the remainder used one or did not know the vaccine used.

About a third (30.6%) of the interviewees reported having abortions in their herds in the previous 12 months; the most common response to this was to take no action (43.9%), followed by selling the cow (26.3%) or slaughtering it (22.8%). Only 21.8% of the interviewees advised they had reported the abortion to animal health workers.

More than half (56.7%) of the interviewees stated they were aware of brucellosis as a disease while 46.1% knew it had some effect on cattle. When these were presented with a list of possible routes of transmission, 86.3% stated they knew of at least one route; of these 61.7% correctly identified grazing contaminated pastures; 17.6% identified venereal transmission and 6.9% identified tick bites as a possible source. Eighty three (46.1%) of the interviewees could name at least one clinical sign of brucellosis and of these, 95.4% of these correctly identified at least one clinical sign when asked to list them. Interviewees who advised they knew about brucellosis were more likely to slaughter cows that aborted compared those who advised in the negative (difference in proportions; chi square test = 4.2; p = 0.040), (Figure 6).

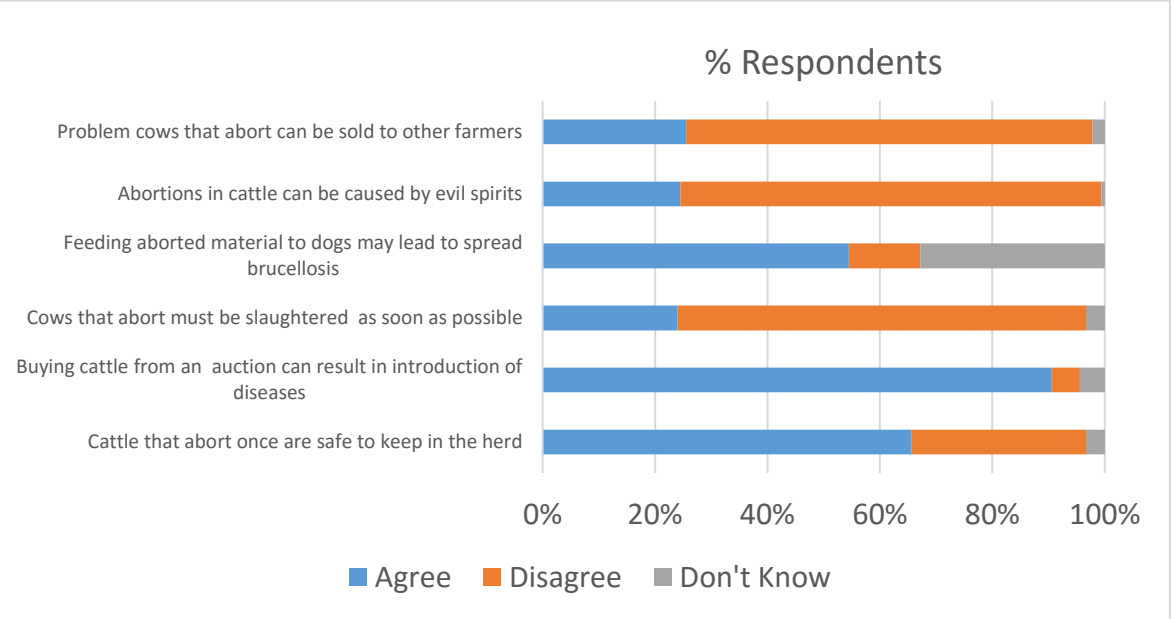

Figure 6 Proportion of interviewees responding to different statements on abortion in cattle

About half, (51.1%) of the interviewees indicated that they consume raw cow's milk; of these 79.3% obtained the milk from their own cows whereas 17.4% got it from another herd. Less than half (43.9%) of the respondents stated they were aware that brucellosis affects people and 32.8% of these provided a list of symptoms possibly caused by brucellosis in humans; of these, 88.1% provided at least one correct answer. Ninety two interviewees (51.1%) advised they consume raw milk; 36.9% of them knew that brucellosis is a zoonosis and 82.4% of these knew that brucellosis can be transmitted to humans through the consumption of raw milk.

Less than half (37.2%) of interviewees reported they had no contact with state veterinary services in the previous 12 months; 27.2% reported one contact while 19.4% reported more than two contacts.

