MANAGEMENT OF THE FERTILITY OF COMMUNAL BULLS IN MORETELE DISTRICT, NORTHWEST PROVINCE IN SOUTH AFRICA

By

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Submitted in partial fulfilment of the requirements for the degree of
MAgric (Animal Production Management)
In the Department of Animal and Wildlife Sciences,
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July 2015

ACKNOWLEDGEMENTS

Professor Edward Webb my supervisor for his guidance, advice and unfailing support during this study.

Professor Cheryl M. E. McCrindle my co-supervisor for her patience, encouragement, perseverance and teaching me how to believe in myself, I acknowledge her competent supervision during this study. Only God can reward her for the contribution she has made in my life.

Professor Lucky Nedambale for being fully involved. From the minute we asked him for assistance with field data collection, he availed his competent staff, namely **Dr. Anza Kharibe**, **Mr. Mphaphathi Masindi**, and two student assistants, who helped with the collection and analysis of semen samples [sperm motility], collection of sheath scrapings for trichomonas fetus and campylobacter fetus testing together with scrotal circumference measurement from bulls during this study.

Mrs. Ester Botha and Mr. Mario Smuts for teaching me how to collect and examine semen from bulls and also being fully involved by helping with the analysis of bull sperm morphology and concentration at the Onderstepoort Laboratories, their effort has been noticed and acknowledged, thanks a lot.

Moretele farmers who participated in this research study: without their cooperation this research study would not have been successful.

Dr. T. Mlilo (Moretele State Veterinarian) for his support from the onset.

Dr. M.J Sekokotla for his relentless encouragement and mentorship.

Directorate of Veterinary Services NWP for allowing me to do the study.

National Research Foundation for funding the project.

International Livestock Research Institute (ILRI) for financial assistance with data gathering and participatory rural appraisal strategies.

DEDICATION

I dedicate the success of this research study to the owner of life, the creator of heaven and earth, for letting me to live and become such a believing scholar.

I also dedicate the success of this research study to the following important people: My wife, (**Mrs. Mmatjie Maime)** and two daughters (**Tshimologo** and **Gomotsegang Maime)**, for being the pillar and strength in my life during the time when I needed them most.

DECLARATION

I, **Masethe Jan Maime**, hereby declare that the work on which this thesis is based is original and that neither the whole work nor part of it has been, is being, or shall be submitted for another degree at this or any other University, institution for tertiary education or professional examining body.

Signature **Date**

Masethe Jan Maime

July 2015

MAgric (Animal Production Management**)**

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ABSTRACT

A low calving rate (ranging from 20% to 40%) was recorded by state veterinary officials in 10 villages in the Moretele Local Municipal District in 2011. A previous study in the same area conducted in 2003 suggested that the probable cause of the low calving rate was bull infertility. However, only 13 bulls were examined in that study. The aim of the current study was to evaluate the fertility of a larger sample of communal bulls (*n*=50) to assess their fertility and the perceptions of farmers about bull fertility.

A participatory planning workshop was held to inform farmers from Moretele Municipal District about the project and 77 farmers agreed to participate in this study. The criteria for assessing bull fertility included testing for infectious diseases (brucella abortus, campylobacter fetus and trichomonas fetus), measuring scrotal circumference as well as scrotal and preputial tick damage. The electro-ejaculator method was used to collect semen from bulls throughout the study and the Computer Assisted Sperm Analysis system was used to measure total, progressive and non-progressive motility. Slides stained with eosin and nigrosin were examined microscopically for semen morphology. In herds studied, the number of cows and number of calves born over the study period (12 months) were recorded during farm visits, to calculate calving percentage. Data on farmer demographics and opinions were obtained using structured interviews.

Two bulls tested positive for brucellosis and ten others were excluded from the project due to various reasons. One was suspicious for *T fetus.* The average calving percentage of herds studied was 35.86%. The overall percentage motility of bull semen was 78.73 ± 25.34 %, but percentage progressive motility was very low, with an average of 27.39 ± 15.81 %. Percentage non-progressive motility was higher at 51.34 ± 19.92 %. Only 50.62 ± 35.80 % of the spermatozoa were morphologically normal. Tick damage to the scrotum and prepuce was observed in 92% of the bulls tested. Scrotal circumference showed an overall mean of 37.63 ± 3.42 cm and the overall mean age of the same bulls observed was 3.88 ± 0.99 years. About 13% of the bulls did not reach the minimum scrotal circumference threshold of 34 cm which is recommended at that specific age. Demographic data indicated that farmers were mostly interested in physical conformation of the bulls (*n* = 9)18.4% and their reproductive performance (*n* = 15, 30.6%). When purchasing a bull, no farmers asked for breeding soundness evaluation or proof that the bull was negative for B. abortus, T. fetus or C. fetus.

It was concluded that most of the bulls (92%) were infertile based on results showing that semen was of poor quality and lack of structural soundness, possibly due to tick damage. It is recommended that extension campaigns be aimed at disseminating information about pre-purchase examination of bulls, disease status and spot treatment of genital areas with an appropriate acaracides, to prevent tick damage to the scrotum and prepuce.

Key word: Calving percentage, fertility, infectious diseases, semen, Ixodid ticks, breeding soundness examination.

SUMMARY

MANAGEMENT OF THE FERTILITY OF COMMUNAL BULLS IN MORETELE DISTRICT, NORTHWEST PROVINCE IN SOUTH AFRICA

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In 2011, a low calving rate (ranging from 20% to 40%), was recorded by state veterinary officials, in 10 villages in the Moretele Local Municipal District. In a preceding study conducted in 2003, a calving rate of 37.74% was reported in Jericho, which neighbours some of the Moretele communal villages. The latter study was based on only 13 bulls and it was postulated that tick damage to the scrotum (n = 5) 38.46% and prepuce (n = 11) 84.62% were a more likely cause of fertility problems than infectious diseases (Mokantla, 2003; Mokantla *et al*., 2004). The aim of the current study was to evaluate the fertility of a larger sample of communal bulls (n = 50) to assess their fertility and the perception of farmers about bull fertility in the Moretele district.

The study area was the Moretele Local Municipality, which falls under the Bojanala Platinum district, situated in the Eastern region of the North West Province, South Africa. The human population was estimated at 186 947 with 52 063 households (StatsSA, 2011). Ten villages were randomly sampled and within each village, five farmers who owned bulls within their herds and five who owned cattle but had no bull, were approached to participate in the project. A workshop was held with farmers from the 10 villages to “scope” the project and ask for voluntary participation in a structured interview. Although 100 farmers initially agreed to participate, only 77 completed the structured interview at a subsequent meeting held at Sutelong village.

The total number of breeding cattle in the ten villages was 2473 out of this 2398 were cows and 75 were bulls, out of the 75 bulls, only 50 were included in the project. Serum collected from the 50 bulls was tested at Onderstepoort Veterinary Institute (OVI), for *Brucella abortus*, using the Rose Bengal (RBT) and Complement fixation tests (CFT). Bulls with a CFT titre of 30 IU/ml were regarded as positive. Two bulls tested positive for *B. abortus*, and were culled. A further 10 withdrew for various reasons. The remaining 38 bulls were tested for Trichomonas fetus and Campylobacter fetus and evaluated for fertility.

The criteria for bull fertility included measurement of scrotal circumference, visual and palpable tick damage to scrotum and prepuce; as well as in-depth examination of semen motility and morphology using the Computer Assisted Sperm Analysis system. During farm visits, data was obtained on the number of breeding cows and the calves born over a 12 month study period. Data obtained was analysed using Microsoft Excel version 15.1 (Microsoft Corporation, USA).

Analysis of demographic data indicated that farmers mainly considered physical conformation (*n* = 9) 18.4% and reproductive performance (*n* = 15) 30.6% compared to other characteristics like when purchasing a bull. None of the farmers that they asked for breeding soundness evaluations or freedom from B. abortus, T.fetus or C.fetus. Less than half of the farmers (*n* = 23) 47% knew about breeding soundness. However more than half (n = 29) 59% did not know about infectious as causes of infertility. Calving percentage was calculated as 35.86 % and the overall bull cow ratio as 1:32.

Although 92% of farmers claimed that they regularly treated the bulls with acaracides, this contradicted the high frequency of ticks observed on the external genitalia (*n* = 38, 100%). Thirty five (92%) of bulls examined for breeding soundness showed scrotal and preputial abscesses, thickening of the skin and visible nodules caused by ticks (*Amblyomma* and *Hylomma* species). It is likely that this observed tick damage contributed to infertility as only 8% of the bulls were fertile.

The low prevalence of brucellosis (*n* = 2) 4 % might have been due to control in communal cattle achieved by the Directorate of Veterinary Services vaccinating communal heifers at 4 – 8 months of age. Although one bull was suspicious for *T fetus,* all bulls in the study area tested negative for C. fetus and T. fetus*.* Scrotal circumference showed an overall mean of 37.63 ± 3.42 cm and the overall mean age of the same bulls observed was 3.88 ± 0.99. *(n* = 5, 13 %) of the bulls did not reach minimum scrotal circumference threshold of 34 cm that is recommended based on the age.

The overall percentage motility of bull semen was 78.73 ± 25.34 %. The percentage progressive motility of semen was very low, with an average of 27.39 ± 15.81 %. The percentage non-progressive motility was higher at 51.34 ± 19.92 %. This low semen motility, contributed greatly to the overall poor semen quality. Only 50.62 ± 35.80 % of the spermatozoa were morphological normal, which was poor when compared with the value of 72.8 ± 1.6 % reported to be low by Vilakazi (2003). Very few (*n* = 3) 8 % bulls were fertile based on the semen quality and structural soundness. During 2013 the calving percentage was only 35.86 %. It was seen that 92% of bulls had semen with a low progressive motility of 27.39 ± 15.81 % and non-progressive motility of 51.34 ± 19.92 %.

It was concluded that most (92%) bulls investigated were infertile, which supported that conclusion reached by Mokantla *et al*., in 2004. From this it is recommended that extension campaigns be aimed at information about pre-purchase examination of bulls; disease testing; bull to cow ratios and spot treatment of genital areas with appropriate acaracides, to prevent tick damage to the reproductive organs. It is probable that ticks have a more serious influence on the fertility of bulls and cows than previously thought.

Key word: Calving percentage, fertility, infectious diseases, scrotal circumference, semen, Ixodid ticks, breeding soundness examination.

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CHAPTER 1

INTRODUCTION

1.1 Motivation

The small scale farming sector within the rural areas of the North West Province in South Africa plays an important role in household food security for the poor. The fertility of bulls in communal cattle herds, can directly influence herd productivity by affecting conception rates in breeding cows. It follows that if the fertility of bulls is below acceptable norms, it lowers calf production, which means that, there would be an inadequate income for the farmer as well as a decrease in food security. Healthy fertile bulls contribute to higher conception, pregnancy and calving rates of a herds. This ensures better financial returns for the farming community.

This research study was conducted to investigate the cause of low calving rate (ranging from 20% to 40%) recorded by state veterinary officials in 10 villages in the Moretele Local Municipal District during 2011. In 2003, the state veterinary report for the local municipality also recorded a calving percentage of 40% (Sekokotla, 2003). Mokantla (2003) reported a calving rate of 37.74% in Jericho, which neighbours some of the Moretele communal villages. His in-depth longitudinal study of the causes of low calving percentage in the communal cows pointed to bull fertility as the main causal factor.

However insufficient bulls were sampled (*n*=13) to substantiate this conclusion. Nonetheless the authors postulated that tick damage to the scrotum (n=5, 38.46%) and prepuce (*n*=11, 84.62%) were a more likely cause of fertility as compared to infectious diseases (Mokantla, 2003; Mokantla *et.al*, 2004). The low values reported in past studies indicated a serious problem in fertility and subsequent production levels, which was mainly due to low bull fertility (Mokantla, 2003; Mokantla *et al.,* 2004).

Fertility in general refers to the ability of animals to produce offspring, and according to Holroyd *et al., (2005*) the fertility of bulls can be classified as:

(i) Fertile : Bulls which can impregnate at least 30 females out of 50 cycling disease-free females in the first 3 weeks of mating or at least 45 of these in the first 9 weeks of mating.

(ii) Sub-fertile**:** Bulls which can achieve pregnancies by natural mating, but not at the same rate as those that are regarded as fertile bulls.

(iii) Infertile**:** Bulls that cannot achieve pregnancies in cows.

Hafez (2004) indicated that the decrease or loss of libido or ability to copulate is the main form of sterility in bulls. Reasons for the loss of libido are:

(i) Non-existent sexual desire: This form is occasionally experienced in young bulls used for the first time. Such bulls are ignorant of what is expected from them, they end up playing with cows instead of mating. It could also be as a result of low level of testosterone due to immaturity or genetic factors.

(ii) Incapacity to copulate *(impotencia coeundi)*: This form of sterility is when the bull attempts to carry the act of coitus without success. This may be due to weakness occasioned by sexual overexertion, lack of exercise in conjunction with rich or too bulky feeds, pot belly or morbid change in the skeleton, joints, muscles and hoofs that cause pain when the bull mounts a cow.

(iii) Incapacity to fertilise *(impotencia generandi)*: This usually results from poor semen quality and diseases. The bull mate's cows but conceptions and pregnancies are absent.

Mokantla (2003) reviewed the international literature about key factors affecting bull fertility. These included genetics (breed selection), herd health, bull management, nutrition, the breeding system used and the bull-cow ratio. Some authors found that the most important measures of fertility are quality of semen (sperm morphology, sperm motility, and concentration), and the disease status of the bulls in the herd (Winder, 2007; Persson, 2007). The current study focussed on the causes of infertility in communal bulls in Moretele district.

1. 2 Problem statement

Bulls in communal herds of smallholder or subsistence farmers in Moretele district are not evaluated for fertility and as a result the role in the low calving rate in communal herds is not known.

1. 3 Hypotheses

1. (Ha): The fertility of bulls in communal herds in the study area is poor compared to the norms for bulls in commercial herds.
(Ho): The fertility of bulls in communal herds in the study area is comparable with the norms for bulls in commercial herds.
2. (Ha): The fertility of bulls influences the conception rates of cows in communal cattle herds.
(Ho): The fertility of bulls does not influence the conception rates of cows in communal cattle herds.

1.4 Aim and anticipated benefits of the study

1.4.1 Aim of the study

The aim of the current study was to investigate the fertility of communal bulls (n=50) and perform a more in depth study than previously done by Mokantla (2003).

1.4.2 Anticipated benefits of the study

(i) Improved understanding in relation management or reproductive aspects that affect bull fertility in Moretele communal herds, particularly aspects that contribute to poor semen quality and the disease status of bulls;

(ii) The bulls would be tested for transmissible diseases including brucellosis which is a serious zoonosis and knowledge of the disease status in bulls will help State Veterinary Services to control the disease effectively for these poor communities;
(iii) Results would help the North West Province (NWP) Department of Agriculture to develop programs that support sustainable animal production in Moretele district, through communication of plans to improve bull fertility in the communal areas.

1. 5 Work plan

The study was divided into the following phases:

Phase 1
The phase of convening farmers meetings to explain, plan and compile agreements with the selected farmers who had communal herds in Moretele district.

Phase 2
Selected farmers who owned a bull and those without bulls but depended on communal or local bulls, were interviewed to test their knowledge and understanding of bull management. Selected bulls were ear tagged for identification, and blood samples collected for Rose Bengal test (RBT) and the Complement Fixation Test (CFT). Sheath scraping samples would be collected from the bulls and submitted to the laboratory for trichomonosis *a*nd campylobacter testing. Semen samples were collected for macroscopic and microscopic examination.

Phase 3
Data from farmer interviews, results of semen examination and laboratory tests were analysed during this phase.

Phase 4
During the fourth phase the research study report was compiled and discussed with the farmers, with development of a relevant extension campaign about enhancing cattle fertility, based on research findings.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Casey and Maree (1993) stated that communal livestock owners should be encouraged to practise farming in a manner that increases the sustainable use of agricultural resources. Bath *et al.,* (2001) suggested that optimum animal production should be enhanced in order to address the problem of food shortages.

It is best practice to involve farmers in the formulation of strategies to improve farming practices, problem identification and testing of new technologies (Biggs *et al.,* 1991; Bembridge, 1991; Chambers *et al.,* 1993; Hawkins and Van den Ban, 1996; Heinrich *et al.,* 1991; Hűttner and Wanda, 1996; Janoff and Weisbord, 1995; Roling, 1992; Francis and Sibanda, 2001).

Agricultural extension campaigns should be implemented with monitoring and evaluation on an ongoing basis (Duvel, 2002; Sekokotla, 2004). The Farmer Support Service Working Group (1998) and Benor *et al.,* (1984) suggested that for extension to be successful, it must be instituted systematically with the participation of farmers. The resources needed to implement extension should be mobilized effectively and efficiently and all stakeholders must be fully committed to the successful attainment of the set goals. Knowledge of adult education principles is essential for effective communication with farmers (Bembridge, 1991; Sekokotla, 2004).

The Strategic Plan for South African Agriculture (National Department of Agriculture, 2001) has been a tool to guide and improve agricultural development in South Africa.

2. 2 Cattle Farming

Cattle are zoologically classified as follows according to Yeates and Schmidt (1974):

- Order = *Artiodactyla*;
- Family = *Bovidae*;
- Sub-family = *Bovinae*;
- Genus = *Bos*;
- Varieties = *Bos Taurus* (European breeds), *Bos Indicus* (Zebu breeds), *Bos sondaicus* (Banteng cattle breeds).

It is important to have a clear understanding of an animal's behaviour under various environmental conditions, for an intelligent analysis of the effect of nutrition, physiology, breeding and management (Kilgour and Dalton, 1984). The fertility of bulls is one of the aspects that affect calving percentage of cattle herds in communal cattle rearing systems in South Africa. This was reported to be around 41% by Bembridge and Tapson (1993). Calving percentage is the number of calves born from the number of female cattle served by a bull (Chenoweth, 1994; Mossman, 1984; Youngquist, 1997).

Calving percentage is a recommended indicator of the breeding performance of a herd (Collett, 1998; Youngquist, 1997). Low calving percentage indicates that there are problems related to herd management, herd health, or a mismatch between herd genetics and the environment (Mickelson, 1990; Vanroose *et al.,* 2000). In general, the bull is left to roam with female cattle throughout the year in communal extensive cattle farming systems (Van Zyl *et al.,* 1993). Strategic castration is needed to prevent indiscriminate breeding by substandard male animals on communal grazing (Hardy and Meadocroft, 1990).

Cattle that have adapted to a given environment perform better in comparison with those that have not adapted (Mabesa, 1994; Mukuahima, 2007). The environmental effects are included in genetic improvement programmes, where adjustment of data is necessary to increase selection efficiency (Taylor, 1995). Rural cattle famers on communal land depend on their herds for subsistence livelihoods and the State Veterinary Services should use veterinary extension and communication to improve livestock health and productivity (Mokantla, 2003; Makgatho, 2004; Sekokotla, 2004).

2.3 Factors that influence bull fertility

2.3.1 Introduction

There are numerous factors that influence bull fertility in communal cattle farming systems and these include environmental, genetic, hormonal, health and management factors (Mokantla, 2003). A proper investigation of these factors should be conducted when evaluating breeding soundness of bulls. Bull fertility is linked to semen quality, regardless of whether it is used in artificial insemination (AI) or natural service (Gordon, 1996; Hafez, 1987; Persson, 2007).

Bulls should be examined for quality and quantity of semen, general health and willingness to find a cow in oestrus, on extensive grazing (Gordon, 1996). The evaluation of the breeding soundness of bulls can be done by using the following parameters (Mokantla, 2003):

- Age (years).
- Body condition score (1-9).
- Scrotal circumference (cm).
- Semen Volume (ml).
- Semen pH (1-10).
- Sperm mass motility (1-5).
- Sperm individual motility (0-100).
- Sperm concentration ($x10^9$ /ml).
- Total abnormal sperm (%).
- Abnormalities of the reproductive tract.
- The presence of infection.

In order to check for breeding soundness before breeding season, the reproductive organs of the bulls should be checked for abnormalities. (Parkinson, 2004).

2.3.2 Genetic and Hormonal factors that cause bull infertility

The genetic makeup of an animal predetermines the animal's phenotype and this happens just after the sperm has fertilized an egg (Bonsma, 1967). The influence of genetic factors on the fertility of cattle has been reviewed by (Cooper and Willis, 1972; Johansson, 1961; Langerloff, 1963; Rollinson, 1955; and Young, *et al.,* 1996). Fertility and reproductive activities are phenotypic expressions, resulting from an interplay of genetic and environmental factors (Payne, 1996; Steffen, 1997). Some genes in an animal can affect the development of spermatozoa and thus influence breeding efficiency (Petherick, 2005). An example is the genetic origin for development of spermatozoa with tails turned back past the head (Asdell, 1955).

Cooper and Willis (1972) confirmed that there are two hormones which affect the normal functioning and development of the testicles. In some bulls there are endocrine disorders that result in penile abnormalities such as micropenis and these disorders may ensue from hereditary genetic disorders or from acquired causes (Smith *et al.,* 1981). Scrotal circumference in bulls is very important because when it increases, so does the daily production of high-quality sperms (Perry, 2008; Chenoweth, 1999).

There is a positive genetic correlation between the sire's scrotal circumference and the scrotum circumference of his male offspring, which means bulls with larger scrotal circumference would likely sire male offspring with larger scrotum circumference, whereas the female offspring have positive and negative genetic correlation of scrotal circumference. Daughters of bulls with large scrotal circumference tend to reach puberty at a younger age and are more likely to start cycling by the beginning of the breeding season (Perry *et al*., 2008; Walker *et al.,* 2009).

2.3.3 Herd health related factors causing bull infertility

2.3.3.1 Viral causes of infertility in the bull

Herpes virus

The infection of the bull's glans penis and prepuce with herpes virus may result in the formation of vesicles and pustules causing balanoposthitis and pain that hinders the bull from serving cows (Hungerford, 1990).

2.3.3.2 Bacterial causes of infertility in the bull

Brucellosis

Brucellosis is a disease caused by members of the bacteria genus *Brucella*, which affects numerous animal species and humans (Godfroid *et al.*, 2004). In cattle Brucellosis is caused by Brucella abortus and is characterized by abortions, stillbirths and weak calves (Godfroid *et al*., 2004; Ahmed, 2009). Abortion usually occurs during the second half of gestation (Godfroid *et al*., 2004; Bakunzi *et al*., 1993).

The disease has both direct and indirect influences on bull fertility. It can be a direct cause of infertility due to orchitis, epididymitis, seminal vesiculities and testicular abscesses, but also an indirect cause if fertility is measured in cows by calving percentage. Brucellosis is considered by the United Nations Food and Agricultural Organisation (FAO) and World Health Organization (WHO) as one of the most widespread zoonotic disease in the world (Ahmed, 2009). Mackereth (2003) reported Brucellosis as a disease that formally had worldwide distribution but now eradicated from many developed countries.

Brucellosis is a controlled animal disease in South Africa and the control measures are instituted by government in terms of the Animal Disease Act, 1984 (Act, 35 of 1984) and

Meat Safety Act, 2000 (Act, 40 of 2000). The State Veterinary Services is mandated to vaccinate cattle every year for brucellosis. The South African government also does surveillance of brucellosis on an ongoing basis under the Brucellosis Eradication Scheme and the herd prevalence is reported to be between 1.5% and 2% in typical communal cattle rearing areas (Bakunzi *et al.,* 1993; Botha and Williamson, 1989). The primary source of infection in a herd is aborted foetal membranes and fluids as well as vaginal discharges from infected females (Godfroid *et a*l., 2004).

Most or all *Brucella* species are found in semen, although the importance of venereal transmission varies with the species (CFSPH, 2009). Infected bulls may excrete the organism in their semen, but venereal transmission of this organism is uncommon (Godfroid *et al*., 2004; CFSPH, 2009). Brucella infection in bulls may result in permanent sterility (Blood *et al.,* 1983). The same author also affirm that "In addition to the loss of milk production, there is a loss of calves and interference with the calving periods". This is of greatest importance in beef herds where the calves represent the sole income (Ahmed, 2009). A high incidence of temporary and permanent infertility results in heavy culling of valuable cows and deaths may occur as a result of acute metritis following retention of the placenta.

Naturally infected cows and those vaccinated as adults with *Brucella abortus* strain 19 vaccine remain positive for the serum and other agglutination tests, for long periods (Bernard *et al.,* 2005). Most animals vaccinated between 4 and 8 months of age return to a negative status within a year. All are considered to have a good immunity to infection. Calves from cows which are positive reactors to the test are passively immunized via colostrum. It is possible that some calves remain immune for an extended period, which can interfere with vaccination (Blood *et al.,* 1983).

The spread of bovine brucellosis from herd to herd and from one farm to another is almost always because of the mixing of infected herds with un-infected herds as is the case in extensive communal cattle rearing farming systems. Brucellosis is diagnosed by serological tests such as the complement fixation test (CFT), ELISA and by isolation of the organism from uterine discharges, aborted foetuses and milk (OIE. 2012). There is no effective treatment for infected animals, which remain carriers and spread the disease to the rest of herd, thus the best way to rid a herd from this disease is to remove infected animals by culling or slaughter.

Bovine genital campylobacteriosis

Bovine genital campylobacteriosis (BGC) or bovine venereal campylobacteriosis (BVC), formally known as vibriosis, is a venereal disease characterized by infertility, early embryonic deaths, a protracted calving season and abortion in cattle (Irsik and Shearer, 2010; OIE, 2008). It is caused by organisms such as campylobacter fetus venerealis or campylobacter fetus. Both are motile, curved or spiral, polar flagellated, microaerophilic, gram negative bacteria (Irsik and Shearer, 2010; Irons *et al.*, 2004).

A single infected cow or a bull can introduce the disease into the susceptible herd (Irsik and Shearer, 2010; Irons *et al*., 2004). The organism can survive in the vagina of infected cows, invade the uterus and attack the early developing embryo causing death with subsequent reabsorption, or expulsion by abortion, which results in a low calving percentage (Irsik and Shearer, 2010). Bulls become infected when they serve infected cows and they transmit the disease among susceptible cows during mating (Irsik and Shearer, 2010; Irons *et al*., 2004). After transmission during coitus, an inflammatory reaction results in the female genital organs.

Another source of infection in a herd, beside venereal transmission, is through contact with contaminated instruments, bedding, or by artificial insemination using contaminated semen (Irons *et al.,* 2004). Samples taken from bulls, cows or aborted foetuses can be analysed for the presence of the causal organism (OIE, 2008). There are two methods for the collection of smegma in bull for bacterial isolation, which are preputial washing and preputial scraping with 5ml of phosphate buffer solution (PBS) with 1% of formalin (OIE, 2008; Iron *et al.,* 2004; Irsik and Shearer, 2010).

According to the OIE (2008) smegma can also be collected from the artificial vagina after semen collection, by washing the artificial vagina with 30 – 20 ml of PBS. Irons *et al*., (2004) suggested that infected cows, heifers and bulls should be treated with an antibiotic that includes streptomycin, administered locally or systemically at 22mg/kg. Cows must be separated from heifers and culled in an attempt to building up a clean herd. Bulls and heifers must be vaccinated 6 – 8 weeks before the commencement of the breeding season, and a single annual booster must be given four weeks prior each ensuing breeding season (Irsik and Shearer, 2010).

2.3.3.3 Protozoan causes of bull infertility

Trichomoniasis

Trichomoniasis is a venereal disease of cattle caused by the protozoan tritrichomonas foetus which parasitizes the genital tract (Irons *et al*., 2004). Kvasnicka (1991) reported that the disease is responsible for herd reproductive failure and considerable economic losses in areas of the world where natural breeding is used. The disease is characterized by infertility, which includes early embryonic death, abortion and pyrometer (Kvasnicka, 1991; Irons *et al*, 2004). Most abortions occur during the first half of gestation starting 45 days after conception, although few abortions occur as late as the 7th month (Kvasnicka, 1991; Parker, 1998).

The organisms that causes trichomonosis infections in cattle are harboured in the reproductive system of infected cows and bulls, and transmitted from cow to cow by chronically infected bulls (Parker, 1998; Hungerford 1990; Huston, 2014).Therefore as bulls age, the skin folds grow, which gives the organism more places in which to grow and thrive (Huston, 2014). Older bulls (4 years and older) are likely to carry the disease for life (Parker, 1998; Kvasnicka, 1991). These organisms cause small nodular lesions on the penis of bulls with mucopurulent discharge from the prepuce and bulls become reluctant to serve cows (Hungerford, 1990).

In cows, tritrichomonas fetus colonizes the vagina, cervix, uterus and oviducts. Infected cow herds experience infertility (Parker, 1998; Kvasnicka, 1991). Anderson *et al* (1994) mentioned that pyometra and abortions are often the first physical signs that indicate the possibility of Trichomoniasis infection, but these signs occur in less than 5% of the infected cows.

Mokantla (2003) found in his research study that tritrichomonas fetus infections played much less role than anticipated, but his findings could have been influenced by the small number of bulls sampled and also three negative tests a week apart, that were not done as described in the literature. Other studies in communal areas of South Africa have shown the prevalence of *T. foetus* to be between 7% and 25% (See Table 2.1).

Table 2.1. Prevalence of *T. fetus* in South Africa

Location	**Prevalence %**	**Reference**	**Year**
North Western Cape, Western Transvaal, Orange Free State	7%	Erasmus *et al*.	1989
Kwa - Zulu Natal	25%	Kitaning	1999
Eastern Cape	23%	Pefanis *et al*.	1988

Peter (1997) emphasized that currently, there is no effective parenteral treatment for bovine trichomoniasis. Curative treatment with topical trichomonadicidal compounds, which include acriflavine and diminazene acetarate, an ointment containing 0.5% di-amino-methyl-acridine and Bovoflavin, have been achieved by number a of workers (Roberts, 1986; BonDurant, 1985; Irons *et al*., 2004). Kvasnicka *et al*., (1989) noted that a vaccine (Trich Guard, Fort Dodge Laboratories) against *T. foetus* was available. The vaccine protects against abortion by shortening the time the cow is infected, following challenge, therefore it should be administered to the cow herd annually before the breeding season (Kvasnicka, 1991). The vaccine has no protective effect for bulls and vaccination is not recommended (Irons *et al.,* 2004).

Besnoitiosis

Bovine besnoitiosis is a protozoal disease of cattle caused by the cyst-forming apicomplexan parasite besnoitia besnoiti (Bigalke and Prozesky, 2004; EFSA, 2010). The EFSA (2010) reported that this disease is either a severe but usually non-fatal disease of cattle, or a mild clinical disease. In South Africa it was first discovered on a farm near Rustenburg by Hofmeyer in 1945 (Bigalke and Prozesky, 2004). The disease has been recorded worldwide in different animal species and has considerable economic importance in subtropical regions of Africa and Asia (Bigalke and Prozesky, 1994).

In South Africa, the majority of new cases occur during the warmer, moister months of the year (Bigalke and Prozesky, 2004). All breeds of cattle, both bulls and cows but excluding calves, are susceptible to B. besnoiti (Bigalke and Prozesky, 2004). The infection is characterized by hyperthermia and non – specific signs, such as depression, swelling of the superficial lymph nodes and loss of weight (EFSA, 2010).

The EFSA (2010) reported that infected animals may develop oedema of the joints which are painful during movement. This can cause permanent posterior lameness. However, progressive thickening, folding or wrinkling of the skin, alopecia, and hyperkeratosis and the typical feature of scleroderma (known as elephant skin disease) occur in most cases with eventual shedding of the epidermis. The testes are swollen and sensitive to palpation (Bigalke and Prozesky, 2004). Sterility in males is caused by a necrotizing orchitis (EFSA, 2010). Bulls invariably become aspermatogenic, due to the presence of persistent orchitis that is followed by uni – or bilateral testicular atrophy and induration in chronic cases (Bigalke and Prozesky, 2004).

At present there is no suitable drug available for the treatment of besnoitiosis, although oxytetracycline has been found to delay the effect after artificial infection in rabbits (Bigalke and Prozesky, 2004). Onderstepoort Veterinary Institute has developed a live vaccine against bovine Besnoitiosis. This vaccine is issued in a frozen form and recommended for use in weaners as well as older animals (Bigalke and Prozesky, 2004).

2.3.4 Management factors causing bull infertility

2.3.4.1 Nutrition

It is important to note that nutrition influences the quality and quantity of semen in animals. Therefore cattle farmers need to make sure that bulls are well fed and are in good condition. Stress related to hunger also reduces bull fertility (Sprott, *et al.,* 2003; Walker *et al*., 2009). Walker *et al.,* (2009) indicated that overfeeding of bulls also has negative effects on reproductive performance due to the excess fat cover around the scrotum. This increases scrotal temperature and can reduce sperm production and the quality of stored sperms.

The reproductive function of growing bulls as compared to adult bulls, appears to be more susceptible to dietary energy restrictions and can result in permanent damage of gonadal tissue. The influence of nutrition on the reproductive process, is mediated via the effects of dietary constituents on the hypothalamic – pituitary axis. As a result, dietary changes may affect the testes directly (Gordon, 1996).

Acocks (1975) reported in his research that the nutritional quality of vegetation in most communal areas, was inadequate. Supplementary feeding of beef bulls on the extensive communal grazing system in the Moretele municipal area in North West Province is lacking, especially in winter when the pasture is poor or there is overgrazing due to overstocking. This might have a negative impact on the reproductive performance of bulls in communal areas.

The National Research Council (NCR) (1996) has summarized the functions of nutrients in the animal body as follows:

- Proteins are for strengthening the immune system and for bone formation. There are numerous sources of protein in plants. Feed supplements sold commercially have adequate protein precursors like urea, or amino acids.
- Calories are for energizing the body – e.g. enhancing walking. There are numerous sources of calories found in plant (e.g. maize silage). Commercial feed supplements are also a source of calories.
- Minerals and vitamins are used for biological processes (hormonal and enzymatic). The main source of minerals and vitamins are commercial premixes that are added to feed.
- Roughage is required for keeping the gastro – intestinal tract (git) functioning optimally and examples of sources of roughage are grass and silage.

2.3.4.2 Improper care of bulls

Trauma to the genitals of bulls may result in indurated and unhealthy testicles that result in permanent sterility of bulls. Mokantla *et al.,* (2004) suggested that damage to the scrotum caused by ticks was an underestimated cause of sub-fertile bulls. Injuries to the scrotum, penis, and prepuce may lead to indurations that result in abnormalities that lower the fertility of bulls or cause sterility (Mokantla, 2003). Mokantla *et al.,* (2004) suggested that the lesions caused by long mouthed tick species such as *Amblyomma species* and *Hyalomma species* could be a major cause of infertility in bulls due to inflammation and scar tissue on the scrotum.

2.3.4.3 Improper selection of bulls for breeding

To ensure desirable genetic makeup of the herd, selection of breeding bulls must be properly done, as improper selection, together with inbreeding results in undesirable or poor genetic makeup of the herd. This may lower fertility due to inherited defects (Dhuyvetter *et al.*, 1996).

2.3.5 Environmental factors that influence bull infertility

The stress of unfavourable environmental weather conditions including extreme heat or cold, can affect the quality of sperm in bulls. It has been confirmed that heat stress lowers bull fertility (Gordon, 1996; Salah *et al*., 1992; Perez and Perez, 1993; Barth and Bowman, 1994). It was also suggested by Mokantla (2003) that heat reflected from the overgrazed soil in communal grazing areas could affect the production of sperm in communal bulls. Chenoweth (2000) indicated that the seasonal ambient temperature and feed availability can influence reproductive capability of cattle.

2.4 Breeding management

The correct management of the herd sire is crucial as one infertile or sub-fertile bull will decrease the calving percentage, leading to severe financial consequences for farmers. Bull fertility has an impact on economic returns for both communal and commercial beef producers (Dhuyvetter *et al.,* 1996). The bull must contribute to genetic improvement and should have a high reproductive capacity (Greiner and Hall, 2007).

To prevent inbreeding it is advisable that a bull should not be used for more than 4 years in a herd of 100 -150 breeding cows. This is because many of his daughters will enter the breeding herd after 4 years (Gerhard and Bosman, 2003). Management of breeding bulls is divided into 3 stages:

- Pre – breeding season or conditioning (2 Months);
- Breeding season(2 to 3 Months);
- Post breeding season (7 to 8 Months).

2.4.1 Management during the Pre – breeding season or conditioning

The most important management aspect is to make sure that all bulls receive breeding soundness examinations (BSE) to ensure optimal fertility (Greiner and Hall, 2007). Another critical aspect is to introduce the young bulls into the breeding cows at least 60 to 90 days prior to the breeding season, because they need time to adjust to the feed and the environment of their new home. Lusby and Selk (1992) suggested that adequate exercise, in combination with a proper nutritional programme, is important so as to make them physically fit for the breeding season.
Hansen (2006) reported that all new bulls need to be tested for trichomoniasis before they are introduced to the breeding cows. This is because newly introduced bulls can bring in sexually transmitted diseases such as campylobacter, trichomoniasis and bovine viral diarrhoea into the herd. They must also be vaccinated prior the breeding season (Bazeley and Hayton, 2007; Hansen, 2006).

Cattle farmers should purchase replacement bulls from reputable breeders who provide records of their herd health programme. They need to obtain all available records and breed registration information papers indicating performance information such as birth weight, yearling weight, average daily gain, weight per day of age, feed efficiency, frame size and scrotal circumference data from the bull test program (Bazeley and Hayton, 2007; Parish, 2005). Where the disease status is not known the farmer needs to request the tests to be performed prior to purchase (Parish, 2005). An important component of a good herd health program includes the treatment of bulls for parasites (Internal and external). Thus deworming and regular tick control strategies before the breeding season are essential (Parish, 2005).

2.4.2 Management during the breeding season

Gerhard and Bosman (2003) stated that it is advantageous to use a breeding season of 75 – 90 days in summer and 45 days in winter. When the bulls are let to run with cows throughout the year, the calving percentage is not higher than when breeding seasons are used. Furthermore Greiner and Hall (2007) started that a young bull should be kept for a maximum of 60 days with the breeding cows or heifers, to prevent overuse, severe weight loss and reduced libido, the reason being that, severe weight loss may impair future growth and development of the young bull and reduce his lifetime usefulness. However this is not practical on communal grazing (Mokantla, 2003).

Parish (2005) suggested that bulls should be turned out with heifers four weeks, before turning them out with the mature cow herd, because heifers may not be fertile on their first oestrus and their gestation may last slightly longer than the mature cows. Breeding heifers ahead of the mature cows allows more time for heifers to be re – bred after the first calving. The number of females a bull can cover depends upon its maturity, soundness, fertility and condition as well as pasture size and length (Parish, 2005).

It is important to place less sexually mature bulls with fewer females as compared to experienced bulls. According to Parish (2005), bulls must be well developed and between the ages 24 – 30 months, before they are let to run with cow herds of 25 – 30 cows. Farmers need to observe whether the bull is servicing and settling the cows during the 90 days of the breeding season, so as to monitor breeding behaviour and libido. The suggested bull-cow ratio is shown in Table 2.2.

To ensure that cows are being served and to be able to provide a reference for return to service or calving date, some herd producers prefer to use colour raddle on bulls to mark cows that are being served (Bazeley and Hayton, 2007). Young bulls need to be provided with extra feed during breeding season, to maintain their body condition because they are still growing, but a farmer must make sure that they do not become fat as this can become a problem (Walker *et al.,* 2009).

Table 2.2. The suggested number of cows/ bull for pastures mating.

Bulls age(Months)	**Number of females exposed to breeding per bull**
12 – 15	10 - 12
15 – 18	12 - 18
18 – 24	18 - 24
24 – up	24 - 30

2.4.3 Management after the breeding season (Post – breeding management)

Following the breeding season, bulls used for mating should be kept in a separate paddock or pasture away from cows or heifers, with plenty of exercise room, protection from bad weather, access to clean water and mineral supplements (Parish, 2005; Greiner and Hall, 2007). Young bulls must be kept on a high plane of nutrition to replenish body condition following the breeding season (Greiner and Hall, 2007).To ensure fertility, all herd bulls must receive an annual breeding soundness examination (BSE).

2.4.4 Breeding soundness examination (BSE)

The main objective of the breeding soundness examination (BSE) is to evaluate breeding potential of bulls before and after the breeding season (Parish, 2005). The breeding potential of a bull according to Landaeta – Hermandez *et al*., (2001) measures the reproductive capacity of a bull according to whether or not the bull has reached puberty and the quantity and quality of its semen. Penny (2010) argued that examination of bulls for breeding soundness was not an exact science, therefore classification between fertility and sub-fertility is not a clear cut. Barth (2000) reported that the BSE is a reliable method for testing bulls that have the potential for higher fertility and those that are unsatisfactory.

McGowan (2004) argued that it was important to examine the potential fertility of beef bulls prior to sale or use, because the fertility of the individual bull has a far greater impact on a herd performance than the fertility of the individual cows. Domestic cattle are not a highly fertile species due to their mediocre per-service calving rate of 50 - 60% (Parkinson, 2004). Mokantla *et al*., (2004) suggested that a bull with low semen quality may require more than one service to get a cow pregnant. This situation is worse in the communal grazing system, because the bull may not able to detect and serve all the cows that are in oestrus (Mokantla *et al.,* 2004).

Bertram *et al.,* (2000) suggested that using young bulls in cow herds may have potential benefits. This type of farming practice is not practical on communal grazing, as farmers prefer to use older bulls in their cow herds. Bulls should be tested approximately 4 – 6 weeks prior to the breeding season (Perry *et al*., 2008; Greiner and Hall, 2007). Ideally, if the score is below recommended standard of BSE prior breeding season, it gives farmers an opportunity to recheck or replace the bulls before the breeding season. Immediately after the breeding season, bulls need to be tested again. If the score is low after the breeding season, it gives the farmers an opportunity to cull that particular bulls as they might be sub-fertile or infertile (Chenoweth *et al.*, 1992). The breeding soundness examination includes physical examination, measurement of scrotal circumference and evaluation of semen quality (Perry *et al*., 2008; McGowan, 2004; Parish, 2005; Penny, 2010).

2.4.4.1 Physical examination of a bull

It is important to examine the internal and external genitalia when assessing a bull's reproductive ability, as injury or infection can render a bull infertile (Hansen, 2006). Parkinson (2004) pointed out that physical examination of the external genetalia of a bull involves the palpation of the penis, prepuce, scrotum and testis, measurement of scrotal circumference and semen evaluations. The internal genetalia are carefully examined by rectal palpation and include the urethra, seminal vesicle, ampullae and vas deference (Parkinson, 2004; McGowan, 2004). The bulls' eyes, teeth, feet, legs and nutritional level (evaluated by body condition score) should be closely scrutinized, because the bulls must be able to see, smell, eat and move normally to successfully breed the cows (Perry, 2008; Eilts, 2005).

These physical characteristics are referred to as the mating ability of bull (Perry and Patterson, 2007).The testes should be examined for carriage, consistency and size (Eilts, 2005). Common abnormalities include small testicles, soft testicles, difference in size of testicles, scrotal hernia, scrotal dermatitis, cryptorchids (high flankers) and palpable epididymal conditions (LeaMaster and DuPonte, 2007). Eilts (2005) reported that any testicular asymmetry is abnormal, and may indicate orchitis and testicular degeneration. The bull needs to have good body conformation, because any disease or injuries that affect joints, muscles, nerves, bones or tendons may cause a bull to be structurally unsound. This can interfere with the mating ability (Perry *et al*., 2008).

2.4.4.2 Measurement of scrotal circumference

Scrotal circumference measurements performed on bulls during breeding soundness examinations provide a good indication of sperm production (Geske *et al.,* 1995). Geske *et al*. (1995) confirmed in his study that bulls with small prepubertal testes are unlikely to develop large testes post pubertal. However Bertschinger *et al*., (1992) indicated in his experiment that the scrotal sizes in two year Bovelder bulls ranging from 34 – 40 cm, proved to produce the best quality semen with the least abnormalities. A scrotal circumference is an indirect measure of testicular mass and associates with sperm production and parenchyma, health of testicular tissues (Perry *et al*., 2008; Eilts, 2005). Mokantla *et al*., (2004) suggested that the measurement of scrotal circumference can be used to select the reproductive efficiency of bulls in communal areas, because it is cost effective and can be done easily and rapidly.

Perry *et al*., (2008) argued that if scrotal circumference increases, so does the daily production of higher quality sperms. There is a positive genetic correlation between the sire's scrotal circumference and that of his male offspring, whereas female offspring have both positive and negative genetic correlation with scrotal circumference (Perry *et al*., 2008, Walker *et al.,* 2009; Kriese *et al,* 1991). Both testicles should be positioned next to each other and the measurement is then taken on the largest diameter of the scrotum using a flexible scrotal measuring tape (Perry *et al*., 2008; Barth and Ominski, 2000).

In general, the bull fails the test if its scrotal contents are found to be abnormal or the scrotal size is not within the normal range (Holroyd *et al.,* 2002*).* Entwistle and Fordyce (2003) illustrated guidelines for minimum requirements of scrotal size between *Bos-*

Taurus (European breed), and *Bos-Inducus* (zebu breed) and *Indicus* crosses on different nutritional levels. Table 2.3 indicates minimum standards.

Table 2.3. Guidelines for minimal scrotal size (Entwistle and Fordyce 2003, p28)

Age (months)	***Bos-Taurus* and *Bos-Indicus* cross bulls on moderate to good nutrition**	***Bos-Indicus* bulls on moderate to good nutrition**	**Bulls on poor to marginal nutrition**
12 -15	30 cm	24 cm	2 cm less
18	32 cm	28 cm	2 cm less
≥ 24	34 cm	30 cm	2 cm less

The size of the scrotum in bulls is a good indicator of the volume of sperm production output expected by the farmer. Bulls with a scrotal circumference which is not within the minimum and maximum range limits could contribute to poor fertility within a communal herd. Jayawardhana (2006) reported that even such bulls produce semen of good quality, they will still lower fertility due to insufficient sperm per ejaculate.