Discussion

This study provided novel and valuable information concerning smallholder herds in GP. The data gathered will be used to inform future epidemiological studies and to assist DAFF officials in improving disease control programmes and extension initiatives. Over 80% of the interviewees were owners, so their responses to the questions can be relied on to reflect a reasonably representative picture of what happens in each herd. Herds were recruited from across the province, which is classified as a city region in policy lexicon. It was not possible to predict the location of smallholder herds due to the lack of underlying data, so some regions were found to have exclusively large cattle herds.

The GP smallholder sector was characterised by the keeping of indigenous (Brahman, Nguni and their crossbreeds) cattle breeds which are best suited to the environment and management – are able to travel distances in search of grazing and most with little or no supplementary feed (Scholtz et al., 2008). Whilst most of the herds in the survey used private land, they had to be moved to other lands for extra grazing purposes especially during the dry months of the year. In some instances, this led to mixing of different herds, thus increasing the risk for contagious diseases such as brucellosis. Most movements were within a 25 km radius, and suggests therefore that disease risk from cattle movements is likely to be local. Smallholder farmers generally have land tenure as a limitation to their ability to work with larger herds. This is especially important in GP as there is massive pressure on land by competing needs such as housing and other infrastructure development as well as conservation. Land reform programs should target these farmers as they play a major role in providing food and alleviating poverty. Policy makers should think about releasing more land for grazing.

Most (71%) of the smallholder herds in GP were kept for financial purposes and almost two-thirds of herds actively traded cattle. This is somewhat surprising but demonstrates that even smallholder herds trade in cattle and one must not assume therefore, that contact through cattle trading does not occur.

The herd sizes [most (50.6%) above 16 cattle per herd] in the survey also support this outcome.

Trading in cattle may be for slaughter to harvest the products or for replacement purposes. Diez and Coelho (2013b) suggested that buying in replacement stock was a risk factor for the introduction and spread of brucellosis. In this study, it is suggested that smallholder herds are at risk of introducing the disease, especially when they buy stock at public sale yards, being cheaply disposed of by unscrupulous cattle barons and speculators.

Almost half were milked, mostly by hand, for domestic consumption. Raw milk consumption is a risk factor for human infection (McDermott & Arimi, 2002). Whilst knowledge of the transmission of brucellosis to humans from infected milk is known, the consumption of raw milk is widespread. This could be because of numerous reasons such as the influence of consumer groups that advocate the consumption of natural products without any processing (Claeys et al., 2013). Some traditionalists also hold the same belief in raw milk being more nutritious than pasteurised milk. In a study by Makita et al. (2011), urban and peri-urban residents were found to be at risk of becoming infected with brucellosis from the consumption of raw milk sold by peri-urban smallholder farmers. Pasteurisation of milk and its benefits were not addressed in the survey. In future such studies, it should be investigated as it may provide insight into what people know and their attitude towards this process. Public health education at clinics, schools and workplaces (as part of wellness programmes) could include the subject of basic food safety and address the facts and myths that are in the public domain.

Although only a quarter of herds utilised a herdsman, where this occurred, the herdsmen cared for more than one herd at a time. This was especially true for smallholder herds on communal grazing. This has epidemiological significance as cattle owned by different people are herded together thus creating a single epidemiological unit and thereby increasing the risk of spread of disease (Diez and Coelho, 2013a). As a consequence, the herd prevalence increase in GP might have been misinterpreted or over-estimated. However, this may be compounded by the fact that each herd is managed in a unique way by its owner. The entry and exit movements from the herds are different thus making the

epidemiology of the disease rather difficult to map. This is particularly important in GP because of the amount of commercial activity in smallholder herds as well as the fact that the majority of cattle brought into herds were female.

The market place was dominated by the price of stock, whether buying or selling. For over 70% of study respondents, the price of stock was of major importance, again supporting the conclusion that just because these herds are small, does not mean they are not commercially aware or active. It has been known that markets are nodes in a complex maze of livestock movements and contacts that make disease control so challenging (Fevre et al., 2006).

Vaccines, antibiotics and anthelmintic are administered by smallholder keepers to their livestock. The various products have specific uses but some smallholders do not fully understand the basis for their use. As a result some believe that vaccination is possible through the use of an antibiotics or anthelmintic. Most cattle keepers indicated that they vaccinated their cattle against specific diseases but revealed a lack of knowledge to distinguish vaccines from other products. A significant gap exists in knowledge regarding veterinary management of cattle (more than 70% of interviewees said they vaccinated their cattle but less than 50% of these did so correctly), and this should be addressed through training of farmers by veterinary extension workers. This is surprising since GDARD veterinary services has a unit dedicated to primary animal health care and creating awareness among farmers. This unit should place emphasis on practical demonstration of techniques and the rationale of each action to farmers. Part-time farmers should avail themselves for this training and avoid being absentee farmers so that a lasting partnership is established.