2.4.4.3 Evaluation of semen quality

Common methods of semen collection in bulls are electro ejaculation (EE) or using an artificial vagina (AV) (Chenoweth, 2004; Eilts, 2005; Noakes *et al.*, 2001). Collection of semen by artificial vagina is only possible on trained bulls (Holroyd *et al.,* 2002). Falk *et al.,* (2001) stated that electro- ejaculation is considered in many countries as a quick, safe and reliable procedure. Some practitioners prefer massage of the internal reproductive genitalia (Hansen, 2006).

Characteristics such as semen volume, concentration and percentage alive, are no longer used as scoring criteria for BSE, because there is a low correlation with fertility, due to poor repeatability within bulls and between ejaculates, especially in electro ejaculated samples (LeaMaster and DuPonte,2007; Chenoweth, 2004; Palmer *et al.*, 2005). Hansen (2006) reported that during semen collection the penis should be exposed for visual assessment to determine the presence of any abnormalities. Immediately after the semen has been collected, the individual and mass sperm motility must be assessed, because fresh semen is susceptible to environmental influences such as excess heat, cold or toxic substances (Chenoweth, 2004). Sperm motility is calculated by evaluating the percentage of spermatozoa that have progressive (head first) movement (Perry *et al*, 2008). Barth (2000) classified semen samples collected in the field by electro ejaculation, as fair (40-59% individual motile spermatozoa), good (60-69% individual motile spermatozoa) and very good (80–100% individual sperm motility).

Sperm morphology is evaluated either directly in the field or in the laboratory. In a sample of ejaculates it is evaluated by using percentages of normal spermatozoa and sperm with primary and secondary abnormalities (Perry *et al.*, 2008, Parkinson, 2004). Parkinson (2004) referred to primary abnormalities, as defects that originated in the testes during spermatogenesis and secondary abnormalities, as defects that originated in the epididymis during sperm transport or handling of sperm.

Normal sperm are made up of a head, a midpiece and a tail. Defects in any of these regions may cause reduced fertility (Bearden *et al.,* 2004). The reduced fertility may be permanent or it may be transient, because some defects still allow the sperm to fertilise an egg (Saacke *et al*., 2000) while others prevent the sperm from fertilising the egg (Chenoweth, 2004). Abnormalities of the sperm head, midpiece and proximal cytoplasmic droplets are regarded as major defects, while abnormalities that includes looped tails, detached sperm heads and distal cytoplasmic droplets are regarded as minor defects (Chenoweth, 2004). A bull must have at least 30% sperm motility, 70% normal sperm morphology and a minimum scrotal circumference based on age, to successfully complete a breeding soundness evaluation (Chenoweth *et al.*, 1992).

CHAPTER 3

MATERIALS AND METHODS

3.1 Study area

The study was conducted in Moretele Local Municipality which falls under Bojanala Platinum district, situated in the Eastern region of the North West Province. The area is about 60km north of Pretoria and it borders Limpopo and Gauteng Provinces. The Moretele municipal demarcation area consists of 66 villages and 10 semi commercial farms. It is divided into three veterinary service delivery wards and each ward is managed by one qualified Chief Animal Health Technician (Para – Veterinarian) who executes regulatory animal health activities and also renders support services to the State Veterinarian. A map of the study area is shown as Figure 3.1

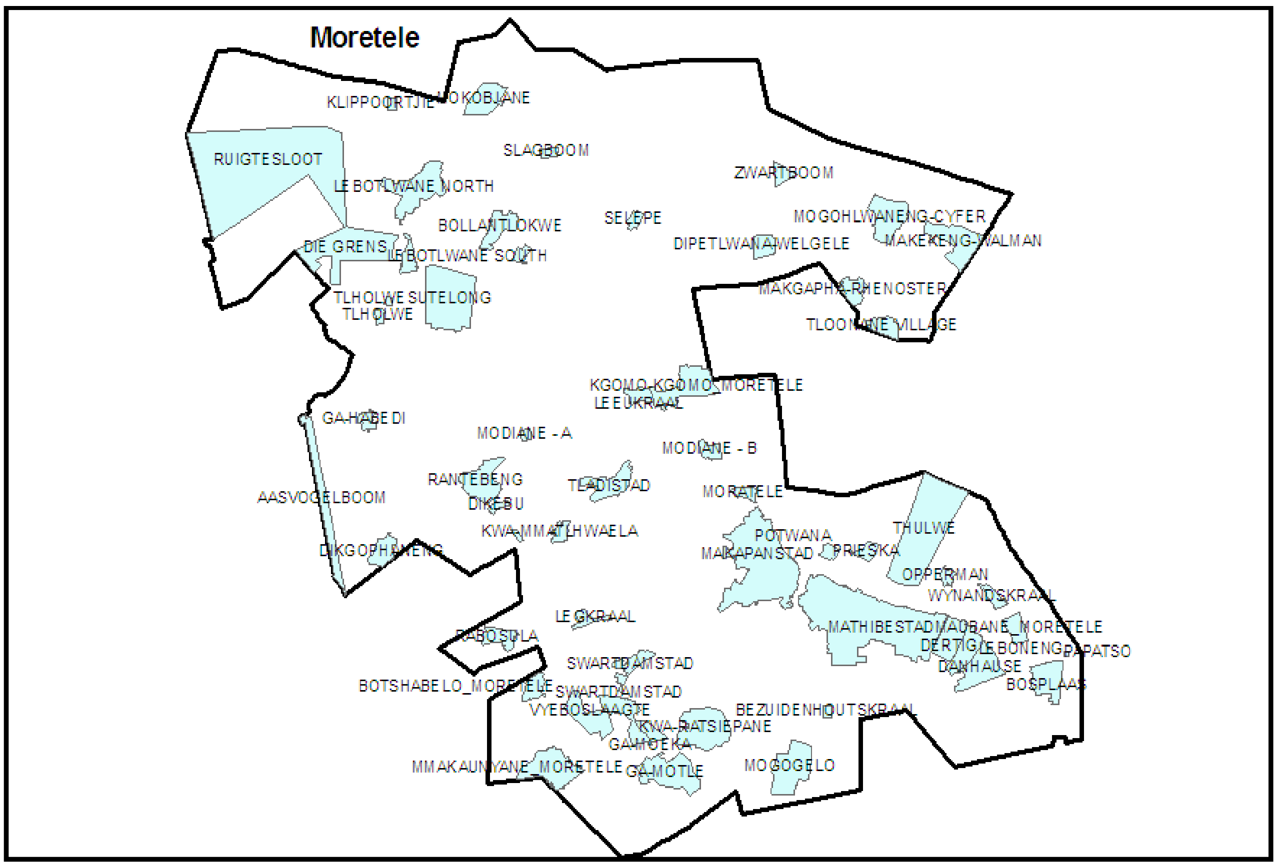

Figure 3.1: Map of the study area

3.2 Study population

The human population in these communities is largely rural, and like other rural areas, subjected to norms and traditions which regulate life. The vast majority of land as depicted in the map (Figure. 3.1) is under four traditional councils (Table 3.1).

Table 3.1. Traditional council, leaders and seat representation formation in Moretele district municipality.

	Traditional Council	**Traditional Leader**	**Seat of Council**
1.	Bahwaduba Traditional Council	Hon. Kgosi Mathibe	Mathibestad
2.	Bakgatla ba Mosetlha Traditional Council	Hon. Kgosi Makapan	Makapanstad
3.	Bakgatla Ba Mocha Traditional Council	Hon. Kgosi Maubane	Maubane
4.	Baphuting Ba Ga Nawa Traditional Council	Hon. Kgosi Nawa	Lebotloane

According to the National Community Survey conducted by Statistics South Africa in 2011, the human population in Moretele local municipality was approximately 186 947 with 52 063 households (StatsSA, 2011). The elderly (both men and woman) constitute the major permanent client base of the Department of Agriculture, as the youth work in urban areas, like Hammanskraal, Brits, Pretoria and Warmbaths.

3.3 Study design

The cross-sectional study design was based on a survey of opinions of farmers in the study area, focus group discussions with farmers, identified stakeholders and role players, as well as samples from bulls. Only willing farmers were selected to participate in this research study. All farmers were each given a consent form to sign, to indicate their willingness to participate in the research (Appendix A).

3.4 Sampling frame

3.4.1 Sampling of villages and farmers

Ten villages out of 66 in the Moretele district municipality, North West Province were selected. A geographical positioning system (GPS) was used to locate the farms. The location and the names of the farms are shown in Table 3.2 below.

Table 3.2. GPS location of farms.

Name of village	**Name of farms**	**Farm no:**	**Geographical location**
Mathibestad	Swartbooistad	63 JR	28° 09' 00E, 25° 18' 00S
Kgomokgomo	Leeukraal	50 JR	28° 03' 00E, 25° 10' 00S
Tladistad	Syferpan	53 JR	28° 02' 00E, 25° 13' 00S
Mmatllwaela	Legkraal	54 JR	28° 03' 00E, 25° 16' 00S
Sutelong	Rhenosterdrift	172 JQ	28° 00' 00E, 25° 09' 00S
Bollantlokwe	Haakdoornkraal	2 JR	28° 00' 00E, 25° 05' 00S
Lebalangwa	Vygeboschlaagte	236 JQ	28° 02' 00E, 25° 20' 00S
Mmakaunyane	Vygeboschlaagte	236 JQ	28° 02' 00E, 25° 20' 00S
Mootla	Kromkuil	99 JR	28° 04' 00E, 25° 24' 00S
Ratjiepane	Haakdoornbult	55 JR	28° 04' 00E, 25° 20' 00S

In each selected village, ten farmers excluding semi- commercial farms, (5 farmers owning a bull or bulls and 5 farmers without bulls) making a total of 100 farmers in all selected villages, were selected using purposive selection (Dargatz and Hill, 1996). The criteria ware based on:

- Only farmers who volunteered to participate in the research study.
- Five out of ten farmers selected per village, each had to have a bull and a minimum of ten breeding cows, and the bull or bulls had to be two years and older.

Ten villages were randomly sampled and within each village, five farmers who owned bulls and five who owned cattle but no bull, were approached to participate in the project. Only willing farmers participated and although 100 were initially selected, only 77 farmers completed the structured questionnaire (Appendix 2) at a subsequent meeting held at Sutelong village. Data collected by structured questionnaires was analysed using Microsoft Excel version 15.0 (Microsoft Corporation, USA).

3.4.2 Sampling of bulls

Fifty (50) selected bulls were tested for brucellosis, and thirty eight (38) that remained in the project after testing for brucellosis, were tested for trichomonas fetus and campylobacter fetus.

3.5 Data collection

3.5.1 Participatory workshops and focus group meetings

Participatory workshops have been defined as Participatory Rural Appraisal (PRA) or Participatory Learning and Action (PLA) (Rambaldi *et al*., 2006). These meetings enable local people to analyse, share and enhance their knowledge to plan, manage and evaluate development projects and programs (Rambaldi *et al*., 2006).These workshops engage the participants and capture their knowledge and are often an effective means of getting participants to reflect on issues and their own personal experience (Rambaldi *et al*., 2006).

The participatory workshop was held on the 27th January 2012 at Roodevallei Country lodge in Gauteng Province. It was sponsored by the University of Pretoria, in collaboration with University of Hohenheim (German South Africa Collaboration Agreement) and the University of Perugia (Italy).The main objectives were to introduce the research study on the evaluation of the fertility of communal bulls in Moretele district, and also to assess or evaluate the farmer’s level of knowledge in terms of bull management. The farmers were actively involved in the planning and the execution of this project.

The workshop was attended by 25 delegates that included different stakeholders:

- University of Pretoria

Prof. E.C Webb (HOD, Animal and wildlife Sciences, UP, Research supervisor)

Prof. CME McCrindle (Medical faculty, UP, Research co-supervisor)

Sister E. Botha (Ondestepoort Veterinary Institute, UP)

Mr. M. Smuts (Ondestepoort Veterinary Institute, UP)

- University of Hohenheim (Germany)

Mr. Christophe Reiber (Workshop facilitator)

- University of Perugia, (Italy)

Dr. D. Garofalo (Student)

- State Veterinarians NWP

Dr. T. Mlilo (Moretele State Veterinarian)

Dr. C.N. Makgatho (Odi State Veterinarian)

- Field staff that interact with farmers (Para - Veterinarians)

Mr S. Manoto (Unit manager)

Ms K.C Kaotsane (Chief Animal Health Technician),

- Main stake holders or role players of the workshop

Moretele Communal farmers (n=15)

The farmers were briefed about bull fertility on communal grazing systems and the back- ground that led to this research study on their herds. The problem statement, hypothesis, objective, the benefits of the study and the plan were discussed. Farmers were given time to ask questions to get clarity about information relayed during the presentation. The pictures (Figure 3.2 and 3.3) shows farmers during the participatory workshop planning together with the researchers.

Figure 3.2 Moretele communal farmers during the participatory workshop

Figure 3.3 Moretele communal farmers during the focus group discussions

3.5.2 Focus group discussions

Farmers were grouped into three groups of five, with one focus group facilitator. The aim was to inform and involve farmers in the planning of this study and to examine their knowledge and perceptions about bull fertility.

Table 3.3 Assessment of famer knowledge about bull management

Questions by group facilitators	**Group A**	**Group B**	**Group C**
Type of bull used on cows	(5/5) Used communal bulls. .	(1/5) Used communal bulls. (4/5) Had their own bulls in their kraals.	(1/5) Had a bull in his kraal or home. (4/5) Used communal bulls.
Primary Animal Health Care of bulls	(5/5) None	(2/5) Treat bulls when they are sick. (3/5) Deworm and dip bulls.	(1/5) Buy licks for the bull. (5/5) Vaccinate bulls against Anthrax, Black quarter, and Botulism.
Bull-cow ratio at present	(1/5) 1:25 (1/5) 1:40 (1/5) 1:20 (2/5) Don't know	(1/5) 1:35 (1/5) 1:40-50 (1/5) 1:33 (2/5) Don't know	(1/5) 1:25 (1/5) 2:18 (1/5) 8:130 (2/5) 1:10
Age of bulls currently owned.	(1/5) 2.5 years (1/5) 3 years (1/5) 5 years (2/5) Don't know	(5/5) 4 years	(5/5) years > 4 years
How do you choose a bull to buy?	(5/5) Choose a bull that is bigger than the others, Big hump and very expensive.	(5/5) Keep the calves born from the good bull to be their future herd sire.	(5/5) They look at the shape, the bull must have sway back, a long big body.
Do you prefer to breed or buy a bull?	(3/5) Prefer buying a bull from reputable breeders. (2/5) Own breeding	(5/5) Prefer buying a bull from reputable breeders.	(5/5) Prefer buying a bull from reputable breeders.

Table 3.4 Planning phase

Questions by group facilitators	**Group A**	**Group B**	**Group C**
1. When should we see cattle?	(5/5) Week days not weekend	(5/5) Prior appointment Weekend not week day	(5/5) Only by appointment
2. Time	(2/5) 9am (3/5) 10am	(5/5) 8am	(1/5) 7am (2/5) 8am (2/5) 9am
3. Where? (Own crush pen or communal crush pen)	(5/5) Communal crush pen. But not in good condition	(5/5) Prefer individual owners crush pens	(4/5) Prefer own crush pens (1/5) Communal crush pen
4.Bulls together with cows or separately	(5/5) Whole group together	(5/5) Each bull handled separately	(5/5) Bring mobile crush pens to farms if possible

3.5.3 Field observations

The cattle handling facilities or crush pens in all ten (10) selected villages were visited to evaluate their condition. These visits were done before the selected bulls were identified with ear tags and sampled for bovine brucellosis. Inspection of crush pens showed a number of problems (Figures 3.4, 3.5, 3.6 and 3.7).

Figure 3.4 One example of the dilapidated crush pen in Mootla village

Figure 3.5 Inspection of the crush pen at Bollantlokwe village

Figure 3.6 Dilapidated crush pen at Sutelong village

Figure 3.7 Prof. E Webb and Prof. CME McCrindle together with cattle farmers during Inspection of crush a pen at Kgomo kgomo village.

3.6 Structured interviews

Simpson and Wright (1998) described the structured interview as a structured procedure with scientific purpose, by means of which the respondent, through a series of questions, is induced to give verbal information. Only farmers who signed consent form (Appendix 1) were permitted to participate in this project. Although 100 farmers were initially selected and agreed to participate in this study, only 77 farmers completed the structured questionnaire at a subsequent meeting (Animal Health Information day) that was held at Sutelong village. Fifty two out of 77 farmers attending owned a bull or bulls within their herds, however 25 did not own a bull but had cattle. A structured questionnaire was prepared to assess their knowledge regarding bull management (See Appendix 2).

3.7 Sample collection

3.7.1 *Brucella* serology

Blood samples were taken from bulls that belonged to the communal farmers at 10 selected villages in Moretele district. Samples were taken in vacutainer tubes without anticoagulant, from 5 bulls per selected village (Table 3.2). A total of fifty (50) bulls were sampled. Blood was collected directly from the coccygeal vein and left to settle and clot in cooler box with ice packs. Before collection of blood samples, blood collection tubes were correctly labelled according to the identification of the bulls. All serum samples were forwarded to Potchefstroom Veterinary Laboratory for the Rose Bengal Test (RBT) and Compliment Fixation Test (CFT) (Van Aert *et al*., 1984). Bulls with a CFT titre of 30 IU/ml or higher were regarded as positive. The results are shown in Appendix 5.

3.7.2 Physical examination of the external genital and scrotal circumference measurement.

The external genitalia of thirty eight bulls (38) that remained in the project after testing for *Brucellosis* were physically examined and observed through palpation as described by Youngquist (1997) and Barth (1995). The bulls were physically examined to check for any injuries that included abscesses and prolapse of the prepuce caused by tick bites (Figure 3.5). These types of injuries in the reproductive organs can be painful and may impact negatively on bull's ability to mate during mating. The scrotal circumference of each bull was measured using flexible measuring tape. The measurements were taken at the widest point of the scrotum as indicated by Walker *et al.*, (2009).

The measurement of scrotal circumference of bulls is important because it is correlated with testicular weight, which is directly related to the sperm producing capacity, therefore bulls with small testes produce less sperm whereas those with larger testes produces more or higher volume of sperms (Perry *et al*., 2008).The results of the scrotal circumference measurements are shown in Appendix 7.

Figure 3.8 External reproductive organ of bull showing physical examination of testicles and Scrotum.

3.7.3 Sheath scraping

Trichomonas fetus and campylobacter fetus are two venereal diseases of cattle that cause reproductive failures, characterized by embryonic deaths and infertility in cattle. Preputial material or smegma was collected from thirty eight bulls (*n* = 38) out of the fifty bulls that remained in the study. The equipment used to collect sheath scraping was a Perspex artificial insemination (AI) or uterine pipette, attached with a rubber tube to a 20ml syringe, which enabled aspiration of preputial smegma as the preputial lining, was scraped (Borchardt *et.al*., 1992).

The collection apparatus was held in one hand by grasping the syringe, and the tip of the pipette was guided into the caudal reaches of the preputial cavity and manipulated vigorously with an in and out movement at the same time as suction was applied to the syringe. The resultant cellular materials and smegma were then washed from the pipette into a 4 ml bottle containing Phosphate-Buffered Saline (PBS). The sample bottles were marked according to the bull's number and kept on ice until they were delivered to Onderstepoort Veterinary Institute within six hours of collection. New apparatus and disposable latex gloves were used for every bull, to avoid cross contaminations. The results are presented in Appendix 6.

3.7.4 Semen collection

The electro-ejaculation method was used to collect semen from bulls throughout the research investigation, as previously described by Barth (1995). The bulls were restrained correctly to prevent movement from side to side or back and forth. Rectal examination of the internal organs together with gentle massage was the starting point in order to relax the bull. A rectal probe of approximately 75mm was inserted and held in the rectum, before commencing with the stimulation at the lowest possible power setting. The probe delivered a rhythmic stimulus, for 2-3 seconds, then was turned off for about one second.

The power setting was increased gradually until the penis protruded or ejaculation of seminal fluids commenced. The power was increased more rapidly to the point of ejaculation if protrusion was not accompanied with ejaculation. When the bull became agitated, stimulation was stopped, and then increased more slowly than previously (Eilts, 2005). When the bull ejaculated, the semen was collected directly into the cone with a 15ml semen collection tube attached. The semen collection tube was kept at 37°C in a water jacket, in order to minimize the risk of cold shock.

A Pasteur pipette attached to a 1ml syringe by latex or silicone tubing was lowered into the cone, resting against its inner wall to allow the pipette to warm up and remain warm. Once warmed, the pipette was lowered further into the tube and an aliquot was withdrawn from the ejaculate and used to evaluate the semen. An electrical extension cord for the supply of electricity to operate the microscope and computer, was connected at the houses close to the crush pen in every village selected for this study.

3.7.5 Macroscopic semen evaluation

Macroscopic semen evaluation was done immediately after collection of each ejaculate. The semen volume was measured using graduated falcon tubes (millilitres). The pH was measured by litmus paper with a range between 5 and 8, because lower pH suppresses motility. The colour was observed and recorded on the data capture sheet (Appendix 3) and the following descriptors were used to assess colour of semen (Table 3.5).

Table 3.5. Descriptive of semen colours.

Semen colour	**Description**
Ivory	Normal colour for a higher concentrated bull semen sample.
White	Normal for sample with a lower sperm concentration
Grey	Normal for sample with a low sperm concentration
Colourless	Indicate low sperm concentration or absence of sperms
Pink or red	The sample mixed with blood, pus or faeces.
yellow	The sample may be contaminated by urine

3.7.6 Microscopic semen evaluation

3.7.6.1 Evaluation of Sperm motility traits

Computer-assisted sperm analysis (CASA) which is known as the Sperm Class Analysers® (SCA® - Microptic, Barcelona, Spain) system was used to evaluate sperm motility traits. Warm stage (37°C), microscope slides (- 76 x 26 mm, frosted end), and cover slips (22mm x 22 x 0.17 mm thick) were used for evaluation. Following swim-up preparation, five microliters of semen sample was placed on the warm glass slide (76 x 26 mm x o.17 mm, *Menzel-Glaser*, Deckglaser) over the microscope warming plate adjusted to 37°C. Sperm motility traits were evaluated by SCA at a magnification of 10 x (Nikon). The kinematic values recorded for each sperm included, the overall percentage of motile sperm and the velocity of the movement. The results are shown in Appendix 7.

3.7.6.2 Evaluation of Sperm morphology

Sperm morphology for each bull semen sample was evaluated. The technique used was the same as that used to make a peripheral blood smear or bone marrow smear. Two separate semen smears stained with Eosin-Nigrosin stain were prepared at the site of collection. For each slide, two clean microscope slides one attached to a coverslip with a drop of water, were placed on top of the warming stage. A few drops of Eosin Nigrosin were transferred on top of the cover slip followed by a drop of semen sample and the two were mixed, while the slides were on top of the warming stage. The second slide was smeared across the surface of the first.