The reports of mortalities among vaccinated herds were almost the same as those in unvaccinated herds. The mortalities were mostly due to conditions for which vaccination is not possible e.g. starvation due to drought conditions. The impact of vaccination could therefore not be ascertained in this study. Mortalities among communal grazing herds were higher than those grazing on private lands. Grazing management could have played a role in keeping it lower on private lands. The grazing resources and feasibility to manage them

in communal grazing could account for the higher mortalities among this group of smallholder cattle herds. Training on cattle management, including the linkage of nutrition and productivity, should be provided by the State's Extension services. The adoption of the information will depend on the availability of financial resources, for example, to buy supplementary feed for feeding during the dry months. Dedicated State institutions could be capacitated to provide this finance that can be repaid under favourable terms.

Profitable and sustainable cattle production requires the use of animal health workers to assist the farmer (http://www.fao.org/ag/againfo/home/en/news_archive/2010_Vet2011_FAO.html). Sick and dead cattle should be examined to determine the cause and prevent further occurrences. The majority of herds could not attribute a cause to mortality and also had few visits from veterinary officials. This disconnect between cattle owners and veterinarians is not beneficial to animal and public health. GDARD veterinary services should provide more capacity to its veterinary extension services to support the smallholder cattle keepers.

There was a high incidence of abortion in cattle herds. Farmers and some lay-people assisted in most cases whereas professionals in animal health played a smaller role. Knowledge of the risks to humans was very important in determining whether protective gear is used. The low usage of gloves and high involvement of lay people are risks to human infection. Vaccinated infected cows tend to shed less bacteria than their unvaccinated counterparts. In this study, vaccination was not universally practiced and yet a lot of obstetric interventions were done without gloves. People with knowledge regarding brucellosis are likely to adopt practices to minimise risk of exposure (Matope et al., 2010a, Muma et al., 2007).

Surveillance is an important aspect of any brucellosis control, prevention and eradication strategy (Godfroid et al., 2013). One of the pillars of this is passive reporting of abortions in cows and heifers and determining the cause of the abortion, then taking action to bring the matter to finality. In this study, less than a third of the herds reported abortions to veterinary authorities, a poor return on a potentially powerful tool for surveillance. On a national scale, South Africa should consider making it a legal requirement for abortions to

be reported to veterinary authorities who should also be empowered to investigate and take appropriate and conclusive action in all cases.

Knowledge regarding brucellosis is important in shaping attitudes and practices that lower the risk of infection for both cattle and humans as well as spread of infection among herds. The level of knowledge was found to be low. As a consequence, herd biosecurity practices were poor (buying in cattle on the basis of price and not health), use of herdsmen thus mixing cattle herds, keeping of aborting cows in the herd or selling them off to unsuspecting buyers. The knowledge, attitudes and practices regarding brucellosis by cattle owners is fundamental to control and eradication efforts in the GP, the country and globally (Musallam 2015; Holt et al., 2011; Diez 2013b; Adesokan et al., 2013). The training and education of farmers on brucellosis in cattle and as a zoonosis focusing on risk factors for cattle and human infection should be prioritised and made a cornerstone of any efforts to manage the disease and protect humans in the GP. It is more urgent now in the face of the onslaught of immunosuppressive conditions in the human population. The national veterinary authorities in conjunction with other stakeholders such as the National Animal Health Forum have made the control of brucellosis in the country a top priority. As an adjunct to this, a one health approach, featuring all stakeholders in animal and human health should be set up as a priority as part of the national strategy to tackle brucellosis.

Animal health managers should consider linking the marketing of stock at public auctions to the brucellosis status of the herd as well as the status of each animal offered for sale. This will lessen the burden imposed by these facilities to disease control in the country. The above can only work if there is a reliable identification system for all cattle in the country.

When cattle farmers have been trained on brucellosis, the implementation of a surveillance plan that includes reporting of cattle abortions by farmers to veterinary authorities would become feasible as farmers would understand the need.