The sperms were spread evenly on the slide before it was air dried, labelled and later sent to the University of Pretoria laboratories. On arrival at the Laboratory all smears were fixed in Entellan before examination. The smears were evaluated under a bright-field microscope, first scanning at x400 magnification and then at x1000 magnification under oil immersion.

A total of 100 sperms cells per each bull semen sample were evaluated. Differential counting was performed at x 1000 magnification under oil immersion. The percentage of live and dead normal sperm cells were recorded, together with abnormalities of sperm cells, focusing on, percentage of head defects, percentage of mid-piece defects and percentage of tail defects (See Appendix 7).

3.7.6.3 Sperm concentration

The sperm concentration (x 10^9/ml) was evaluated by haemocytometer on the same day, while samples were still fresh for every bull sampled, at University of Pretoria laboratory. Sperm concentration is one of the important parameters in standard semen analysis (Coetzee and Menkveld, 2001). The haemocytometer and cover slide were cleaned with water and alcohol, followed by drying with a tissue paper. A 10 microliter aliquot of semen was diluted in 1.0ml of water, to kill the sperm cells. The coverslip was placed carefully on the haemocytometer after wetting with warm water. Then 10 – 15 microliters of diluted sperm was placed under the coverslip on each side of the haemocytometer. The haemocytometer was placed on the pre-wetted chambers, the lid closed and left for five minutes. The haemocytometer was placed on the microscope without tilting. Sperm cells were counted in five grids on each side of the haemocytometer. The total of both counted grids was divided in half and the answer recorded in billions. The results of concentration evaluation were recorded on the data capture sheet (Appendix 7).

3.8 Information and data analysis

Demographic data was analysed using Microsoft Excel version 15.1 (Microsoft Corporation, USA). Quantitative data collected was entered into Microsoft Excel® and transferred into the SPSS 20 computer software (Statistical Analysis System Inc., 2013), statistical programme for analysis. Data was presented as frequency tables, pie charts and graphs. Standard deviation and means were analysed and interpreted using methods described for survey data analyses by Thrusfield (1995).

CHAPTER 4

RESULTS AND DISCUSSION

4 Introduction

The results are presented under the following headings namely; focus group discussions, structured interviews, bull fertility and infectious diseases status.

4.1 Focus group discussions

4.1.1 Planning phase

It was important to investigate the baseline knowledge of farmers using the focus group discussions at the workshop, so as to estimate their knowledge and management practices before bulls were examined. The results from the focus group discussions were shown in Table 3.3 and 3.4 respectively. It was found that the general knowledge of the farmers regarding the basic management of bulls was inadequate and that this might have played a role in the low calving rate observed.

The information presented in Table 3.4 showed that, selection or choosing a bull by most of farmers was a challenge, as all (15 famers) were more interested in the physical appearance than reproductive ability. Lack of knowledge regarding bull fertility by all farmers participated on focus group discussions, might have played a role as they associated bull physical appearance or conformation with fertility. Primary animal health care, which is very important, was inadequate. The bull – cow ratios were incorrect, and some farmers did not even know it.

4.1.2 Results and discussion of crush inspection and repairs

Crush pens had to be inspected as no mobile crush pen was available from State Veterinary Services (SVS). It was found that (7) 30% out of twenty three crush pens in the selected villages were not suitable to handle bulls, as they were dilapidated (See Figures 3.4, 3.5, 3.6 and 3.7).

The main problems identified during the inspections were:

1. Missing poles at all crush pens, bought 49 new poles
2. Gates and poles were poorly secured
3. Poles were badly attached or broken
4. New crushes had to be built because the size and dimension of the pens were incorrect.
5. Some poles needed reinforcement by tying pole securely using heavy grade galvanised fencing wire steel.

Funds were accessed from the University of Pretoria to buy steel wire and gum poles to rebuild the dilapidated crushes. Farmers from the villages offered their help to repair the crush pens, as it was important, not only for this research study but for future use, leaving an everlasting legacy for Moretele district villages. The following pictures (Figures 4.1, 4.2, 4.3 and 4.4) shows gun poles bought to rebuilt dilapidated crushes, demonstration showing farmers how to build proper crush pen and some of the rebuilt cruses out seven that needed to be repaired.

Figure 4.1 Gum poles bought for the repairs of crush pens

Figure 4.2 showing farmers how to build a proper crush pen

Figure 4.3 Rebuilt crush pen at Tladistad village

Figure 4.4 Rebuilt crush pen at Mathibestad village

4.2 Analysis of the structured interview

4.2.1 Characteristics of the farmers

Of the 77 farmers who participated in the survey, (*n* = 7 or 9%) were woman and (*n* = 70 or 91%) men. These findings agree with those of Maree and Casey (1993), who observed that woman were more interested in small stock (goats and sheep) and chickens than large stock. In the current study cattle owning households were predominantly headed by men. The age distribution of the farmers ranged from 25 to 94 years, with a mean age of 62.38 (SD = 14.13 coefficient of variation = 22.65%). Further it was found that most of the people owning cattle in the study area, were over 65 years of age, with 53% being pensioners. Only 10% of the respondents were young adults (Table 4.1). This outcome agreed with the finding of Mokantla (2003), who recorded that (57.14 %) of the respondents aged between 60 and 80 years. Nthakeni (1993) also observed that (64%) of respondents in his study were between 60 and 80 years.

Table 4.1. Age distribution of farmers.

Description	**Age range (years)**	**No. of farmers**	**Percentage**
Young Adults	25 - 40	8	10
Adults	41 - 55	6	8
Adults plus	55 - 65	22	29
Pensioners	> 65	41	53
Totals	**4**	**77**	**100**

The majority of the farmers (*n* = 55) 71.4% were living together as married couples as compared to (*n* = 13) 16.9% that were not married (Figure 4.5). Married couples enjoy better social and economic benefits, for example the rural house wife's are used to participate in cleaning of animal shed, preparing milk products, selling of milk and eggs, and on the hand they regularly engaged on household activities like preparations of meals, fetching of water (Mihiret and Amsalu, 2014). Although their role in livestock activities is limited. Selling of oxen and cows, barn preparation and deliver assistance of cows are considered to be the tasks that should not be performed by woman (Mihiret and Amsalu, 2014). Households that were headed by widowers comprised of (*n* = 5) 6.5%. In addition to that Quisumbing *et al*., (1995) mentioned that woman particularly widowers often denote more time and resources under their control towards improving concerns related to food security as compared their men counterpart and their involvements. It was found that *(n* = 4) 5.2% of the farmers in the current study were divorced or separated. Being divorced, separated or single did not make a difference in terms of livestock decision making or cattle management, although they had not enjoyed mutual help as compared to the married couples.

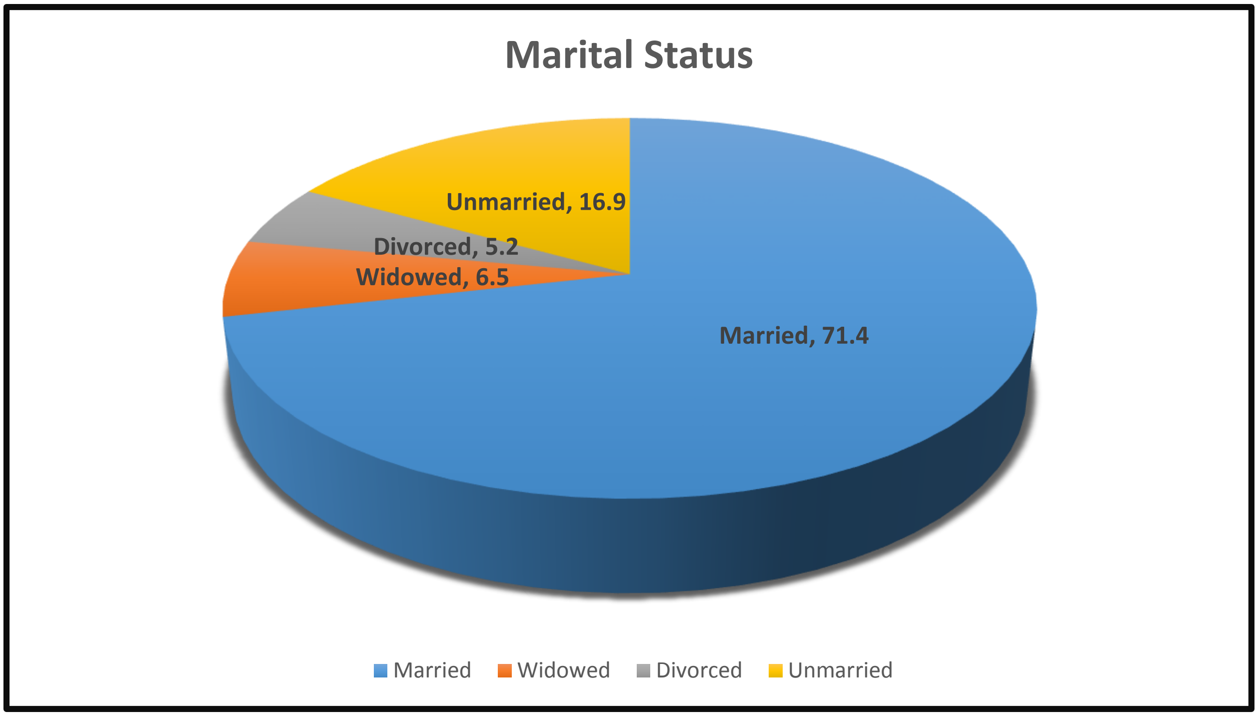

Figure 4.5 Marital status of farmers in the study area

4.2.2 Educational level of the farmers

The educational level of the farmers in the current study varied, as 10% of farmers had no education or had never attended school at all, 43% had attended school until primary level, while most of the farmers (46%) had secondary level schooling. Only one percent of all participants had attended high school (Table 4.2).

Table 4.2 The level of education among the farmers.

Educational Level	**Number of participants**	**Percentage**
No Education	8	10
Primary level	33	43
Secondary level	35	46
High school completed	1	1
Totals	**77**	**100**

These results suggested a low level of education among the communal farmers studied. Therefore knowledge of the basic management of bulls that includes treatment of parasites, supplementary feeding during drought and testing for infectious diseases comes from experience, not school education. In view of this, extension to the farmers in the current study must be practical and needs to be taught in the language farmers understand, so that adoption of knowledge can be achieved.

4.2.3 Source of income

Cattle made up the main source of income by communal farmers studied. Although supplementary income from other sources were reported (Table 4.3). It can be seen that 65% were pensioners receiving a government grant and 23% were unemployed, leaving only 12% who received a salary, presumably not from farming. The 23% unemployed could be consider to be full-time farmers.

Table 4.3 Farmer's supplementary income.

Source of income	**Number of participants**	**Percentage**
Government sector	1	1
NGO	2	3
Pension [Old age grants]	50	65
Private sector	6	8
Unemployed	18	23
Totals	**77**	**100**

4.2.4 Land used for grazing livestock

In the current study, knowledge of the size of the land occupied by the herds was not known by (*n* = 57) 74% of the farmers. Those farmers who knew the size of their grazing camps did so because they were Government lease camps. (*n* = 11) 14% of farmers indicated that their herds occupied less than 500 ha, (*n* = 4) 5% indicated that their herd occupied between 501 and 1000 ha, while (*n* = 4) 5% indicated the available land was 1500 ha or more. Only one percent indicated a size between 1001 and 1500 ha. The land in the study area was classified according the following categories (Table 4.4.)

Table 4.4 land tenure classification

Land Classification	**No of farmers**	**Percentage**
Communal Land	65	84
Private land	3	4
Trust land	9	12
Totals	**77**	**100**

Land in South Africa has been regarded as the most important aspect for livestock production. If the size of the land was known, it would be easy for the farmers to deal with the issue of overstocking as to prevent overgrazing and degradation of fertile land. Increased grazing pressure increases competition among animals for available forage, and when a certain threshold is exceeded, the performance of individual animals will decrease (Van de Ven *et al,* 2003).

The impact of overgrazed land on bulls results in them shedding weight, if they are not on supplementary feeding. Bulls must always be in good body condition (BCS) so that they are able to serve cows. It is important to include ways of measuring grazing pressure (large animal units/hectare) in extension messages to improve bull condition scores. To do this farmers must learn the importance of knowing the size of the grazing.

4.2.5 Water source for livestock

Water is the essential component for survival in any livestock production, and it had to be available on a daily basis to breeding bulls. The different types of drinking water sources available for cattle are shown in Table 4.5.

Table 4.5 Water sources for animals

Water source	**Number of farmers**	**Percentage**
Tap water	1	1,3
Tap and borehole	1	1,3
Tap and dam	4	5,2
Borehole	3	3,9
Borehole and dam	3	3,9
Borehole, dam and river	1	1,3
Dam	40	51.9
Dam and river	4	5,2
River	20	26,0
Totals	**77**	**100**

Nearly three quarters of farmers used surface water (dam and or river) for their cattle. Five percent of the farmers indicated that their herds had access to both dams and rivers. Tap water was purified water supplied by the local municipality, using bulk tankers or municipal pipes, but this could not be accessed in all the villages in the study. Boreholes were only found in certain villages. The rivers that run across the study area are Tshwane (Apies) River and Moretele (Pienaars) River. The problem with surface water is that it is not always potable and could also result in disease transmission between different herds on communal grazing. The distance between the kraals or homestead and the water source were a challenge to the livestock in the current study. Only 19 (25%) of farmers indicated that their herds walked <500m to access water sources. Some farmers (n= 12, 16%) indicated that cattle walked >3km every day to access water (Figure 4.6).

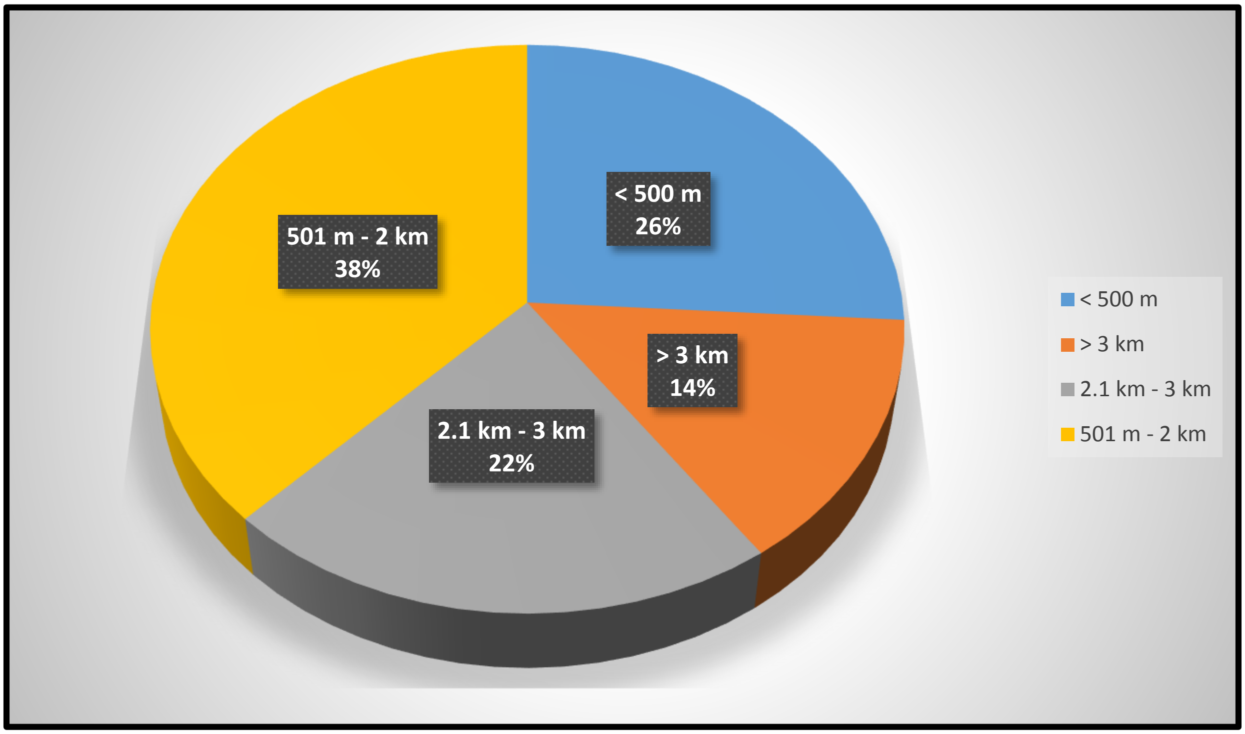

Figure 4.6 Distance between water source and the cattle kraals

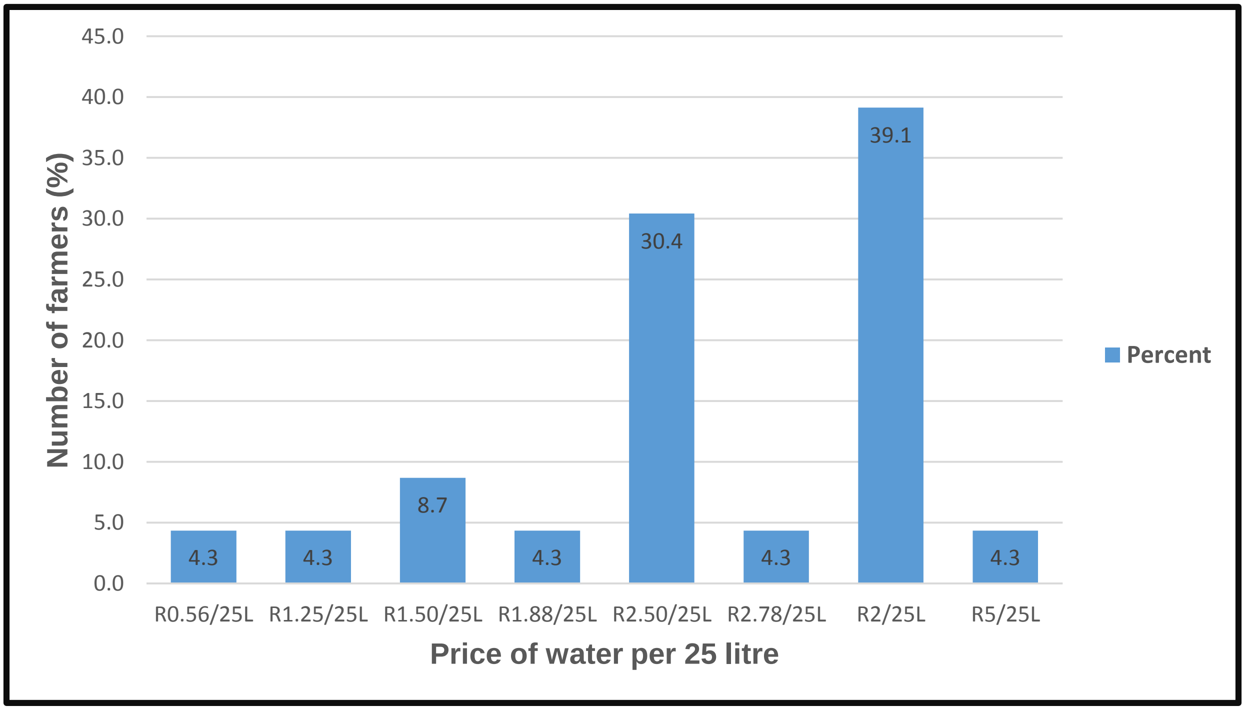

Figure 4.7 Cost of water for the cattle during the dry season

Based on the feedback from the present study, water scarcity was experienced during winter or droughts. Despite water scarcity in the study area, seventy percent of the farmers were not buying water for their livestock, because their herds depended on the two rivers that ran across their villages. Only thirty percent of the farmers were buying water for their herds during winter and the reason given was the distance to rivers.

Figure 4.7 shows the selling price for a 25 litre bucket of drinking water. The cost of drinking water, differed from one seller to another. Some people in the village's fetched water from rivers or dams with bulk water tankers and tractors then sold to the farmers in 25L buckets. The local people in the villages who had boreholes also sold water to the farmers. During the interviews some farmers were concern about certain bore-hole water that contained mineral salts. As cattle drink between 20 and 40 litres per day, the cost of water was an important cost for cattle farmers.

4.2.6. Animals

4.2.6.1 Bulls

The survey questionnaire indicated that, out of 77 farmers who participated in the current study, (*n* = 49) 64% owned one or more bulls each. Another (n = 28) 36% owned cattle but had no bulls. The cows from herds without bulls benefited from bulls that grazed on communal pastures. The bull-cow ratio was therefore left to chance and not calculated by farmers. The bull-cow ratio could therefore have resulted in bulls being overworked, which could affect semen quality.

The bull-cow ratio was determined by calculating total number of breeding cows plus heifers, divided by the number of bulls in a particular herd. The overall number of cows including heifers was 2398 and these were served by 75 bulls. The bull-cow ratio was therefore 1:32. During the study (12 months) in 2013, 860 calves were born from the total number of cows (2398), so the calving percentage was 35.86%. This can be compared to the 37.74% calving percentage reported by Mokantla (2003) in communal beef herds in Jericho, which borders some villages of the study area. Analysis of the survey questionnaire showed that;

- 49 of the farmers owned bulls;
- 33 of the farmers had one bull;
- 9 had two bulls;
- 5 had three bulls;
- 1 had four bulls, and
- 1 had five bulls (of these three were inferior "mankurwane" and two were stud bulls.

4.2.6.2 Type of bull breeds

The farmers that owned the bulls were asked what breed their bulls were, and (*n* = 35) 71.4% had Brahman bulls, and *(n* = 14) 28.6% had Brahman X or N'guni bulls. From these, (*n* = 29) 59.2% of the farmers said their bulls were born and grew in the same herds, while (*n* = 20) 28.6% farmers indicated that they bought a bull from other famers or commercial bull breeders.

4.2.6.3 The age of the bulls

In this research study, *(n* = 1) 2.1% of the farmers had a younger bull which was 18 months old, (*n* = 4) 8.2% of the farmers had bulls under two years and *(n* = 6) 12.2% had bulls aged between 24 and 36 months of age. The majority of the farmers (*n* = 30) 61.2% had mature bulls between the ages of 37 and 48 months and a further (*n* = 8) 16.3% of the farmers had bulls older than 4 years of age.

Mixing different age group of bulls on a communal grazing system could have a negative impact on the production of the herd. Bull hierarchy can impact on sexual ability and reproductive performance as the older bulls (3 years and older) always dominate younger or yearling bulls (Blockey, 1979). If a dominant bull had a problem

with semen quality, or an infectious disease, this could have adverse effects on the reproductive performance of the herd.
During 2013, (*n* = 3) 6% of the farmers indicated that their bulls had been in the herd for less than 12 months, while (*n* = 14) 28.5% had kept their bull in the herd between 12 and 24 months. A further (*n* = 18) 37% of the farmers had kept the bull between 37 and 48 months. While (*n* = 14) 28.5% had kept their bulls for more than 48 months.

The bulls under study were therefore assumed to be more mature and sexually active, based on the statistics given by the farmers. If the bulls were to be kept for more than three years in a herd, there was a likelihood of them mating with their daughters (inbreeding). Long term inbreeding in a closed herd usually reduces performance of bulls and survival of calves. Farmers in the current study need to be taught or cautioned about the consequences of keeping bulls in the herds for too long a time.

4.2.6.4 Reason for the choice of the bull

The results indicated that farmers in this study differed in terms of how they chose a bull to purchase for their herds. Nine farmers (18.4%) were interested in physical conformation, while (*n* = 15) 30.6% farmers were interested in reproductive performance more than other characteristics like color, size and temperament. The criterion dynamics or characteristics preferred by farmers when purchasing a bull are summarized in Appendix 4.

4.2.7 Bull management

4.2.7.1 Knowledge of Breeding Soundness Evaluation (BSE)

Knowledge about testing BSE was lacking among most the farmers in the study. Almost half of the farmers *(n* = 25) 52.1% did not know about Breeding Soundness Evaluation and their bulls were never tested. Only (*n* = 23) 47.9% of the farmers had some idea about BSE as they had previously participated in an ARC-Animal production program called *Kaonafatso ya dikgomo* scheme.

Very few (*n* = 6) 26.1% of the farmers who knew or had an idea about BSE indicated that their bulls had once been tested by ARC officials but they did not ask for the test results as they did not see the importance of testing. (*n* = 9) 39.1% of the farmers knew that their bulls had undergo BSE, yet only a single test was done during the ARC program. (*n* = 2) 8.7% of the farmers indicated that their bulls were tested twice during the ARC program. (*n* = 4) 17.4% of the farmers knew about BSE and their bulls were tested more than twice, and (*n* = 2) 8.7% of the farmers knew about BSE but did not remember whether their bulls had been previously tested or evaluated.

These findings suggest that the farmers who participated in the study did not subjected their bulls to BSE. This was either or due to lack of knowledge of the importance of BSE or they were only interested in the physiological characteristics of the bulls, rather than their fertility or breeding soundness. These findings also suggest that there is a need to teach and encourage farmers about the importance of testing bulls for BSE, so that they can know whether their bulls are fertile or not in order to make an economically sound decision (Chenoweth, 2002). These findings also agree with Ellis (2008) who reported that mating bulls must be evaluated prior to every mating season.

4.2.7.2 Knowledge of trichomonas fetus and campylobacter fetus

The majority of farmers, (*n* = 28) 58.3% when asked about trichomonas fetus and campylobacter fetus, said they did not know or that they had never been taught about such diseases. This could explain why their bulls had never been tested. Less than the farmers (*n* = 20) 41.7% knew about infectious disease. This is because their bulls had previously been tested by local state veterinary officials. Also (*n* = 10) 50% of the farmers who knew about trichomonas fetus and campylobacter fetus indicated that their bulls were tested once previously, while (*n* = 4) 20% of the farmers indicated that their bulls had been tested twice previously, and (*n* = 6) 30% indicated that, their bulls had been tested more than twice previously.

Despite the test done by local State Veterinary officials in the past, all farmers in this study indicated that, they had never requested the bulls to be tested for any infection diseases or obtained disease free certificates, when purchasing bulls. These findings suggest that farmers in the study area must be taught about infectious diseases in bulls, and the State Veterinarians and Animal health technicians must yearly test all communal bulls for trichomonas fetus and campylobacter fetus as these diseases might or had contributed to the low calving rate experienced.

4.2.7.3 Knowledge about testing the libido of bulls

The bulls in the study area had not previously been tested for libido. This was even the case during the BSE program (Kaonafatso ya dikgomo) that was conducted by ARC-Animal Production Institute officials. (*n* = 16) 33.3% of the farmers knew about libido testing but they had not requested that their bulls be tested. (*n* = 32) 66.7% of the farmers did not even know about the existence of the libido test. Mating ability is a competency acquired thorough experience (Ellis, 2008). Hafez (2004) emphasized that the decrease or loss of libido or ability to copulate are important form of bull infertility. Like other tests, extension messages regarding libido should be emphasized as an important component of fertility.

4.2.8 Access to veterinary and extension services

Access to these services was seen as good by (*n* = 64) 83% of the farmers. Few farmers (*n* = 13) 17% indicated that access to Veterinary or Extension Services was not available
(Table 4.6). The Provincial Department of Agriculture provides free Veterinary and Extension advisory services to its farmers at regional and district level. This is to ensure the healthy livestock and better animal production outputs.

Table 4.6 Access to Veterinary and Extension Services by farmers.

Service	**No. of the farmers**	**Percentage**
State Veterinarian	10	15.6
State Veterinarian and Private Veterinarian	1	1.6
State Veterinarian, Private Vet, and AHT	2	3.1
State Veterinarian and Vet drug supplier	4	6.3
State Veterinarian and AHT	9	14.1
State Veterinarian, AHT and Extension Advisor	8	12.5
Private Veterinarian	1	1.6
Private Veterinarian and Veterinary drug supplier	1	1.6
Private Veterinarian and AHT	2	3.1
Private Veterinarian and Extension Advisor	1	1.6
Veterinary drug supplier	1	1.6
AHT only	15	23.4
AHT and Extension Advisor	6	9.4
Extension Advisor only	3	4.7
Totals	**64**	**100**

4.2.9 Herd health

4.2.9.1 Control of external and internal parasites in herd bulls

Control of external and internal parasites influences the health and performance of bulls. The methods used for control of external parasites (ticks) are shown in Table 4.7. The data from the survey questionnaire indicated that (*n* = 45) 92% of the farmers indicated that they dipped their bulls, while *(n* = 4) 8% had never dipped their bulls. Of those that dipped their bulls, (*n* = 21) 43% dipped their bulls when needed, meaning when ticks were visible on the bulls, and (*n* = 28) 57% dipped on a routine basis. The routine basis mean that individual farmer had his own dipping schedule that soot his or her management style, some prefer to dip their bulls every two weeks, others every month or every six months.

Table 4.7. Dipping method preferred by farmers.

Dipping methods	**No. of farmers**	**Percentage**
Plunge dips and hand spray	1	2.0
Plunge dip, pour-on dips and Injectable dips	1	2.0
Spray rays dip	20	40.8
Spray rays dip and pour-on dips	4	8.2
Spray rays dip, pour-on dips, hand dressing and injectable	1	2.0
Spray rays dip, pour-on dips and injectable dips	2	4.1
Spray rays dip and injectable dips	1	2.0
Pour-on dips	11	22.4
Pour-on dips and hand dressing	1	2.0
Pour-on dips and traditional methods	1	2.0
Hand dressing	3	6.1
Injectable	1	2.0
Traditional method	2	4.1
Totals	**49**	**100**

The Provincial Department of Agriculture, extension services had built spray races in most of the villages, however some had been vandalized. This could explain why the majority, (*n* = 20) 41% of the farmers preferred spray dips to other methods. The traditional method of using old motor oil was also reported by Sekokotla (2003). The treatment of bulls for external parasites using an approved dip should be emphasized during extension campaigns. It was found that (*n* = 40) 82% of farmers indicated that they dewormed their bulls as compared to (*n* = 9) 18 % of the farmers who did not deworm at all. Table 4.8 shows reasons given by the farmers to deworm their bulls. The data indicated that most (*n* = 22) 55% of the farmers dewormed their bulls to get rid of worms, while (*n* = 13) 33% of the farmers deworm their bulls to improve condition score. Only few (*n* = 5) 13% of the farmers indicated that they dewormed their bulls to prevent death. The results indicated that, farmers in this study knew that bulls had to be dewormed which was very important because bulls with load of worms or internal parasite would decrease the general health status which in turn affect the performance on the herds.

Table 4.8 Reasons for the control of internal parasites on herd bulls.

Reason for deworming	No. of the farmers	Percentage
To get rid of worms	22	55
To improve condition score	13	32.5
To prevent deaths	5	12.5
Totals	**40**	**100**

The results observed indicated that farmers in this study differed in their preferences for deworming bulls (Table 4.9). The method that were preferred by most of the farmers (*n* = 31) 77.5 % were injectable remedies. This could be because they were easier to administer than oral dosing of heavy, powerful bulls. Drenching with dewormers was only used by (*n* = 6) 15% farmers, and (*n* = 3) 7.5 % of the farmers used a homemade mixture or traditional medicine against internal parasites.

It is an interesting finding that traditional medicines used by farmers as de-wormer was a mixture of the aloes leaves and cooking oil. However the effectiveness of that mixture to kill internal parasites was not known, hence it was not approved to be used. Nevertheless it was used by few farmers. These suggest that extension information and training of farmers in the study regarding the importance of de-worming bulls with the approved de-worming remedies it is very important as to improve the health and wellbeing of their bulls. Healthy bull, free of external and internal parasites can perform better in terms of reproductive output.

Table 4.9 Deworming methods preferred by farmers

Methods	No. of the farmers	Percentage
Drenching	6	15
Injectable dips	31	77.5
Traditional remedies	3	7.5
Totals	**40**	**100**

4.2.9.2 Disease treatment and control

It was shown that (*n* = 53) 59% of the farmers used drugs and vaccines to treat or prevent cattle diseases in their herds. Only (*n* = 24) 31% of the farmers indicated that they did not or preventing diseases because they believed that “nature” would take care of their cattle. Drugs and vaccines that were used by the farmers to treat and prevent diseases are summarized in Table 4.10.

Table 4.10 Summary of remedies used by farmers to treat cattle.

Product	**Summary of drugs mentioned**	**No. of farmers**	**Percentage**
Antibiotics	Terramycin LA ® Pfizer Animal Health Tyrolon LA ® Virbac Animal Health	22	64.7
Injectable paracide	Ivomec ® Merial Detomax® Pfizer Animal Health	7	20.6
Vaccines	Black quarter, Anthrax, and Lumpy Skin Disease® OBP	5	14.7
Totals		**34**	**100**

* Pfizer RSA, Pty Ltd.,* Virbac RSA, Pty, Ltd.,* Merial RSA, Pty. Ltd.,* Onderstepoort Biological Products, RSA, Pty. Ltd.

From Table 4.10 it can be seen that farmers used Black quarter (clostridium chauvouei), Anthrax (bacillus anthracis) and Lumpy Skin Disease vaccines. All of these are manufactured by Onderstepoort Biological Product (OBP). Although farmers did not mention vaccination against brucellosis, the Brucella S19 vaccine (OBP) is provided to all communal cattle farmers, free of charge, by North West Province Directorate of Veterinary Services. It may be important to inform farmers about why the heifers are being vaccinated and how it assists in controlling diseases like anthrax, black quarter, brucellosis etc.

4.2.10 Feeding Management

It was found that supplementary feeding of bulls was not always done adequately. Herd bulls should be conditioned though out the year to maintain their reproductive performance. However (*n* = 26) 53% of the farmers in this study indicated that they did not buy feeds needed to supplement their bulls, even during poor grazing conditions in winter. Reasons given by farmers for not buying extra feed for the bulls were that;

- (*n* = 23) 88% of the farmers, indicated that supplementary feed was expensive;
- (n =2) 8% of the farmers also indicated animal feeds were not available at their local Co-operatives; and
- (*n* = 1) 4% of the farmers indicated that there was no need to buy extra feed, because his herd could survive adverse climatic conditions as they did before.

Table 4.11 shows the detailed feeding expenses of bulls during dry season in winter, as supplied by the farmers.

Table 4.11 Detailed feeding annual expenses during the dry season in winter.

Type of feed	**Amount (kg)/ respondent**	**No. of farmers (n = 23)**	**Estimated money spend each/year**
Lucerne	1 bag	5	R 30
Winter lick concentrates	4 bags	2	R360 - R600
Winter lick concentrates	5 bags	2	R600 - R875
Winter lick concentrates	8 bags	1	Not sure
Winter lick concentrates	10 bags	3	R1600 - R2000
Winter lick concentrates	Not sure	2	R180 - R500
White buffalo grass	1 roll	1	R180
White buffalo grass	4 large bales	1	R600
Block of salt	I box	6	R150 - R200
Total		**23**	

It can be seen from Table 4.11 that the amount of supplementary feeds by farmers was very variable. The dry season lasts from May to September in the study area. It is suggested that AHT must introduce the idea of supplementary feeding of bulls using extension, training and workshops. Only half of the farmers (*n* = 23) 47% were supplementing bulls during the dry season in late autumn and winter.

4.3. Overall analysis of bulls sampled

4.3.1 Infectious diseases

Brucellosis

Two (4%) of the fifty bulls that tested were positive for *Brucella abortus* using the CFT (Appendix 5). This suggest that the prevalence of brucellosis on communal bulls in the study was low, although comparable to the prevalence of 3.7% published by Njiro *et.al*., (2011) as the prevalence in Gauteng Province among the cattle of emerging farmers. The low prevalence of *Brucella abortus* detected in bulls in this study, might be due to vaccination of communal heifers (4-8 months) by the Directorate of Veterinary Service in the North West Province as mandated in terms of Animal disease Act, 1984 (Act 35 of 1984) by Directorate of Animal Health.

It is therefore probable that the two positive bulls were already infected when purchased. The testes, seminal vesicles and epididymis of the infected bulls are normally affected by *Brucella abortus* (Interim brucellosis manual, 2013). According to the Interim *Brucellosis* Manual (2013) infected bulls are of the minimal importance as a source of the spread of the disease in the farm, but infection will affect bull fertility. It was interesting to see that vaccination of heifers, although done free of charge, was not mentioned by farmers (Table 4.10).

Trichomonas fetus and Campylobacter fetus

The 38 bulls that remained in the project after the bulls that tested positive for brucellosis were removed, were tested for trichomonas fetus and campylobacter fetus. One (3%) bull tested positive for *T. fetus* on the first sample of semen collected. However 3 subsequent samples from that bull were negative, so it was probably a false positive (Appendix 6). All bulls (100%) tested negative for campylobacter fetus. These results differed from the findings of Njiro *et al*., (2011), who recorded a prevalence of 2.1 % of trichomonas fetus in cattle belonging to the emerging farmers in a part of Gauteng Province, which is close to the Moretele villages.

The farmers also indicated that when they purchased bulls, they did not request testing for the above mentioned infectious disease. This practice could expose their herds to that two infectious disease and thus low bull fertility. There is currently little information on the prevalence of trichomonas fetus and campylobacter fetus in cattle in North West Province, as these are not notifiable diseases. It might be advisable for the state to organise testing, as their presence in the herds could threaten food security in communal farmers, however testing is expensive.

4.3.2 Clinical examination of external genital organs

Morphology of the testes

All 38 bulls (100%) included in this part of study showed normal consistency of their testes. Testes should be firm, like a rubber ball, and should they have normal consistency. If found to be extremely hard it indicates infection (orchitis). Soft or extremely soft testes indicate testicular degeneration and is related to reduced sperm production, poor seminal quality, subfertility or sterility (Coulter and Footer, 1979). However there were adhesions to the scrotal sac in all but three bulls.

Scrotum, prepuce and the sheath

It was found that 35 (92%) of bulls observed in this study showed scrotal and preputial abscesses, thickening of the scrotal skin together with nodules caused by infestation with long mouth ticks like *Amblyomma* and *Hyalomma spp*. (Plate 1- 3). The abnormalities observed in this study were similar to those recorded by Mokantla (2003) on communal bulls.

This observation suggests that tick damage and high level infestations, may have played a role on the fertility of bulls in this study. Tick damage to the scrotal sac could influence sperm production during the inflammation stage, or chronic induration of the testes. Tick damage to the prepuce could also prevent extension of the penis during copulation. The high frequency of ticks observed on the external genitalia of 38 (100%) bulls in this study contradicted the results obtained from the survey questionnaire that indicated 45 (92%) farmers in this study were dipping their bulls. These results suggest that either control of external parasites on communal bulls in the study area was not done properly, or there could be tick resistance to dips being used.

Scrotal circumference

The scrotal circumference (SC) of the thirty eight bulls (24 Brahman, Brahman cross and Tuli) in the current study were measured following the method suggested by Perry *et al*., (2008). The results showed an overall mean scrotal circumference of 37.63 ±3.42 for all three breed observed. The overall mean age of the same bulls observed was 3.88 ± 0.99. An average scrotal circumference and age of the bulls per breed are shown in Table 4.12.

Table 4.12 Average scrotal circumference by age of the bulls per breed.

Variables	Breeds		
	Brahman	Brahman x	Tuli
Number of bulls per breed observed	24	13	1
Mean age of the bulls pre breed (Yrs.).	4.06	4	4.5
Min. std. Requirement	34 cm	34 cm	34 cm
Observed below standard	2	3	0
Below standard % observed	8	23	0
Mean (*M*)	38.41	13.35	4.87
Standard deviation (*SD*)	1.12	18.51	13.78
Standard error (*SE*)	0.39	6.64	4.87
Range (cm)	32 -42	30 - 44	39

The results indicated that the scrotal circumference of 5 (13%) out of 38 bulls observed (Figure 4.8 and 4.9), did not reach minimum level or standard of 34 cm that is recommended based on the age (Chenoweth, 1994). The scrotal circumference was described as an important part and good method of determining fertility in bulls (Strous, 2010). The current study indicated an overall mean scrotal circumference of 37, 63 which was based on the age of bulls, of which that mean scrotal circumference was above the minimum level or standard of 34 cm that is recommended (Chenoweth, 1994). The majority 33 (87%) of the bulls in the study area, was found to have a scrotal circumference which was above minimum set norm of 34cm.

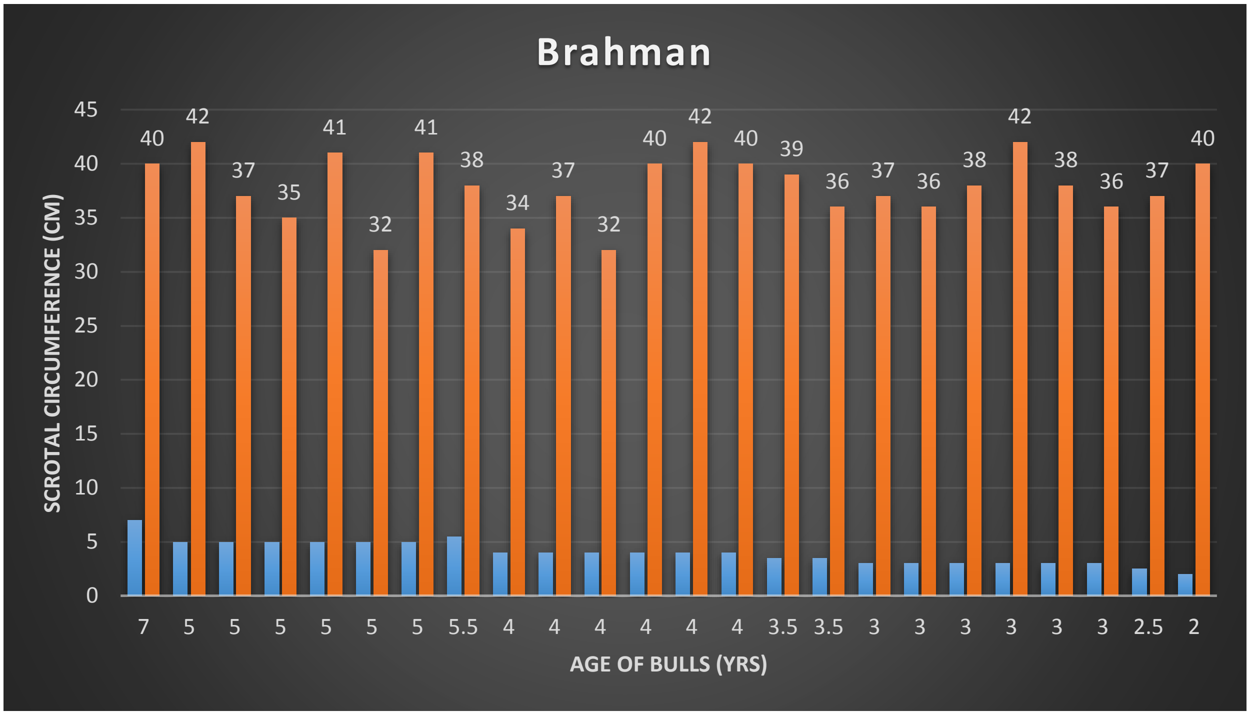

Figure 4.8 Relationship between the scrotal circumference and age of the Brahman bulls

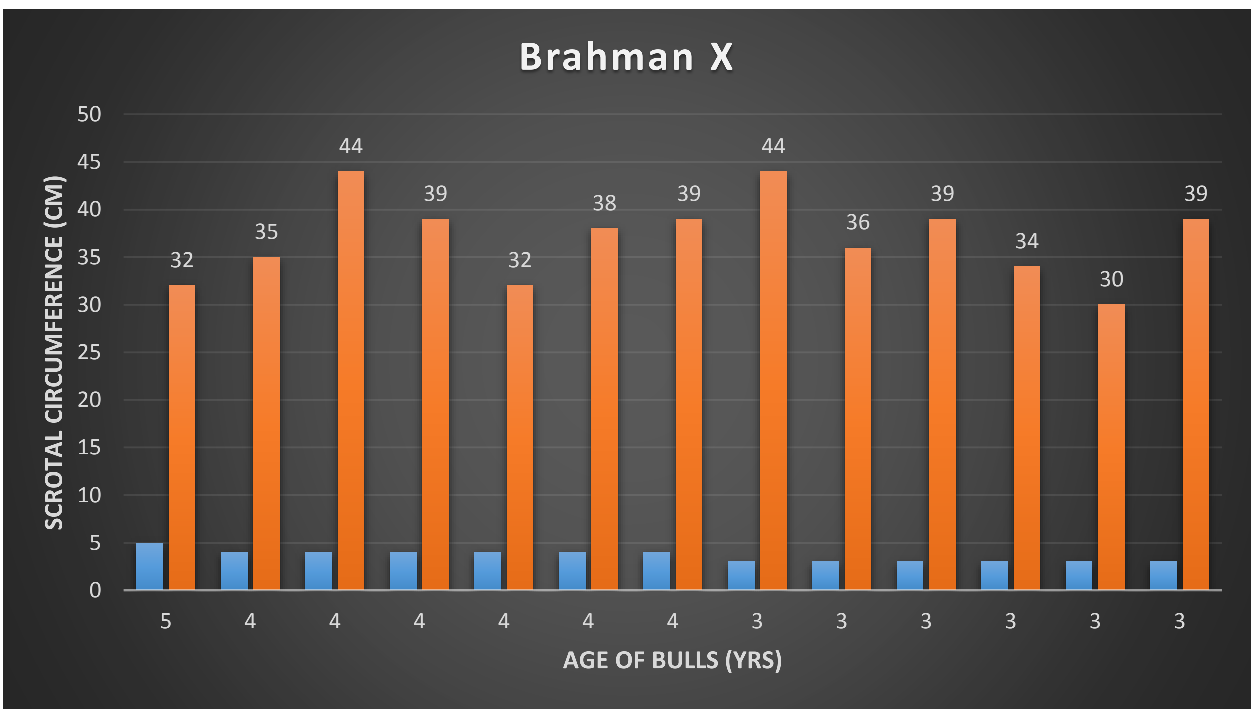

Figure 4.9 Relationship between the scrotal circumference and age of the Brahman cross bulls

However the standard or levels of scrotal circumference measurement is not obligatory, it differs between breeds (*Bos. taurus* or *Bos. indicus*), between countries or cattle breeders associations. Figure 4.10 indicated mean scrotal circumference of all three breeds based on the age.