As a field and observational study, the project faced several challenges. The use of polygons on the map of GP to identify participants in the study and the visiting of each polygon meant the work was considerable, time consuming and expensive. Future studies should be based

on a substantial database of all cattle farmers in the province. The database would contain information on the demography of owners, location and size of each herd. This would then allow for selection of herds that suit the case definition from the entire population. Participants would then be randomly selected from this cohort of herds. A study of a similar nature can then be conducted focusing on a specific demography in the context of transformation in the cattle industry in the province.

Some of the participants in the study were speculators in the cattle industry, keeping a small core breeding herd but buying in and selling more cattle during the course of time. As a result, when approached for an interview, they were found to meet the criterion of owning between one and 30 cattle at the time, but did not operate as true smallholder herds. This was a complex group of interviewees that skewed the amount of cattle marketed.

There is a continuum between all cattle farmers in GP, whereby cattle are bought and sold between the large and smallholder sectors, so the epidemiology of brucellosis is inextricably linked. This needs to be borne in mind when designing future studies or interventions. Smallholders are not geographically separated from large holders, some are neighbours that share fences so what happens on smallholders is not totally unique and must be looked at in a broad context.

Poor knowledge and biosecurity practices suggest the risk of brucellosis may be higher than previously anticipated and therefore the prevalence of human brucellosis in GP should be determined. This might require a major shift in mind set among human health workers in that patients with fever of unknown origin will be tested for brucellosis.

The socio-economic impact of current brucellosis control measures should be evaluated to determine if the desired outcomes cannot be achieved using different approaches.

Conclusion

Smallholder cattle herds in GP vary in size, with a commercial bias. They are heavily involved in commercial activity so that contacts between herds is complex as it involves public auctions which are social networks for disease transmission. Any plans by authorities or not-for-profit organisations to provide financial and material assistance must take this into account. Most cattle keepers are able to pay some of the bills that may be incurred in this regard. The trade in cattle coupled with the use of shared grazing in the province lead to a complex web of animal contacts that increases the risk of spread of brucellosis infection. The practice by some farmers, to sell cows that have aborted also contributes to spread of disease.

Recommendations

Training and education must be provided to smallholders to improve their knowledge and practices regarding brucellosis. Public and consumer awareness drives must be implemented to improve societal awareness and thus put pressure on milk producers to provide wholesome milk to the market. A survey must be conducted to determine the prevalence of human brucellosis in the country starting with one that targets people at highest risk such as farmers, their workers as well as animal health workers both in the public and private sectors.

A full blown knowledge, attitudes and practices study regarding brucellosis among cattle owners, animal health workers both in the private and public sector, human health workers (general practitioners and nurses) in GP should be undertaken as part of a broader effort to create a One Health platform for a concerted effort to control and eventually eradicate BB.

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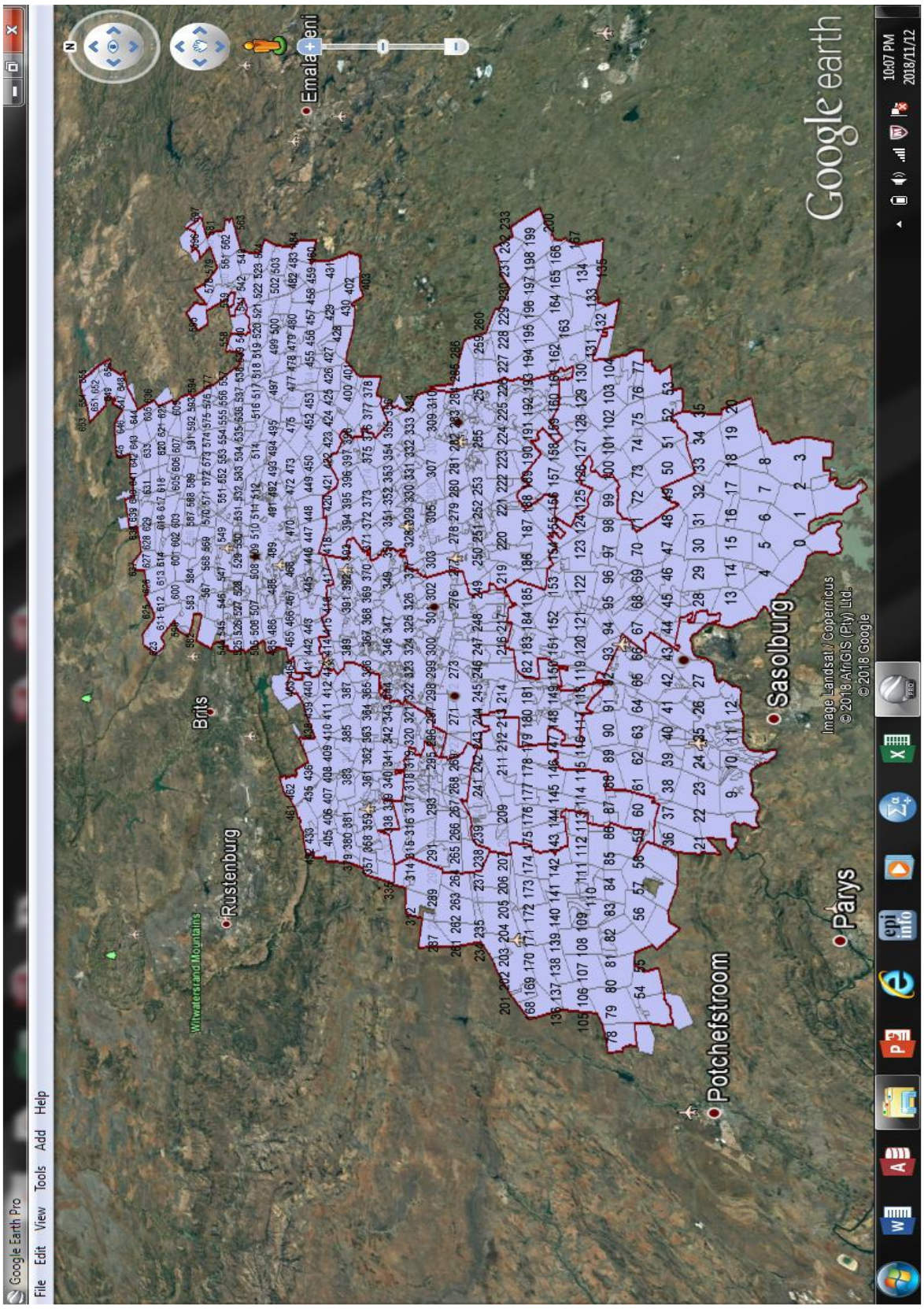
Annexures

Annexure 1

A map of GP with a polygon layer of 666 polygons



Annexure 2

A structured questionnaire

OFFICE USE ONLY

Date questionnaire received	
Date data entered	
Reference Number	**GP_216/**
Queries to be addressed	**D MPOFU** **0715433028**

1. INTERVIEWER DETAILS

1.1	First name & surname		
1.2	Cell Number		
1.3	Date of Interview		

2. INTERVIEWEE DETAILS

2.1 Respondent Details

2.1.1	First name & surname		
2.1.2	Cell Number		
2.1.3	Landline Number		
2.1.4	Email Address		

2.2 Status of the Respondent (tick ALL that are appropriate)

		√	
2.2.1	Owner		
2.2.2	Manager		
2.2.3	Employee		
2.2.4	Family Member		
2.2.5	Other, (Please specify)		

3. HERD DETAILS

3.1 How many cattle are kept in this herd?

		n
3.1.1	Bulls older than 24 months	
3.1.2	All other males older than 8 months	
3.1.3	Heifers (9-24 months)	
3.1.4	Cows (older than 24months)	
3.1.5	Calves	

3.2 What cattle breeds are kept? (tick the appropriate)

		√	
3.2.1	Brahman		
3.2.2	Jersey		
3.2.3	Nguni		
3.2.4	Crossbreeds		
3.2.5	Unknown		
3.2.6	Other (please specify)		

3.3 Where are the cattle usually kept? (tick the appropriate and fill in required detail)

3.3.1	Farm/Plot Number/Property Name			
3.3.2	Local Municipality Name			
3.3.3	District Municipality Name			
3.3.4	Province Name	**Gauteng**		
3.3.5	GPS EAST	deg	min	sec
3.3.6	GPS SOUTH	deg	min	sec

3.4 Who owns the land on which the cattle are usually kept? (tick the appropriate)

		√
3.4.1	Communal	
3.4.2	Other private owner of land	
3.4.3	Cattle owner	

3.5 Are the cattle kept on the same property/land throughout the year? (tick the appropriate)

		√	
3.5.1	Yes		*Proceed to Question 3.9*
3.5.2	No		*Answers Questions 3.6 to 3.8*

(3.6) To where do the cattle move? (tick the appropriate)