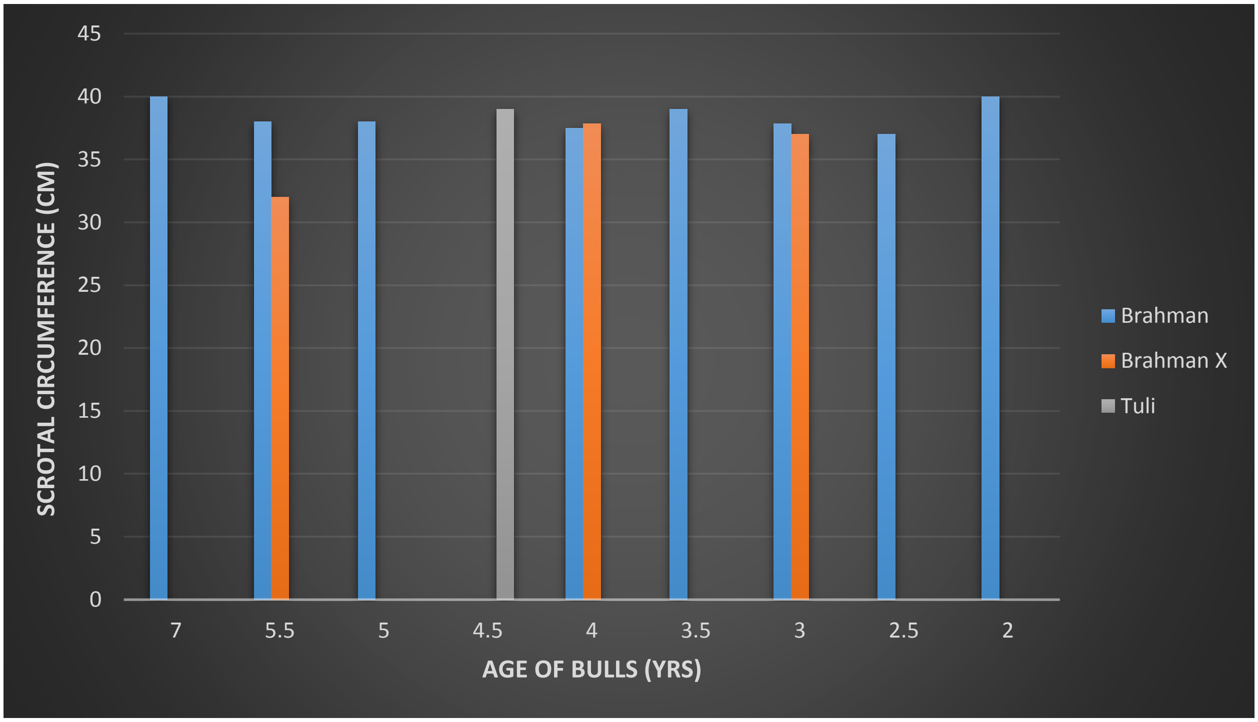

Figure 4.10 Mean scrotal circumference of three breeds based on age.

The results showed that the average measurement of the scrotal circumference of three different breeds in this study, were almost the same size in diameter (Figure 4.11), and very few bulls failed to reached the minimal scrotal requirement level. The scrotal circumference of 5 (13%) bulls were regarded as unsatisfactory based on the minimal threshold value recommended (Chenoweth, 1994). It is likely that, bulls with scrotal circumference below minimum level observed, had probably contributed to the poor fertility or low calving rate experienced in the study area. Even if such produce semen of good quality, they will still lower fertility due insufficient sperm per ejaculate (Jayawardhana (2006).

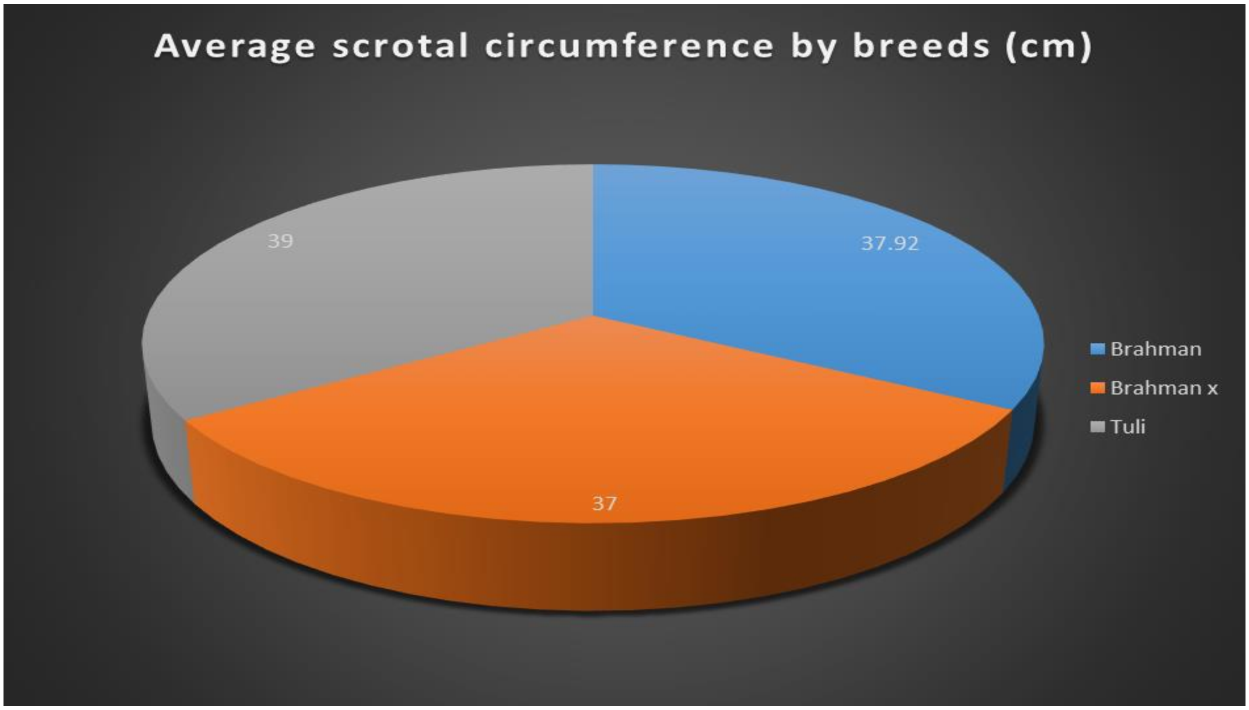

Figure 4.11 Average scrotal circumference by breed

Alexander (2008) suggested that bulls regarded as satisfactory potential breeders must meet minimum standard in four categories, namely: physical reproductive examination, scrotal index for age, semen motility and sperm morphology. The bull failed if the scrotal contents were found to be abnormal, or the circumference was not within minimum range (Holroyd *et al*., 2002). In the current study, despite normal scrotal circumference in most bulls, all but two bulls failed due to poor semen quality. It is therefore likely the scrotal circumference did not play a role in the poor semen quality observed in this study

The information about the measurement of the scrotal circumference on the majority of the communal bulls in this study was lacking because most of the bulls were not subjected to any breeding test (BSE) at all. There is a need to address these problem by State officials (Veterinarians, Animal Health Technicians and Agricultural advisors) that work closely with the farmers. Communal farmers must be encouraged to participate in the schemes like Kaonafatso ya dikgomo which if offered by the Agricultural Research Council – Animal Production Institute (ARC-AP) with partnership with Technology Innovation Agency (TIA) and all nine Provincial Department of Agriculture.

4.4 Microscopic semen evaluation

4.4.1 Semen motility

The focus on motility traits in this study was on the percentage total motility (TM), progressive motility (PM) and non-progressive motility (NPM). The assessment results observed using the CASA system for motility traits can be found in in Appendix 7. The mean overall bull semen total motility (TM) was found to be 78.73± 25.34 %. This showed that 92 % of bulls in the study had a total semen motility of more than 30 %. This is good, based on the minimum standard suggested by Chenoweth (2002). Although, progressive motility (PM) of semen was very low, with an average of 27.39 ±15.81 %, and non-progressive motility (NPN) was higher at 51.34 ±19.92 %.

It was seen that 60 % of bulls had progressive motile (PM) sperm counts which were poor in that they were less than or equal to 30 %, while 12% had a fair progressive motile sperm counts which was greater than 30 % but less than or equal to 49 %. This is based on the interpretation of minimum threshold suggested by Chenoweth (2002). The low semen motility contributed greatly to the overall poor semen quality found in the current study. Three (8 %) of the 38 bulls in this study, showed progressive motile sperm counts greater than 50 % together with greater than 70% normal morphological sperm. The semen of the three bulls was regarded as satisfactory, despite other categories suggested by Alexander (2008), that the bull had to meet minimum standard in four categories, namely: physical reproductive examination, scrotal index for age, semen motility and sperm morphology. The bulls that were found to have good semen were the ones that had recently been introduced into the herd, based on the information obtained from the survey questionnaire.

4.4.2 Semen morphology of bulls in Moretele district

The morphologically normal spermatozoa observed, from semen samples taken from the current study, showed an average of 38.52 ± 24.47 % of live normal sperms and 12.10 ± 11.33 % of dead normal sperms respectively. Under natural mating the bulls is highly or likely to be fertile if the morphologically normal sperm is 70 % or above. In the current study the overall normal sperms were below minimum threshold of 70 % that is recommended (Chenoweth, 2002; Alexander 2008), is for that reason they were regarded as poor when compared with the value 72.8±1.6 % of semen morphology reported as low in dairy bulls by Vilakazi (2003) in summer. The overall head defects observed in the current study indicated the mean of 6 ± 6.92 %, mean overall mid piece defects 7.39 ± 10.14 % and mean overall tail defects of 28.07±24.15 % respectively (Table 4.13).

Under natural mating, the semen sample of a bull with 50 – 69 % normal morphologically sperm can be regarded as satisfactory because the is a high probability of being fertile, although caution should be excised in mating them as single sire or with high mating load (Holroyd *et al*., 2002). In this study, 20 (52 %) of the bulls observed showed a normal morphological sperm between 50 – 69%, that include both live and dead normal spermatozoa, but they were regarded as unsatisfactory because they failed to meet minimum threshold of more than 30 % progressive motility and 70 % normal morphological spermatozoa (Chenoweth, 2002). Only 3 (42 %) out of 38 bulls had morphologically normal sperm, and demonstrated good motility, they were classified satisfactory as potential breeders.

Table 4.13 Morphological sperm defects or abnormalities

Morphological defect observed	**Mean**	**(SD)**	**Range**
Head defect	6.0	6.92	0 - 20
Mid piece defect	7.39	10.14	0 - 36
Tail defect	28.07	24.15	0 - 68

Figure 4.12 and 4.13 compare the variations between sperm total motility and normal morphologically spermatozoa based on the age of bulls in the study area.

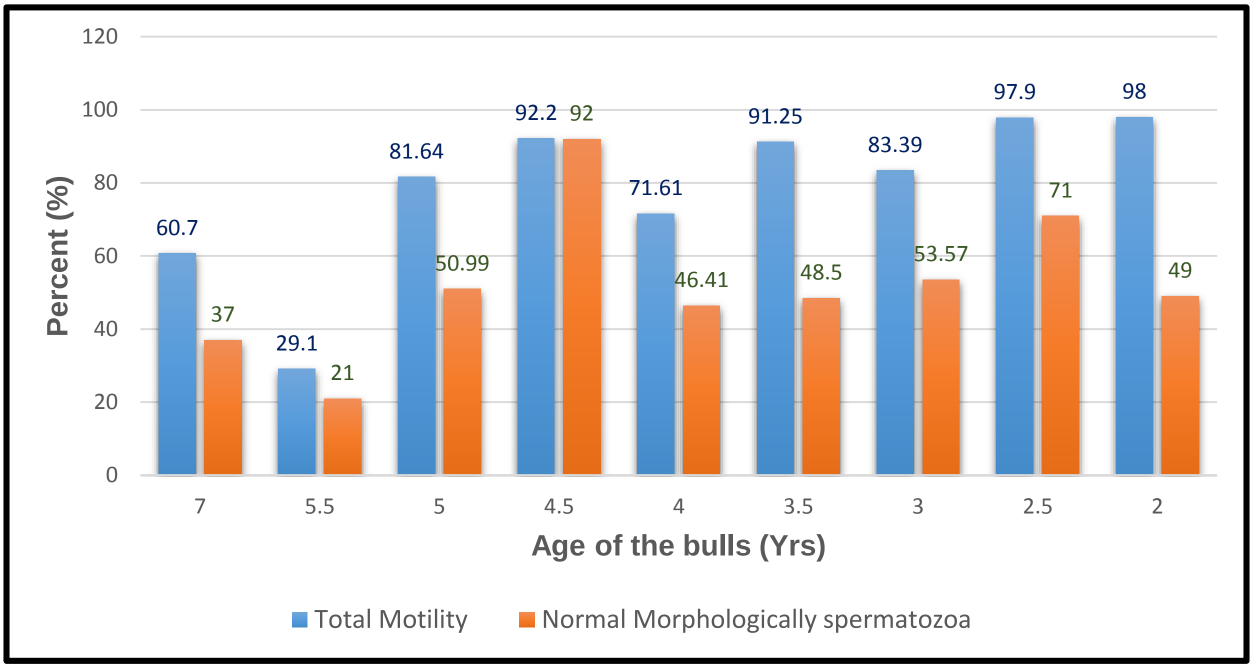

Figure 4.12 Comparison between the mean total motility and normal morphologically spermatozoa by age of the bulls.

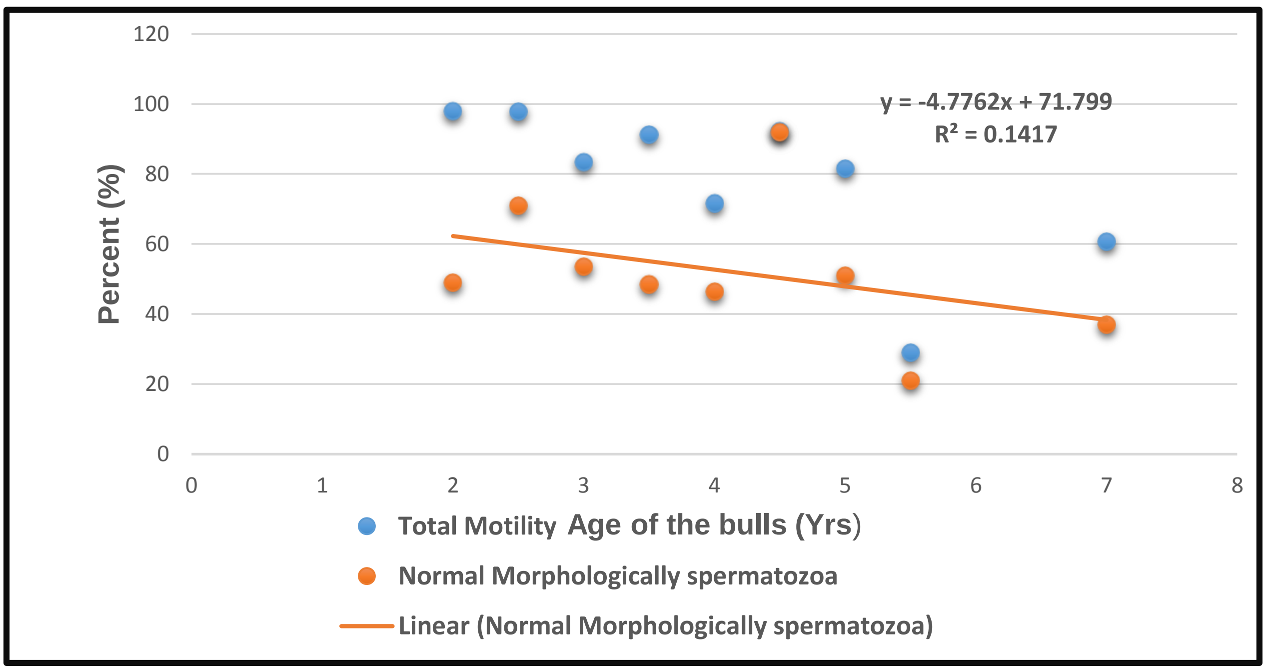

Figure 4.13 Comparison between Total motility and normal morphologically spermatozoa by age of the bulls

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

5.1. Conclusions

It was concluded that very few (8 %) of the bulls examined, were fertile due to poor semen quality, poor structural soundness and Brucellosis status. During 2013 the average calving percentage of herds studied was only 35.86 %, but this poor fertility was not due to *Campylobacter* or *Trichomonas*. About 92 % of the bulls in this study had semen with a low progressive motility of 27.3±15.81 % and non-progressive motility of 51.34±19.92 %. Semen morphology was also very poor, with an average of 50.6±23.56 % if compared with the average semen morphology of 72.8±1.6 % reported by Vilakazi (2003) in summer.

Although two bulls tested positive for brucellosis, they were culled after testing. It is likely that the low fertility of bulls in this study contributed to the low calving percentage. Mokantla (2003) found that bull and not cow fertility, was a problem in communal herds. Factors which may have influenced fertility of bulls in the present study are:

- Bull fertility (semen quality and small scrotal circumferences).
- An incorrect cow to bull ratio (e.g. high number of cows to bulls of 2398:75) In such a situation the bulls are overworked, become exhausted and consequently have low semen counts. The bull to cow ratio in this study was 1:32, while a ratio of 1:25 is recommended under extensive conditions with low management input.
- Owners did not do Breeding Soundness Examination (BSE) before bulls were purchased – it was suggested that the fertility status of infertile bulls was concealed, in fear of not being able to sell the bulls.
- The farmer who bought a *Brucella* positive bull did not asked for a CA test or certificate when he purchased the bull.
- Tick damage to the scrotum and prepuce was found in 92% of bulls tested.

Deficiencies noted from the structured interviews

- Some (*n* = 14) 28.5% of the farmers kept their bulls for more than 48 months in their herds. If the bulls were to be kept for more than three years in a herd, there was a likelihood of them mating with their daughters (inbreeding. It was concluded that farmers in the current study need to be taught or cautioned about the consequences of keeping bulls in the herds for too long a time.

- Farmers were mostly interested in physical conformation (*n* = 9) 18.4% and reproductive performance (*n* = 15) 30.6%. When purchasing a bull, no farmers asked for breeding soundness evaluation or proof that the bull was negative for *b. abortus*, *t. fetus or c. fetus*.

- The lack of knowledge to test bulls for BSE was identified or noted, as almost half of the farmers *(n* = 25) 52.1% did not know about Breeding Soundness Evaluation and their bulls were never tested. It was concluded that farmers must be encouraged to participate in the schemes like Kaonafatso ya dikgomo which if offered by the Agricultural Research Council – Animal Production Institute (ARC-AP) with partnership with Technology Innovation Agency (TIA) and Provincial Department of Agriculture. BSE testing which include, bull infectious diseases, age, scrotal circumference, libido, semen motility and morphology must be emphasized during extension campaigns or farmers information days by state Veterinarians, Animal health technician and Agricultural advisors.

- Supplementary feeding of bulls was a challenge to most (*n* = 26) 53% of the farmers in this study. Bulls need to be conditioned throughout the year to maintain their reproductive performance. However, financial constrain and unavailability of animal feed at their nearest co-operatives was mentioned by farmers as some the reasons for not buying feeds for their bulls. It was suggested that farmers must be encouraged or advised to sell some of their unproductive stock and buy feed for their herd bulls and be taught about the importance of supplementary feeding during the extension campaigns or animal health information days.

These conclusions are in line with the study hypothesis, that the fertility of bulls in communal herds is poor as compared with the fertility of bulls in commercial herds. Support for this conclusion, is that the recommended standard for calving rate in commercial herds using natural mating in extensive grazing in South Africa is 62 % (Grobler *et al.,* 2014), while this study indicated a much lower level of 35.86% over a period of 12 months (2013). This finding is in agreement with the low calving rate of 27% to 35 % that was adjusted to herd composition of communal herds reported by Scholtz and Bester (2010) from the national cattle structured survey.
As all bulls had scrotal and preputial tick damage, it is highly likely that poor tick control contributed to low fertility and may be the major cause of low fertility seen on communal bulls in the study area.

5.2. Recommendations

The recommendations for livestock extension advisors and veterinary professionals to farmers were identified namely:

- Bulls must be visually inspected, testes measured and certificates of fertility must be issued before they are sold to farmers. Five bulls in this study had small scrotal circumference. If routine examination of herds included measuring scrotal circumference, these would have been picked up and removed.

- The bulls must be tested for brucellosis before they are purchased, or should be put in quarantine and tested by the State Veterinarian or AHT. The two bulls in this study that tested positive for *Brucella abortus* would have been identified and excluded if this recommendation had been followed.

- Breeding bulls must be certified free of campylobacter and trichomonas or put into quarantine and tested by state Veterinarians. That should be done before the bulls are introduced into the cow herds and they should also be subjected to one test per year. This is important as one of the bulls in this study was suspicious for *Trichomonas fetus*, although the 2^{nd} and 3^{rd} test were negative.

- Pedigreed bulls should have a pre-purchase certificate of fertility and semen examination should be done. The farmers must insist on a certificate of fertility before purchase. None of the farmers in the present study had asked for a BSE when they purchased a bull.

- Farmers should be given more information on how to estimate a correct bull-cow ratio, as this was found to be incorrect in this study.

- The high level of tick damage seen in bulls in this study indicates a serious need for farmers to apply spot treatment for ticks, and monitor bulls for tick damage in the genital areas. Similar damage to the teats or udders of cows has previously been described, which resulted in high mortality rates of calves. It is probable that ticks have a more serious influence on the fertility of bulls than previously thought.

- Bull BSE are advised for communal bulls before each breeding season.

CHAPTER 6

REFERENCES

1. Acocks J P H 1975 *Veld types of South Africa with accompanying veld type map*. 2nd Edition; South African Botanical Research Institute: 44-48

2. Ahmed A M 2009 *Seroprevalence of cattle Brucellosis in Gabiley District*. Somaliland. Sheikh Technical Veterinary School. Diploma in Livestock Health Sciences (Thesis). STVS/0039. http://www.scribd.com/doc/18682678/Abdirahim-thesis.

3. Alexander J H 2008 Bull breeding soundness evaluation: A practioner's perspective. *Theriogenology,* 70: 469-472.

4. Asdell S A 1955 *Cattle Fertility and Sterility*. J & A Churchill Ltd 104 Gloucester Place W1 London, U.K.: 175.

5. Anderson M L, Barr B C, and Conrad P A 1994 Protozoal causes of reproductive failure in domestic ruminants. *Veterinary Clinics of North America Food Animal Practice* 1: 439 – 461.

6. Bakunzi F R, Ziyambo G C N, Morris S D 1993 A serological survey of bovine brucellosis in the Molopo district of Bophuthatswana. *Journal of the South African Veterinary Association* 64 (4): 154-155.

7. Barth A D 2000 *Bull Breeding Soundness Evaluation Manual*. The Western Canadian Association of Bovine Practitioners. 2d ed. Lacombe, Alberta, Canada.

8. Barth A D and Bowman P A 1994 The sequential appearance of sperm abnormalities after scrotal insulation or dexamethasone treatment in bulls. *Canadian Veterinary Journal* 35: 93-102.

9. Barth A D and Omniski K H 2000 The relationship between scrotal circumference at weaning and at one year of age in beef bulls. *Canadian Veterinary Journal* 41:541-546.

10. Bath G F, Hansen J W, Krecek R C, Van Wyk J A, and Vatta A F 2001 *Sustainable approaches for managing haemonchosis in sheep and goats*. Final reports of the Food and Agricultural Organization (FAO) Technical Co-operation project No. TCP/SAF/8821(A).1.

11. Bearden J D, Fuqual J W, and Willard S.T 2004 *Applied animal reproduction*. 6th Edition. Pearson Prentice Hall. New Jersey. USA.

12. Bembridge T J 1991 *The Practice of Agriculture Extension: a training manual*. Development Bank of South Africa: 18-28, 43-53, & 227-252.

13. Bembridge T and Tapson D 1993 Communal livestock systems. *Livestock production systems principles and practice*. Edited by C Maree and N.H Casey. Pretoria: Book productions 23:157 -373

14. Benor J, Harrison J Q and Baxter M 1984 *Agricultural Extension – The training and visit system:* World Bank. Washington DC. USA: 8-16, 43-53 & 227-252

15. Bertschinger H J, Ehret W J, Woods R and Coertze R J, 1992 *Beef bull performance, scrotal circumference and semen quality*. 12th Int. Congress on Reproduction, The Hague, Netherlands.

16. Bigalke R D and Prozesky L 2004 Besnoitiosis. In Coetzer J A W and Tustin R C (eds). *Infectious Diseases of livestock*. Oxford University Press. Cape Town South Africa: pp 351 – 359.

17. Biggs S D, Bingen R J, Ewell P T, McAllister J L, Merrill-Sands D M, and Poats S V 1991 Institutional considerations in strengthening on-farm client orientated research in national agricultural research systems: lessons from a nine-country study. *Exemplary in Agriculture*. 27 (4): 343-373.

18. Blockey M A 1979 Observations on group mating of bulls at pasture. *Applied Animal Ethology.* 5:15-34.

19. Blood D C, Radostis O M, and Handerson J A, Arunded J H, Gay C C 1983 Normal Laboratory values. *Veterinary Medicine* 6TH edition. ELBS and Bailliere. Tindall. East bourne. UK: 867-875 & 894-944

20. BonDurant R H 1985 Diagnosis, treatment, and control of bovine Trichomoniasis. The *Compendium of Continuing Education* 7: S 179 -188.

21. Bonsma J C 1980 *Judging cattle for functional efficiency*. Livestock Production – A global approach. Tafelburg publishers. Cape Town. South Africa.

22. Borchardt K A, Norman B B, Thomas M W, Harmon V M 1992 Evaluation of new culture method for diagnosing *Tritrichomonas foetus* infection. *Veterinary Medicine* 87:104 – 12.

23. Botha C J, Williamson C C 1989 A serological survey of bovine brucellosis in four districts of Bophuthatswana. *Journal of the South African Veterinary Association* 60 (1): 50.

24. Casey N H and Maree C 1993 *Principles of livestock production.* Principles and Practice. Agri- Development Foundation. Brooklyn. South Africa: pp. 69-70.

25. Chambers R, Pacey A, and Thrupp L A 1993 *Farmer First*: *farmer innovation and agricultural research*. Intermediate Technology Publication: xiii, 4, 178 – 188.

26. Chenoweth P J, Spitzer J C, and Hopkins F M 1992 A new bull breeding soundness evaluation form. In*: Proceedings of the Annual Meeting for Society of Theriogenology.* Aug. 14-15. San Antonio. TX. pp, 63 -70.

27. Chenoweth P J 1994 Aspects of reproduction in female *Bos Indicus* cattle: a review. *Australian Veterinary Journal* 71 (12): 442-426.

28. Chenoweth P J 2000 *Bull sex drive and reproductive behaviour*. Topics in bull fertility. International Veterinarian Information Service. USA.

29. Chenoweth PJ 2002 *Semen quality assessment*: Proceedings of the Applied Reproductive Strategies in Beef Cattle Workshop. Manhattan, Kansas, USA.

30. Chenoweth P J 2004 Evaluation of natural service bulls – The ‘‘other’’ BSE. *Veterinary Journal* 168: 211- 212.

31. Coe P H 1999 Associations among age, scrotal circumference and proportion of morphologically normal spermatozoa in young beef bulls during initial breeding soundness examinations. *Journal of American Veterinary Medical Association* 214:1664-1667.

32. Coetzee K and Menkveld R 2001 *Validation of a new disposable counting chamber: Reproductive Biology Unit*. Department of Obstetrics and Gynaecology. University of Stellenbosch and Tygerberg. Tygerberg. South Africa.

33. Collett S 1998 SPA Standardised Performance Analysis. Part 1: What do production number mean? *The Bovine Practitioner* 32(2): 29-35

34. Dargatz D A and Hill G W 1996 Analysis of survey data. *Preventative Veterinary Medicine* Vol 28 No 4:225 - 253

35. Dhuyvetter K C, Schroeder T C, Simms D D, Bolze Jr R P and Geske J 1996 Determinants of Purebred Beef Bull Price Differentials*. Journal of Agricultural and Resource Economics* 21(2):396-410

36. Duvel G H 2002 *Towards an appropriate extension approach for South Africa*. Final Report Drafted for the National Department of Agriculture. University of Pretoria. South Africa: 27- 209.

37. Eilts B E 2005 *Bull Breeding Soundness Examination*. pp. 222-235. http:www.vet.med./su-edu/eiltslotus/theriogenology – 5361/bull.htm.

38. Entwhistle K and Fordyce G 2003 *Evaluating and Reporting Bull Fertility*. Australian Association of Cattle Veterinarians. Indoolroopilly, Queensland. Australia (eoaacv@bigpond.net.au) ISBN 0-9585654-4-9.

39. European Food Safety Authority 2010 Bovine Besnoitiosis, an emerging disease in Europe. (EFSA). Parma, Italy. *EFSA Journal* 8(2): 1499.

40. Falk A J, Waldner C L, Cotter B S, Gudmundson J and Barth A D 2001 Effects of epidural lidocaine anaesthesia on bulls during electro-ejaculation. *Canadian Veterinary Journa*l 42: 116 – 120.

41. Fitzpatrick L A, Fordyce G, McGowan M R, Bertram J D, Doogan V J, De Faveri J, Miller R G and Holroyd RG 2002 Bull selection and use in Northern Australia. Part 2. Semen traits. *Animal Reproduction Science* 71: 39-49.

42. Francis J and Sibanda S 2001 Participatory action research experiences in smallholder dairy farming in Zimbabwe: *Livestock Research for Rural Development* (13), 3, : 1-15.

43. Geske J M, Schalles R R and Zoellner K O 1995 Yearling scrotal circumference prediction equation and age adjustment factors for various breeds of beef bulls. *Agricultural Experiment Station and Cooperative Extension. Kansas State University. USA.* 727:99.

44. Godfroid J, 2004 *Brucellosis in wildlife*. In Coetzer J A W and Tustin R C (eds). *Infectious Diseases of livestock*. Oxford University Press. Cape Town South Africa, pp 1546 – 1552.

45. Godfroid J, Bosman P P, Herr S and Bishop G.C 2004 Bovine Brucellosis. In Coetzer J A W and Tustin R C (eds). *Infectious Diseases of Livestock*. Oxford University Press. Cape Town South Africa, pp 1510 – 1527.

46. Gordon I 1996 *Controlled Reproduction in Cattle and Buffaloes*. CABI Publishing. Wallingford. Oxon.UK. ISBN-10:0851991149.

47. Greiner S P and Hall J B 2007 Management of yearling bulls. Extension Animal Scientist. VA Tech. http://www.thedairysite.com/articles/867/management-of-yearling-bulls/print.

48. Grobler S M, Scholtz M M, Greylling J P C, Neser F W C 2014 Reproduction performance of beef cattle mated naturally following synchronization in the Central Bushveld bioregion of South Africa. *South African Journal of Animal Science* 44(5)

49. Hafez E S E 2004 *Reproduction in Animals* (7ed.) Editorial Manual. Sao Paulo. Brazil.

50. Hoflack G, Van Soom A, Maes D, de Kruif A, Opsomer G and Duchateau L 2006 Breeding Soundness and libido examination in Belgium Blue and Holstein Friesian Artificial Insemination bulls in Belgium and the Netherlands. *Theriogenolog*y 66: 207 -216.

51. Hansen G R 2006 *Managing bull fertility in beef cattle herds*. Animal Science Department. Florida Cooperative Extension Service. Institute of Food of Agricultural Sciences. University of Florida. USA. AN153.

52. Hawkins H S and Van den Ban A W 1996 *Agricultural Extension*. Wiley Blackwell. Blackwell Science. Australia. Pp 120 – 173.

53. Heinrich G M, Koketso C, and Worman F 1991 Integrating FPR with conventional on-farm research programmes: An example from Botswana. *Journal for Farming Systems Research* 2 (2): 1-15.

54. Holroyd R G, Doogan V J, De Faveri J, Fordyce G, McGowan M R, Bertram J D, Vankan D M, Fitzpatrick L A, Jayawardhana G A and Miller R G 2002 Bull selection and use in Northern Australia for calf output and predictors of fertility of bulls in multiple-sire herds. *Animal Reproduction Science 71*: 67-79.

55. Hungerford T G 1990 *Diseases of Livestock*, 9th Edition, Lindsay Costelloe, Australia. pp 210,242

56. Hüttner K and Wanda G W 1996 On-farm investigation of management and husbandry in Malawi Zebu cattle in Mzuzu Agricultural Development Division. In: (Ed). Huttner K. Primary Animal Health Activities in Southern Africa. *Proceedings of an international seminar held in Mzuzu, Malawi from 26th February to the 8th March 1996; Food and Agriculture Development Center of the German Foundation for International Development*: 108.

57. Huston C L 2014 *Trichomonas in Beef Cattle*. Extension service of Mississippi State University. Co-operating with U S Department of Agriculture. USA. Publication 2009.

58. DAFF 2013 *Interim Brucellosis Manual*. Department of Agriculture, Forestry and Fisheries, Republic of South Africa.

59. Irons P C, Schutte A P, Herr S and Kitching J P 2004 Trichomonosis. In Coetzer J A W and Tustin R C (eds). *Infectious Diseases of livestock*. Oxford University Press. Cape Town, South Africa, pp 309 – 315.

60. Irons P C, Schutte A P, Van Der Walt M L and Bishop G C 2004 *Genital Campylobacteriosis in cattle*. In Coetzer J A W and Tustin R C (eds). *Infectious Diseases of Livestock*. Oxford University Press. Cape Town South Africa, pp 1459 – 1467.

61. Irsik M B, DVM. MAB, and Shearer J K, DVM. MS 2010 *Bovine Genital Campylobacteriosis*. University of Florida. IFAS Extension.VM 166.

62. Janoff S and Weisbord M R 1995 *Future Search: An action guide to finding common ground in organizations and communities*. Berrett-Koehler Publishers, San Francisco, USA.

63. Jayawardhana G 2006 *Testes size – fertility indicator in bulls*. Australian Government. Agnote K44. Retrieved 20 September 2014.

64. Johannson I 1961 Gentle cause of faulty germ cell low fertility. *Journal of Dairy Science* 43 *(*Supplement): 1.

65. Kilgour R and Dalton 1984 *Livestock Behaviour*: A Practical Guide. Granada. Herts. United Kingdom.

66. Kriese L A, Bertrand J K and Benyshek L L 1991 Age adjustment factors, heritabilities and genetic correlation for scrotal circumference and related growth traits in Herford and Brangus bulls. *Journal of Animal Science*. 69:478-489.

67. Kvasnicka W G 1991 *Prevention and control of Trichomoniasis*. Animal Science Department. Range Beef Cow Symposium. University of Nebraska - Lincoln. University of Nevada. Reno. USA. http://digitalcommons.w/.edu/rangebeefcowspmp./255.

68. Landaeta-Hernandez A J, Chenoweth P J and Berndtson W E 2001 Assessing sex drive in young *Bos Taurus* bulls. *Animal Reproduction Science* 66: 151 – 160.

69. Langerloff N 1963 Hereditary factors in fertility in cattle. In: *Infertility in Livestock*. Animal Health Branch Monograph No.5 FAO (Food and Agricultural Organization of the United Nations), Rome. Italy. pp. 10 – 17.

70. LeaMaster B R, DuPonte M W 2007 *Bull Power. Examination of Beef Cattle Bulls for Breeding Soundness*. Department of Human Nutrition, Food and Animal Science. Livestock Management. Cooperative Extension Service. College of Tropical Agriculture and Human Resources. University of Hawai'i at Monoa. LM 17.

71. Lusby KS and Selk G E 1992 *Oklahoma Beef Cattle Manual*. (3rd Ed.) Oklahoma Cooperative Extension Service. Stillwater. Oklahoma.USA.

72. Mabesa H T 1994 *Environmental factors influencing production in a Herd of Bonsmara Cattle*. Thesis submitted in partial fulfilment of the degree M Inst Agrar at the Pretoria University.

73. Mackereth G 2003 Reaffirming New Zealand's freedom from bovine brucellosis. *Surveillance* 30(3): 3-6.

74. Makgatho C N 2004 *An Assessment of Constraints to Accurate Reporting of cattle Mortality in Odi District, Northwest West Province.* Thesis submitted in partial fulfilment of the requirement for the degree of Magister Scientiae (Veterinary Sciences) in the Department of Paraclinical Sciences, Faculty of Veterinary Sciences. University of Pretoria.

75. McGowan M 2004 Approach to conducting bull breeding soundness examinations. *In Practice* 26: 485 – 491.

76. Mickelson W D 1990 Investigating the cause of low pregnancy rates in beef cattle herds. *Veterinary Medicine*: 418-427.

77. Mokantla E 2003 *The influence of brucellosis, trichomoniasis, campylobacteriosis, herd management and bull fertility on the calving percentage of beef cattle kept on communal grazing system in Jericho*. Thesis submitted in partial fulfilment of the degree M. Med. Vet. University of Pretoria. South Africa.

78. Mokantla E, McCrindle C M E, Sebei J P and Owen R 2004 An investigation into the causes of low calving percentage in communally grazed cattle in Jericho, North West Province, South Africa. *Journal of South African Veterinary Association*. 75 (1): 30 – 36.

79. Mossman D H 1984 A theory of beef production. Proceedings, *68th J D Stewart Memorial Refresher course on Beef Cattle Production*. University of Sidney. Sidney. Australian 6- 10 February 1994. pp. 90-227.

80. Mukuahima G 2007 *The Performance of Beef Cattle Bulls in the Vrede District of Mpumalanga, South Africa*. Thesis submitted in partial fulfilment of the degree M Inst Agrar at the University of Pretoria. South Africa

81. Mulugeta M and Amsalu T 2014 Women's role and their decision making in livestock and household management. *Journal of Agricultural Extension and Rural Development.* 6(11). pp. 347 - 353

82. National Research Council 1996 *Nutrients Requirements of Beef Cattle* (7th Ed.) National Academy Press. Washington DC. USA.

83. National Department of Agriculture 2001 The National Strategy for South African Agriculture. Department of Agriculture, South Africa.

84. Nielsen K, Smith P, Gall D, Widdisson J, Kelly L, Kelly W and Nicoletti P 2004 Serological relationship between cattle exposed to *Brucella abortus*. *Yersinia enterocolitica* 0:9 and *Escherichia coli* O157:H7 *Veterinary Microbiology*. 100: 25-30.

85. Njiro S M, Kidanemariama A G, Tsotetsia A M, Katsandeb T C, Mnisia M, Lubisia B A, A Pottsa A D, Baloyib F, Moyob G, Mpofub J, Kalakeb A and Williams R 2011 A study of some infectious causes of reproductive disorders in cattle owned by resource-poor farmers in Gauteng Province, South Africa. *Journal of South African Veterinary Association* 82(4): 213–218

86. Noakes D E, Parkinson PJ and England G C W 2001 *Veterinary reproduction and obstetrics.* W B Saunders, London, UK. 8th ed, P.700.

87. Nthakheni D N 1993 *Productivity measures and dynamics of cattle herds of the small scale producers in Venda*. MSc Dissertation. University of Pretoria

88. OIE 2008 Bovine *Genital Campylobacteriosis* Manual of diagnostic tests and vaccines for terrestrial animals. Pp. 661 - 670 http:/www.oie.int/international-standard…/terrestrial-manual/access-online/

89. OIE 2012 Bovine *Brucellosis*. Manual of diagnostic tests and vaccines for terrestrial animals. pp. 616-650
http:/www.oie.int/international-standard…/terrestrial-manual/access-online/

90. Palmer C W, Brito L F C, Arteaga A A, Soderquist L, Persson Y, and Barht A D, 2005 Comparison of electro ejaculation and trans rectal massage for spermatozoal collection in range and yearling feedlot beef bulls. *Animal Reproduction Science* 87: 25 – 31.

91. Parish J A 2005 *Bull Purchasing and Management*. Mississippi State University. http://www.thedairysite.com/articles/717/bull-purchasing-and-management.

92. Parker R 1998 *Disease affecting reproduction in beef cattle*. Cooperative extension service. College of Agriculture and Home Economics. Guide B – 215, p4 (Replace 400 B 44). New Mexico State University and the US Department of Agriculture Cooperation, USA.

93. Parkinson T J 2004 Evaluation of fertility and infertility in natural service bulls. *Veterinary Journal* 168: 215 – 229.

94. Penny C 2010 The BCVA bull pre-breeding examination certificate. Veterinary Records. *Journal of the British Veterinary Association* 167: 551-554 doi:10.1136/vr.c5216. http:veterinaryrecords.bmj.com/content/167/15/551.full.

95. Perez - Gutierrez J F and Perez y Perez F 1993 *Effect of selective testis cooling on bull semen production and quality*. In Proceedings of the 5th International Symposium on Animal Reproduction (Portugal), vol. 2, pp 187-194.

96. Perry G and Patterson D 2007 Determining reproductive fertility in herd bulls. University of Missouri Extension, Missouri, USA.

a. http//extension.missouri.edu/publications/DisplayPub.aspx?P=G 2011

97. Perry G, Walker J, Daly R 2008 *Reproductive fertility in herd bulls*. Extension Extra. Animal and Range sciences. South Dakota State University/ College of Agriculture and Biological Sciences. USDA. ExEx 2066.

98. Perry V E A, Chenoweth P J, Munro R K 1991 Patterns of development of gonads, sex drive and hormonal responses in tropical beef bulls. *Theriogenology* 35: 471 – 486.

99. Persson Y 2007 *Breeding Soundness Evaluation of Young Beef Bulls*. Thesis submitted in partial fulfilment of Doctoral. Swedish University of Agricultural Sciences. Uppsala, Sweden.

100. Peter D 1997 Bovine venereal diseases. In: Youngquist R S, editor. *Current therapy in large animal theriogenolog*y.1 ed. Philadelphia: W B Saunders Company, USA. pp 355-363.

101. PetherickK J C 2005 A review of some factors affecting the expression of libido in beef cattle, and individual bull and herd fertility. *Applied Animal Behaviour Science*. 90: 185 – 205.

102. Quisumbing A R, Brown L R, Feldstein H S, Haddad L, Pena C 1995. *Women: The Key to Food Security*. Food Policy Report. Washington, DC: International Food Policy Research Institute

103. Rambaldi G, Chambers R and McCall 2006 *Practical ethics for PGIS Practitioners,Facilitators, Technology intermediaries and Researchers*, PLA 54.

104. Roling N 1992 Effects of allied Agricultural Research and Extension. Issues for knowledge management. *Journal of Extension Systems, 8 (1): 167–184.*

105. Rollinson D H L 1955 Oestrus in Zebu cattle in Uganda*.* *Nature* 176: 352

106. Sascke R G, Dalton J C, Nadir S, Nebel R L and Bame J H 2000 Relationship of seminal traits and insemination time to fertilization rate and embryo quality*. Animal Reproduction Science* 60 -61, 663 – 667

107. Salah M S, El-Nouty F D and Al-Hajri M R 1992. Effect of water sprinkling during the hot – dry summer season on semen on semen quality of Holstein bulls in Saudi Arabia. *Animal Production* 55: 59-63.

108. Scholtz M M and Bester J 2010. Off-take and production statistics in the different South African cattle sectors: results of a structured survey. *Applied Animal. Husbandry and Rural Development* 3(1), 19-23

109. Sekokotla M J 2003 *Annual Report*; Submitted by Moretele Veterinary Office to Moretele Local Municipality District, NW Province, South Africa.

110. Sekokotla M J 2004 *Assessing implementation of veterinary extension on control of cattle parasites, in Moretele District, Northwest Province*. Thesis submitted in partial fulfilment of the requirement for the degree of Magister Scientiae (Veterinary Sciences) in the Department of Paraclinical Sciences, Faculty of Veterinary Sciences. University of Pretoria, South Africa.

111. Simpson B H and Wright D F 1998 *The use of questionnaires* to assess the importance of clinical diseases in sheep. Ministry of Agriculture and Fisheries, Private Bag, Palmerston North, New Zealand: 97–105.

112. Smith M F, Morris D L, Amoss M S, Parish N R, Williams J D and Witbank J N 1981 Relationship among fertility, SC, seminal quality and libido in Santa Gertruidis bulls. *Theriogenology* 16: 379 – 397.

113. Statistics South Africa 2011 *Community survey*. Pretoria. South Africa.

114. Steffen D 1997 *Genetic causes of bull infertility*. Department of Veterinary and Biomedical Science. University of Nebraska. Lincoln. USA. http:/www.ncbi.nlm.nih.gov/pubmed/9216046.

115. Strous E E C 2010 *Population structure and reproductive aspects in a traditional farming system in Mpumalnga Province. Republic of South Africa.* Research internship. Curriculum 2001. Faculty Veterinary Medicine. Utrecht University.

116. Sprott L R, Thrift T A, Carpenter B B 2003 A. *Breeding Soundness of Bulls. Texas Beef Cattle Management Handbook.* Texas Agricultural Extension Service, USA. L-5051.

117. Sprott L R, Carpenter B B, Thrift T A 2003 B. *Breeding Soundness of Bulls. Texas beef cattle management handbook*. Texas Agricultural Extension Service. USA. B-6064.

118. Taylor W T *1995 Relationship of lifetime fertility of Bonsmara cows with growth and scrotal circumference of their calves*. Thesis submitted in partial fulfilment of the requirement for the degree of Magister Scientiae (Agric) at the University of Pretoria, South Africa.