		√
3.6.1	Communal land < 25 km away	
3.6.2	Communal land > 25 km away	
3.6.3	Private land < 25 km	
3.6.4	Private land > 25 km	

(3.7) How many properties/places do you take them to per year? (tick the appropriate)

		√
3.7.1	1	
3.7.2	2	
3.7.3	> 2	

3.8 Do they mix (nose-nose contact) with other cattle at these other properties? (tick the appropriate)

		√
3.8.1	Yes	
3.8.2	No	

3.9 Do you milk any of your cows? (tick the appropriate)

		√	
3.9.1	Yes		*Proceed to Question 3.10*
3.9.2	No		*Proceed to Question 3.11*

3.10 What method do use to milk your cows? (tick the appropriate)

		√
3.10.1	Hand milking	
3.10.2	Machine milking	
3.10.3	Both hand and machine milking	

3.11 Do you or your family consume raw milk? (tick the appropriate)

		√	
3.11.1	Yes		*Proceed to Question 3.12*
3.11.2	No		*Proceed to Section 4*

3.12 Where do you obtain the raw milk? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
3.12.1	My own cows			
3.12.3	Obtained from another herd			
3.12.4	Purchase from a vendor			
3.12.5	Other (please specify)			

4. MANAGEMENT OF THE HERD

4.1 Who looks after the cattle during the day? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	*n*
4.1.1.	Owner		
4.1.2	Stockman or Employee		
4.1.3	No one		
4.1.4	Family member (not paid)		

4.2 Do any employees or stockmen work with cattle in other herds? (tick the appropriate)

		√
4.2.1	Yes	
4.2.2	No	

4.3 Do the cattle mix (have direct nose-nose contact) with other cattle? (tick the appropriate)

		√	
4.3.1	Yes		*Proceed to Question 4.4*
4.3.2	No		*Proceed to Question 4.5*

4.4 When do they mix? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
4.4.1	During grazing			
4.42	During drinking water			
4.4.3	During veterinary interventions			
4.4.4	In kraal at night			
4.4.5	Other (please specify)			

4.5 Why do you keep cattle? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
4.5.1	Primary source of income			
4.5.2	Source of meat and milk			
4.5.3	Cultural or spiritual reasons			
4.5.4	Financial security			
4.5.5	Other (Indicate)			

4.6 Do your cattle have nose to nose contact with wild antelope? (tick the appropriate)

		√
4.6.1	Yes	
4.6.2	No	

5. CATTLE MOVEMENT INTO OR OUT OF THE HERD

5.1 Have you added any cattle to your herd in the last 12 months? (tick the appropriate)

		√	
5.1.1	Yes		*Answer Questions 5.2 to 5.4*
5.1.2	No		*Proceed to Question 5.5*

5.2 Where did you get them from? (Indicate the number of cattle by category and source)

	Source	Herd on communal land			From Auction		From Commercial Herd		
		Shared Common land	< 20 km	> 20 km	< 20 km	> 20 km	Neigh-bour	< 20 km	> 20 km
5.2.1	Bulls (> 24 months)								
5.2.2	Other males (> 8 months)								
5.2.3	Heifers (9-24 months)								
5.2.4	Cows (> 24 months)								
5.2.5	Calves								

5.3 Why did you purchase/obtain more cattle? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc

		√	n	
5.3.1	Growing herd			
5.3.2	Replace cattle that died			
5.3.3	Other (please specify)			

5.4 If No, why not? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
5.4.1	Herd at maximum size			
5.4.2	Insufficient funds			
5.4.3	Timing not appropriate			
5.4.4	Other (Indicate)			

5.5 What factor(s) determines <u>where</u> you buy your cattle? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
5.5.1	Price			
5.5.2	Accessibility of market			
5.5.3	Quality/Type of animals on offer			
5.5.4	Quality of service			
5.5.5	Other (Indicate)			

5.6 Have you sold or moved cattle from your herd in the last 12 months? (tick the appropriate)

		√	
5.6.1	Yes		*Proceed to Question 5.7*
5.6.2	No		*Proceed to Question 6.1*

5.7 If yes where did you sell/move them to?

	Source	Herd on communal land			To Auction		To Commercial Herd			
		Shared Common land	< 20 km	> 20 km	< 20 km	> 20 km	Neigh-bour	< 20 km	> 20 km	To Abattoir
5.7.1	Bulls > 24 months									
5.7.2	Other males > 8 months									
5.7.3	Heifers (9-24 months)									
5.7.4	Cows (> 24 months)									
5.7.5	Calves									

5.8 What factor(s) determines where you sell your cattle? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
5.8.1	Price			
5.8.2	Convenience (closeness to market)			
5.8.3	Other (Indicate)			

6. HEALTH OF THE HERD

	n	Don't know √
6.1 How many cattle died during the last 12 months?		