119. The Center for Food Security and Public Health (CFSPH) 2009 *Brucellosis*. Iowa State University. College of Veterinary Medicine. Iowa State University. Ames, Iowa, USA, 50011.

120. Thrusfield M 1995 *Veterinary Epidemiology* 2nd edition London: Blackwell Science Ltd, UK.

121. Van Aert A., Brion P., Dekeyser P., Uytterhaegen L., Sijens R J. and Boeye A 1984. A comparative study of ELISA and other methods for the detection of *Brucella* antibodies in bovine sera. *Veterinary Microbiology* 10: 13-21.

122. Van de Ven G W T, De Ridder N, Van Keulen H and Van Ittersum M K 2003 Concepts of production ecology for analysis and design of animal and plant-Animal production systems. *Agricultural Systems*. 76.507-525

123. Van Zyl J G E, Maree C, Selfert G W 1993 *Beef production systems*. In livestock productions. Principles and practice. Edited by Maree C and Casey N H. Agric development foundation. ISBN 0-620-17126

124. Vilakazi D M 2003 *Factors affecting the quality of semen of A.I dairy bulls*. Thesis submitted in partial fulfilment of the requirement of the Degree Magister Institunonis Agrariae (Animal Production). Department of Animal and Wildlife Sciences. Faculty of Natural and Agricultural Sciences. University of Pretoria. South Africa.

125. Walker J, Perry G, Duly R and Olson K 2009 *Bull management and nutrition*. Animal Science Department. Range Beef Cow Symposium. University of Nebraska – Lincoln, USA.

126. Yeates N T and Schmidt P J 1974 *Classification and distribution*: In Beef Cattle Production: Butterworth Pty, Limited. UK. 27-29

127. Young L E, Butterworth S C and Wilmut I 1996 Increased Ovine fetal weight following transient asynchronous embryo transfer is not associated with placental weight at day 21 of gestation. *Theriogenology.* 45: 231

128. Youngquist R S 1997 *Current Therapy in Large Animal Theriogenology*, W.B. Saunders, Philadelphia, USA.

APPENDIXES

Appendix1

UNIVERSITEIT VAN PRETORIA
UNIVERSITY OF PRETORIA
YUNIBESITHI YA PRETORIA

Faculty of Natural and Agricultural Sciences
Department of Animal and Wild Life Science

Researcher's Name: Masethe Jan Maime

Address: Private bag x 498

Hammanskraal

0400

Name of institution: **University of Pretoria**

Title of study: Management of the fertility of communal bulls in Moretele district, Northwest Province in South Africa.

Purpose of the study: To investigate the level of fertility in Moretele communal bulls by examining and comparing semen quality [motility, morphology, volume] as well as evaluating the disease status in order to prove whether the fertility of those bulls thus influences or does not influence the conception rate of cows in communal cattle herds.

Procedures: I understand that I will be part of the interview respondents in a study that investigates **the level of fertility in Moretele communal bulls** and that the interview will require 45 minutes of my time.

Risks and Discomfort: I understand that I will not be exposed to any risks and discomfort during the interview (study). However, I will inform the researcher of my discomfort should I experience any during the interview.

Benefits: I understand that I will not be offered any benefits be it financial or in kind for **participating** in the interview. I also understand that the result of this study may be used to develop a strategy for improving cattle production in North West Province

Participant's Rights: I understand that my participation in this study is voluntary and that I will not be disadvantaged in any way if I decide to withdraw from the study.

Confidentiality and anonymity: I understand that the researcher will take all reasonable steps to protect my identity and treat all information confidentially. I understand that my responses to interview questions will be recorded on the semi structured questionnaire, which will be collated with those from other research participants to document findings into a research report for the University of Pretoria. I also understand that findings of this study may be published in a professional journal and/or presented at a conference. I understand that should there be a need to disclose any information, it will be done with my consent.

Person to contact: Masethe Jan Maime

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And

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Declaration

I, …………………………………….., understand my rights as a research participant, and I voluntarily consent to participate in this study. I understand what the study is about and how and why it is being conducted.

-----------------------	---------------------------------	--
Date	Place	Participant's signature
-----------------------	---------------------------------	--
Date	Place	Researcher's signature
-----------------------	---------------------------------	--
Date	Place	Supervisor's signature

Bull Number

APPENDIX 2

FARMERS QUESTIONNAIRE

DATA ON PERSONAL PARTICULARS

(D1) Name of the respondent:

(D2) Farm name:

(D3) Farm no:

(D4) District:

(D5) Gender: M (1) / F (2)

(D6) Age:

(D7) Marital status of respondent:

1	2	3	4
Married	Widowed	Divorced	Unmarried

(D8) Education of respondent:

1	2	3	4	5	6	7
No Formal Education	Up to grade 1	Up to grade 3	Up to grade 6	Up to grade 9	Up to grade 12	Post matric qualification

(D9) Employment of respondent:

1	2	3	4	5	6	7	8
Nil	Trade	Agriculture	Commerce	Mining	Industry	Pension	Other *

* Specify

(D10) Number of people living with you on your property (include people who live away from the house during the week or month, but come back on a regular basis and contribute to the income of the household)

Persons	Number
Adult male (>18)	
Adult female (>18)	
Boys	
Girls	
Babies	

DATA ON LAND USE

(L1) Grazing land available (in ha)

(L2) Land tenure arrangements:

1	2	3	4	5
Communal land	Trust land	Private land	Hired land	Other*

*Specify

DATA ON WATER FOR ANIMALS

(W1) Source of water for animals

1	2	3	4	5	6	7
Tap in house	Tap in yard	Borehole	Spring	Dam	River	Other*

*Specify

(W2) If not at homestead, how far is the water source from the kraal?

1	2	3	4	5	6	7	8
Less than 100m	100-500m	600m-1km	1.1-1.5 km	1.6-2.0 km	2.1-2.5 km	2.6-3.0 km	More than 3.0 km

(W3) Is water fetched for the animals?

Yes (1)	No (2)

(W4) If yes, how much water (in litres) is fetched daily?

(W5) What is size of container used (in litres)?

(W6) Who fetches water?

1	2	3	4	5	6	7	8
Head	Wife	Son	Daughter	Brother	Sister	Parent	Other*

Specify

(W7) Is the water collected (1) / delivered (2) or both (3)?

(W8) Who owns the water source?

(W9) Do you have to pay for the water?

Yes (1)	No (2)

(W10) If yes, how much do you have to pay per litre?

DATA ON BREEDING

(B1) Do you own bulls?

Yes (1)	No (2)

If the answer is yes, how many?

If the answer is no whose bull or bulls do you use?

(B2) What is the primary reason for keeping bulls

1	2	3	3
Breeding	Socio – cultural	Animal Traction	Other*

*Specify

(B3) Give reason for choice of bull (s) for breeding

1	2	3	4	5	6	7	8
Confirm ation	Colour	Size	Horns	Temper amen t	Perform ance	Availabil ity	Other*

*Specify……………………………………..

(B4) Mating

1	2	3	4	5
Uncontrolled	Hand mating	Group Mating	AI	Other*

*Specify……………………………………..

(B5) What is the source and breed(s) used in the herds?

1	2	3	4	5
Own bull(Bred)	Own bull(bought)	Bull donated	Bull borrowed	Communal bull
Breed				

(B6) How long have you been using the bull in the herd?

(B7) What is the bull(s) age?

1	2	3	4	5
15 – 18 months	18 -24 months	24 – 36 months	36 -48 months	More than 48 months

(B8) Do you know what breeding soundness examination of bulls is?

Yes (1)	No (2)

(B9) If yes, to what extent has breeding soundness examination(s) of bulls been used in the past?

1	2	3	4	5
Not all	Once	Twice	More than twice	Don’t remember

(B10) Have the bull(s) been cultured for *Campylobacter fetus* and *Trichomonas fetus*?

Yes (1)	No (2)

If the answer is yes, how many times has it been done?

1	2	3	4	5
Once/ year	Twice/year	More than Twice/year	Don’t Remember	Never

(B11) Have libido and dominance tests been performed on bull(s)?

Yes (1)	No (2)

If yes, to what extent has these tests been performed?

1	2	3	4	5
Once/ year	Twice/year	More than Twice/year	Don't Remember	Never

DATA ON HERD HEALTH

(HH1) Do you have access to Veterinary Services?

Yes (1)	No (2)

(HH2) If the answer is yes, please specify

1	2	3	4	5
State Veterinarian	Private Veterinarian	Veterinary Drug supplier	Animal Health Technician	Extension services

(HH3) Do you treat your bull(s) for external parasites?

Yes (1)	No (2)

(HH4) If the answer is yes, specify how often?

1	2
Done when need arises	Done routinely

(HH5) What method do you use?

1	2	3	4	5	6
Plunge dip	Spray dip	Pour-on	Hand dressing	Injectable	Traditional

HH6) Do you treat your bull(s) for internal parasites?

Yes (1)	No (2)

(HH7) If the answer is yes, please state the reason?

1	2	3
To get rid of worms	To improve conditioned score	To prevent deaths

(HH8) Please specify how often?

1	2
Done when need arises	Done routinely

(HH9) What method do you use?

1	2	3
Drench	Injectable	Traditional

(HH10) Have you ever culled a bull in the last 12 months?

Yes (1)	No (2)

(HH11) If the answer is yes what was reason for culling?

1	2	3	4	5
Health	Poor Body Condition	Bad Temperament	Old age	Poor Performance or Poor fertility

(HH12) Do you know what a breeding season is?

Yes (1)	No (2)

(HH13) if the answer is yes, please elaborate,

(HH14) Do you know that bull(s) need to be rested in order to perform optimally?

Yes (1)	No (2)

(HH15) if the answer is yes, why your bull(s) are usually not given time to rest.

1	2	3	4	5
It is not important	Shortage of grazing camps	They need to do their work	No one taught us that	We need many calves

(HH16) Do you buy extra feed for the Bull(s)?

Yes (1)	No (2)

(HH17) If the answer is yes, what type of supplement do you buy?

Product bought	**Season fed**	**Amount fed**	**Price per kg**

(HH18) If the answer is not, please give reasons.

1	2	3
Expensive	Not available	Other*

*Specify…………………………

(HH19) Do you use any drugs or vaccinations for your bull(s)?

Yes (1)	No (2)

(HH20) If the answer is yes, what do you use?

Product used	**How often per year**	**Amount used**	**Price of product**

(HH21) If the answer is not, please give reasons.

1	2	3
Expensive	Not available	Other*

*Specify…………………………

(HH22) How many calves were born from cows of your herd in the last 12 months?

(HH23) How many abortions occurred from cows of your herd in the last 12 months?

GENERAL DATA FOR CATTLE HERD

(CA1) Do you ever slaughter your own animals?

Yes (1)	No (2)

(CA2) Do you use all the meat for your own family?

Yes (1)	No (2)

(CA3) Do you sell some of the meat to other people?

Yes (1)	No (2)

(CA4) How many calves were born during the last year?

(CA5) How many animals died during the last year?

Demographics	Number	Cause of death
No of cows (1)		
No of heifers (2)		
No of bulls (3)		
No of oxen (4)		
No of calves (5)		

(CA 6) What did you do with the cattle that died?

(CA7) How many animals do you own?

Demographics	Number	Why sold	Price received per head
No of cows (1)			
No of heifers (2)			
No of bulls (3)			
No of oxen (4)			
No of calves (5)			

(CA8) How many animals did you buy over the last year?

Demographics	Number	Why bought	Price paid per head
No of cows (1)			
No of heifers (2)			
No of bulls (3)			
No of oxen (4)			
No of calves (5)			

(CA9) Reasons for keeping cattle (more than one answer possible)

1	2	3	4	5	6	7	8	9
Commercial /sale	Traditi on	Mil k	Mea t	Securi ty	Manur e	Draught power	Compa nionshi p	Other*

* Specify……………………………………………

APPENDIX 3

MORETELE BULL DATA CAPTURE SHEET

Date:		Place:		Owner:	
	Age:	Breed:		Brand:	
Identification	Colour:			Tattoo:	
	Ear notches (draw them in)			Ear tag:	
Final conclusion about the bull:					
Clinical Examination					
General Health	General Health Status:				
	Condition Score:		Weight:		
	Eyes:		Teeth and bites:		
Locomotion System	Back:				
	Legs:				
	Hooves:				
	Conformation:				
	Gait:				
Clinical Examination of reproductive tract	Preputium:				
	Penis:				
	Scrotal circumference:				
	Scrotum:				
	Left testis:		Right testis:		
	Left epididymis:		Right epididymis:		
	Left spermatic cord:		Right spermatic cord:		
	Left vesicular gland:		Right vesicular gland:		
	Left ampulla:		Right ampulla:		
	Prostate:		Urethra:		
Libido and ability to serve:					
Semen evaluation					
Method of collection: AV EE:		Ejaculate: into sheath:		From protruded penis:	
Interval since previous ejaculates:		Fraction of ejaculate collected:			
Microscopic evaluation	Volume:	Colour:		Consistency:	
	Marbling:	Distinct:	Weak:		Absent:
	Concentration of semen ejaculates:				
	PH:		Odour:		
Motility	Mass motility:				
	%Progressive	% Aberrant		% Immotile	

APPENDIX 4

Reason given by farmers to choose a bull

Reasons	**No. of the respondents**	**Percentage %**
Conformation	9	18.4
Conformation and colour	1	2.0
Conformation, colour and size	1	2.0
Conformation, colour, size and Performance	2	4.1
Conformation, colour and other (Testes and prepuce)	1	2.0
Conformation and size	2	4.1
Conformation, size, temperament, performance	1	2.0
Conformation , size and performance	2	4.1
Conformation and performance	1	2.0
Conformation and other (Testes and prepuce)	1	2.0
Colour	2	4.1
Colour and size	1	2.0
Colour, size and temperament	1	2.0
Colour, size and performance	2	4.1
Colour, temperament and performance	1	2.0
Size	2	4.1
Size and performance	2	4.1
Performance	15	30.6
Other (Testes and prepuce)	2	4.1
Totals	**49**	**100**

APPENDIX 5

Table 4.12 Bulls serological test results on RBT and CFT

Village *(n = 10)*	Bull Id. No *(n = 50)*	Rose Bengal Test(RBT)	Compliment Fixation Test(CFT)
Mmakaunyane	A 1	Negative	Negative
	A 2	Negative	Negative
	A 3	Negative	Negative
	A 4	Negative	Negative
	A 5	Negative	Negative
Tladistad	B1	Negative	Negative
	B 2	Negative	Negative
	B 3	Negative	Negative
	B 4	Negative	Negative
	B 5	Negative	Negative
Mmatlhwaela	C 1	Positive	Positive 98IU/ml
	C 2	Negative	Negative
	C 3	Negative	Negative
	C 6	Negative	Negative
	C 7	Negative	Negative
Mathibestad	D 1	Negative	Negative
	D 2	Negative	Negative
	D 3	Negative	Negative
	D 4	Negative	Negative
	D 5	Negative	Negative
Kgomokgomo	E 1	Negative	Negative
	E 2	Negative	Negative
	E 3	Negative	Negative
	E 4	Negative	Negative
	E 5	Negative	Negative
Sutelong	F 1	Negative	Negative
	F 2	Negative	Negative
	F 4	Negative	Negative
	F 6	Negative	Negative
	F 7	Negative	Negative
Bollantlokwe	G 1	Negative	Negative
	G 3	Negative	Negative
	G 4	Negative	Negative
	G 5	Negative	Negative
	G 6	Negative	Negative
Mmotla	H 1	Negative	Negative
	H 2	Negative	Negative
	H 3	Negative	Negative
	H 4	Negative	Negative
	H 5	Negative	Negative
Ratjiepane	I 1	Negative	Negative
	I 2	Negative	Negative
	I 3	Negative	Negative
	I 4	Negative	Negative
	I 5	Negative	Negative
Lebalangwa	J 1	Negative	Negative
	J 2	Negative	Negative
	J 3	Positive	Positive 30IU/ml
	J 4	Negative	Negative
	J 5	Negative	Negative

APPENDIX 6

Results of Trichomonas fetus and Campylobacter fetus on bacterial PCR (n = 38)

Village *(n = 10)*	Bull Id. No *(n = 38)*	Breed	Age (Years)	Trichomonas foetus	Campylobacter fetus	Number of tests
Mmakaunyane	A 1	Brahman	5	Negative	Negative	3
	A 2	Brahman	5	Negative	Negative	3
	A 3	Brahman X	3	Negative	Negative	3
	A 4	Brahman X	4	Positive	Negative	3
	A 5	Brahman X	3	Negative	Negative	3
Tladistad	B1	Brahman	4	Negative	Negative	3
	B 2	Brahman	5	Negative	Negative	3
	B 3	Brahman	4	Negative	Negative	3
	B 4	Brahman X	4	Negative	Negative	3
	B 5	Brahman	3	Negative	Negative	3
Mmatlhwaela	C 2	Brahman	2	Negative	Negative	2
	C 3	Brahman X	3	Negative	Negative	2
	C 6	Brahman X	4	Negative	Negative	1
	C 7	Brahman X	3	Negative	Negative	2
Mathibestad	D 1	Brahman	3	Negative	Negative	1
	D 5	Brahman	7	Negative	Negative	1
Kgomokgomo	E 1	Brahman	4	Negative	Negative	3
	E 2	Brahman	5	Negative	Negative	3
	E 3	Brahman	3	Negative	Negative	3
	E 4	Brahman X	4	Negative	Negative	3
	E 5	Brahman X	3	Negative	Negative	3
Sutelong	F 2	Brahman	3.5	Negative	Negative	2
	F 5	Brahman	5.5	Negative	Negative	3
	F 6	Brahman	5	Negative	Negative	3
	F 7	Brahman	3	Negative	Negative	3
Bollantlokwe	G 1	Brahman	3	Negative	Negative	1
	G 3	Tuli	4.5	Negative	Negative	1
	G 4	Brahman X	4	Negative	Negative	2
	G 5	Brahman	3	Negative	Negative	2
Mmotla	H 1	Brahman	3.5	Negative	Negative	3
	H 2	Brahman X	4.0	Negative	Negative	3
	H 3	Brahman X	3	Negative	Negative	2
	H 4	Brahman	4	Negative	Negative	2
	H 5	Brahman X	5	Negative	Negative	2
Ratjiepane	I 1	Brahman	2.5	Negative	Negative	3
	I 2	Brahman	4	Negative	Negative	3
	I 3	Brahman	4	Negative	Negative	3
	I 5	Brahman	5.	Negative	Negative	1

APPENDIX 7

The results of bulls semen evaluation (n = 38)

Bull Id. No *(n = 38)*	**Breed**	**Age** Yrs.	**SC**	**Sperm Motility**			**Sperm Morphology**					**Good Quality**
				TM	PM	NPM	LN	DN	Head Abn	Mid P Abn	Tail Abn	**Yes / No**
A 1	Brahman	5	42	95.2	57.9	37.3	64	10	2	3	21	**Yes**
A 2	Brahman	5	37	93.2	12.3	80.9	50	0	5	2	43	**No**
A 3	Brahman X	3	44	86.1	27.6	58.5	54	0	2	12	32	**No**
A 4	Brahman X	4	35	71.0	36.6	34.4	10	10	25	40	15	**No**
A 5	Brahman X	3	36	75.5	14.6	60.8	very	little	sperm			**No**
B1	Brahman	4	40	.0	.0	.0	very	little	sperm			**No**
B 2	Brahman	5	35	54.8	37.8	17.1	very	little	sperm			**No**
B 3	Brahman	4	42	88.7	60.6	28.0	50	20	5	10	15	**Yes**
B 4	Brahman X	4	44	98.9	22.4	76.4	28	17	0	10	45	**No**
B 5	Brahman	3	37	98.0	20.3	77.7	14	43	3	28	12	**No**
C 2	Brahman	2	40	98.0	33.6	64.4	15	34	4	9	38	**No**
C 3	Brahman X	3	39	90.3	20.8	69.5	15	37	6	3	39	**No**
C 6	Brahman X	4	39	93.6	46.8	46.8	36	5	9	3	47	**No**
C 7	Brahman X	3	34	37.3	6.0	31.3	29	6	11	9	45	**No**
D 1	Brahman	3	36	90.6	38.9	51.6	17	9	1	36	37	**No**
D 5	Brahman	7	40	60.7	11.7	49.0	37	0	7	19	37	**No**
E 1	Brahman	4	40	53.4	15.8	37.6	37	7	2	10	44	**No**
E 2	Brahman	5	41	85.8	14.2	71.6	56	14	6	2	22	**No**
E 3	Brahman	3	38	95.0	16.3	78.7	61	8	2	2	27	**No**
E 4	Brahman X	4	32	7.3	5.2	2.1	23	32	8	3	34	**No**
E 5	Brahman X	3	30	58.3	11.7	46.7	36	14	9	9	32	**No**
F 2	Brahman	3.5	39	82.5	22.8	59.7	16	20	10	7	47	**No**
F 5	Brahman	5.5	38	29.1	.0	29.1	0	21	14	3	62	**No**
F 6	Brahman	5	32	59.3	16.2	43.1	20	10	32	30	8	**No**
F 7	Brahman	3	42	96.5	34.8	61.7	43	13	10	0	34	**No**
G 1	Brahman	3	38	82.6	24.2	58.4	79	9	4	1	7	**No**
G 3	Tuli	4.5	39	92.2	13.0	79.3	92	0	0	2	6	**No**
G 4	Brahman X	4	38	98.3	48.1	50.3	62	4	2	8	24	**No**
G 5	Brahman	3	36	95.7	50.3	45.5	85	1	2	0	12	**Yes**
H 1	Brahman	3.5	36	100.0	41.4	58.6	44	17	4	6	29	**No**
H 2	Brahman X	4	39	97.5	39.7	57.8	54	7	6	5	28	**No**
H 3	Brahman X	3	39	94.8	27.6	67.3	61	9	4	1	25	**No**
H 4	Brahman	4	32	94.3	24.4	69.8	49	24	2	0	25	**No**
H 5	Brahman X	5	32	89.8	46.3	43.5	36	20	20	2	22	**No**
I 1	Brahman	2.5	37	97.9	41.5	56.4	44	27	2	3	24	**No**
I 2	Brahman	4	37	71.7	27.2	44.4	53	3	3	2	39	**No**
I 3	Brahman	4	34	84.7	45.1	39.6	20	6	5	1	68	**No**
I 5	Brahman	5.	41	93.4	27.2	66.2	74	3	1	0	22	**No**

Abbreviations: SC=Scrotal circumference, TM = Total motility, PM = Progressive motility, NPM = Non progressive motility, LN = Live normal morphological sperm, DN = Dead normal morphological sperm, Head Abn = Head abnormalities, Mid P Abn = Mid piece abnormalities, Tail Abn = Tail Abnormalities

Plate 1 Bull Scrotum with high infestation of ticks

Plate 2 Bull Scrotum with high infestation of ticks

Plate 3 Bull prepuce showing high infestation of ticks