6.2 What ages were they?
(indicate number of cattle by age)

< 8 months	9 to 24 months	> 24 months
6.2.1	6.2.2	6.2.3

6.3 Why did they die? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
6.3.1	Insufficient feed			
6.3.2	Parasites – worm/ticks			
6.3.3	Unknown			
6.3.4	Disease (Indicate if cause known)			
6.3.5	Other (Indicate if known)			

	n
6.4 How many cattle became sick during the last 12 months?	

6.5 What ages were they?
(indicate number of cattle by age)

< 8 months	9 to 24 months	> 24 months
6.5.1	6.5.2	6.5.3

6.6 What caused them to get sick? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
6.6.1	Insufficient feed			
6.6.2	Parasites – worm/ticks			
6.6.3	Unknown			
6.6.4	Disease (Indicate if cause known)			
6.6.5	Other (Indicate if known)			

6.7 What action <u>would</u> you take if your cattle get sick? (tick ALL that are appropriate and where there is more than one tick, indicate importance in descending order where 1 = most important, 2 = next etc)

		√	n	
6.7.1	Nothing			
6.7.2	Provide own medicine			
6.7.3	Consult family/friends			
6.7.4	Consult iSangoma			
6.7.5	Consult Co-operative			
6.7.6	Consult State Vet Services			
6.7.7	Consult Private Veterinarian			
6.7.8	Other (Indicate)			

6.8 Do you vaccinate your cattle against any diseases? (tick the appropriate)

		√	
6.8.1	Yes		*List the diseases/vaccines at 6.9*
6.8.2	No		*Proceed to Question 6.10*

6.9 List of diseases vaccinated against:

Disease	Vaccine Used
6.9.1	
6.9.2	
6.9.3	
6.9.4	

6.10 Have any of your cows experienced difficulty in giving birth in the last 12months? (tick the appropriate)

		√	
6.10.1	Yes		*Proceed to Question 6.11*
6.10.2	No		*Proceed to Question 6.13*
6.10.3	Don't know		*Proceed to Question 6.13*

6.11 Who assisted the cows to give birth? (tick the appropriate)

		√	
6.11.1	State Vet Services		
6.11.2	Private Vet		
6.11.3	Family/friends		
6.11.4	No one		
6.11.5	Other (Indicate)		

6.12 Were gloves used during assistance? (tick the appropriate)

		√
6.12.1	Yes	
6.12.2	No	
6.1.2.3	Don't know	

6.13 Have any of your cows aborted in the last 12 months? (tick the appropriate)

		√	
6.13.1	Yes		*Proceed to Question 6.14*
6.13.2	No		*Proceed to Question 6.16*
6.13.3	Don't know		*Proceed to Question 6.16*

6.14 What happened to the cow(s) that aborted? (tick ALL that are appropriate)

		√	
6.14.1	Isolated from the herd		
6.14.2	Slaughtered the cow		
6.14.3	Sold the cow		
6.14.4	Nothing		
6.14.5	Other (Indicate)		

6.15 Following the abortion, what action did you take? (tick ALL that are appropriate)

		√
6.15.1	Reported to veterinary officials	
6.15.2	Consulted private veterinarian	
6.15.3	Took samples to the laboratory	

6.16 Do you know of the cattle disease brucellosis (contagious abortion)? (tick the appropriate)

		√	
6.16.1	Yes		*Proceed to Question 6.17*
6.16.2	No		*Proceed to Question 6.23*
6.16.3	Don't know		*Proceed to Question 6.23*

6.17 Are you aware of what effect it has on cattle? (tick the appropriate)

		√	
6.17.1	Yes		*Proceed to Question 6.18*
6.17.2	No		*Proceed to Question 6.19*

6.18 List the signs/effects on cattle:

6.18.1
6.18.2
6.18.3
6.18.4
6.18.5

6.19 How do you think cows get brucellosis? (tick ALL that are appropriate)

		√
6.19.1	Through consuming contaminated pastures	
6.19.2	Through mating with diseased bulls	
6.19.3	Through tick bites	
6.19.4	Through mixing with diseased cows	
6.19.5	I don't know	

6.19.6	Other (Indicate)		

6.20 Do you think brucellosis affects people? (tick the appropriate)

		√	
6.20.1	Yes		*Proceed to Question 6.21*
6.20.2	No		*Proceed to Question 6.23*
6.20.3	Don't know		*Proceed to Question 6.23*

6.21 List the signs/effects on people:

6.21.1
6.21.2
6.21.3
6.21.4
6.21.5

6.22 How do you think people get brucellosis? (tick ALL that are appropriate)

		√	
6.22.1	Through drinking infected raw milk		
6.22.2	Through tick bites		
6.22.3	Through eating infected meat		
6.22.4	Don't know		
6.22.5	Other (Indicate)		

6.23 Indicate whether you agree or disagree with the following statements, or don't know:

(tick the appropriate response)

		Agree √	Disagree √	Don't know √
6.23.1	Cattle that abort once are safe to keep in the herd			
6.23.2	Buying cattle from an auction can result in introduction of diseases			
6.23.3	Cows that abort must be slaughtered as soon as possible			
6.23.4	Feeding aborted material to dogs may lead to spread brucellosis			
6.23.5	Abortions in cattle can be caused by evil spirits			
6.23.6	Problem cows that abort can be sold to other farmers			

6.24 Do you vaccinate your cattle against brucellosis? (tick the appropriate)

		√	
6.24.1	Yes		*Proceed to Question 6.25*
6.24.2	No		*Proceed to Question 6.26*
6.24.3	Don't know		*Proceed to Question 6.26*

6.25 Please indicate the vaccine used: (tick the appropriate)

		√	
6.25.1	Strain 19		
6.25.2	RB51		
6.25.3	Other (Indicate)		

6.26 Have you had contact with any government veterinary officials in the last 12 months? (tick the appropriate)

		√		*n*
6.26.1	Yes		6.26.3 How many times?	
6.26.2	No		6.26.4 What was the purpose of the visit(s)?	

Thank you for your time

Annexure 3

Informed consent

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Bovine Brucellosis: A cross-sectional study of non-commercial cattle herds in Gauteng Province.

Informed Consent

Dear Participant,

I am an MSc student with the University Of Pretoria School Of Veterinary Tropical Diseases. You are kindly requested to participate in this survey:

Bovine Brucellosis: A cross-sectional study of non-commercial cattle herds in Gauteng Province.

The purpose of the survey is:

1. To provide baseline data on the location, size, demography, trading patterns and management of the sampled herds.
2. To describe the distribution, nature and farm behaviour of non-commercial bovine herds in Gauteng Province.
3. To yield information on the behaviours, attitude and level of knowledge of farmers in the sector.

Your participation will help us to collect data that we will use to determine the risk of brucellosis spread in this sector and to develop strategies to assist farmers to improve the productivity of their cattle and safeguard public health.

You are requested to answer the questionnaire fully. The answers you provide will be treated with the strictest confidence and your personal details will not be shared with any third party. The results of the full survey will be summarised and you will be provided with feedback on the outcome and recommendations.

The Research Ethics Committee of the University of Pretoria has granted approval for this study.

Yours Sincerely,

Dumakude Mpofu (BVSc)

Annexure 4
Animal Ethics Approval

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

ANIMAL ETHICS COMMITTEE
Private Bag X04
0110 Onderstepoort

Tel +27 12 529 8434 / Fax +27 12 529 8300
e-mail: aec@up.ac.za

Ref: V098-16

29 August 2016

Prof. D Abernethy

Dean: Faculty of Veterinary Science

(darrell.abernethy@up.ac.za)

Dear Prof Abernethy

V098-16 : Bovine Brucellosis: A cross-sectional study investigating non-commercial cattle herds in Gauteng Province (D Mpofu)

The AEC has reviewed your protocol. Since no animals or animal samples are not involved, ethical approval is not required

Kind regards

Prof. V Naidoo

CHAIRMAN: UP-Animal Ethics Committee

Cc Prof T Matjila (HoD)

Dr D Mpofu (Researcher)

Prof M Oosthuizen (Research Coordinator)