

2010

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[POPULATION STRUCTURE AND  
REPRODUCTION ASPECTS IN A  
TRADITIONAL FARMING SYSTEM IN  
MPUMALANGA PROVINCE, RSA]

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## ABSTRACT

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This study investigated the population distribution in the Mnisi area, a rural area in the Mpumalanga Province in The Republic of South Africa. Also the bull health and fertility of the herd was evaluated. During the field study a questionnaire was carried out with the owners, bull were clinically observed the birth figures of the cattle register were analyzed.

The Mnisi study area (= 15 dip tanks) has 1,097 owners and they all together have 12,005 head of cattle. An average herd consists of 17 head of cattle, divided into 2 bulls, 1 ox, 8 cows, 3 heifers and 3 calves. 52% of the farmers have a small herd, 22% of the farmers have a medium herd and 26% of the farmers have a large herd. The average percentage of bulls, oxen, cows, heifers and calves at a certain dip tank are respectively 11%, 6%, 46%, 19%, 18%.

In the area the breed *Bos indicus* is particularly present. 40% of the owners in the Mnisi study area use a specific bull for breeding. 72% of the owners do think that the bulls are good enough for breeding in their herd. The bulls in the area have an estimated average age of three years and eight months. The bulls in the area seem to be healthy.

The calving rate is with a 17,1% quite low. A cow gets a calve every two years and nine months. A major part of the calves is born in the first three months of the year (January-March). There is a relationship between calves born and the rainfall nine months previously ( $p < 0,05$ ).

**Key-words:** *population distribution, bull health, fertility, calving rate*

## SAMENVATTING

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In deze studie is onderzoek gedaan naar de populatie verdeling in het Mnisi onderzoeksgebied, een plattelands gebied in de Mpumalanga Province in Zuid-Afrika. Ook is er gekeken naar de gezondheid van de stieren en fertiliteit in de koppels. Tijdens het veldonderzoek is er een vragenlijst afgenomen bij eigenaren, is er een klinische observatie gedaan bij stieren en is er een analyse gedaan van de geboortegedaten in het 'cattle register'.

Het Mnisi gebied (= 15 dip tanks) heeft 1,097 eigenaren en ze hebben samen 12,005 stuks vee. Een gemiddelde koppel bestaat uit 17 runderen, bestaande uit 2 stieren, 1 os, 8 koeien, 3 vaarzen en 3 kalveren. 52% van de boeren heeft een kleine koppel, 22% heeft een medium koppel, 26% heeft een grote koppel. Het gemiddelde percentage stieren, ossen, koeien, vaarzen en kalveren per dip tank is respectievelijk 11%, 6%, 46%, 19% en 18%.

In het gebied is vooral het ras *Bos indicus* aanwezig. 40% van de eigenaren gebruikt een specifieke stier om te fokken. 72% van de eigenaren vindt dat de stieren goed genoeg zijn om te gebruiken in hun koppel. De stieren in het gebied hebben een geschatte gemiddelde leeftijd van drie jaar en acht maanden. De stieren in het gebied lijken gezond.

Het percentage van de koppels dat per jaar een kalf krijgt is met 17,1% vrij laag. Een koe krijgt elke twee jaar en negen maanden een kalf. Een groot deel van de kalveren wordt geboren in de eerste drie maanden van het jaar (januari - maart) Er is een relatie tussen kalveren die geboren worden en de regenval negen maanden eerder ( $p < 0,05$ ).

## INTRODUCTION

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### LIVESTOCK SYSTEMS

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Livestock is very important in South Africa. It is the largest of the various agricultural sectors with a cattle population of 14.1 million. Over two-third of the cattle are found in communal areas (National Department of Agriculture, 2008). This research has taken place in the Mnisi area in Mpumalanga Province. It is a rural area, where communal livestock systems are being used. In a communal livestock system, as a general rule, farming activities are left to women, old men and children. On average 80-90% of the family income is derived from earnings in the urban sector and pensions. Livestock only contributes for a small part to the income. Most families in rural areas are therefore not producers of food but consumers (Wilson, 1995).

In modern systems livestock is raised for financial gain and not just for subsistence. In addition to its management and production objectives, ranching differs from communal systems in supporting fewer people on the land, in always being sedentary, in land tenure, and with the options for intensifying water and feed supplies (Wilson, 1995).

Understanding of the multiple functions of livestock in a rural society, and the way in which farmers actually use the resources available to them on communal land will give insight into how cattle are used (Maree & Casey, 1993).

### THE ROLE OF LIVESTOCK AND HERD STRUCTURE

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The cultural attitudes and farming practices in rural communities are not primarily geared towards production, but more towards the use cattle as a form of wealth-accumulation. It is like a way of capital savings as well as an important source of draught power, milk and manure. It is a reserve fund, mostly for emergencies or expenses requiring large sums of money. These farmers do not have access to loans

and use their cattle instead. Although traditional patterns of cultural behavior are changing, ceremonial slaughtering at funerals and weddings, the payment of labola (dowry) and the perception of cattle as a form of security should not be ignored (Maree & Casey, 1993; Van Rooyen, et al., 2009).

The traditional goal of almost all communal land livestock owners is an unlimited increase in the number of animals owned instead of an increase in the productivity per unit. The average cattle owned in the communal areas of southern Africa possesses six head of cattle (Table 1). Table 2 shows a skewed distribution pattern based on the numbers of animals held by individual households (Maree & Casey, 1993). Mapiye (2009) found that about 60% of the farmers had small herd sizes in the sweet and sour communal rangelands in South Africa. Cattle herds were mainly composed of cows (Mapiye, Chimonyo, & Dzama, 2009).

TABLE 1 TYPICAL HERD COMPOSITIONS IN COMMUNAL LAND (MAREE & CASEY, 1993)

CLASS OF ANIMAL	HERD COMPOSITION				AVERAGE	
	CISKEI		TRANSKEI		NO	%
	NO	%	NO	%		
<i>Cows</i>	2.52	36.7	2.06	33.9	2.29	35.6
<i>Heifers</i>	1.06	15.3	1.39	22.9	1.22	18.9
<i>Calves</i>	0.72	10.5	0.66	10.9	0.69	10.7
<i>Steers (1-3 years)</i>	2.06	30.0	0.84	13.9	1.45	22.5
<i>Oxen</i>	0.37	5.4	0.81	14.3	0.59	9.2
<i>Bulls</i>	0.15	2.2	0.25	4.1	0.20	3.2

TABLE 2 DISTRIBUTION ACCORDING TO HERD SIZE IN 4 COMMUNAL LAND AREAS (MAREE & CASEY, 1993)

<i>HERD SIZE CATEGORY</i>	<i>AREA</i>				<i>AVERAGE</i>
	<i>GAZANKULU</i>	<i>TRANSKEI</i>	<i>CISKEI</i>	<i>KWAZULU</i>	
<i>1-5</i>	<i>31.3</i>	<i>46.1</i>	<i>39.0</i>	<i>37.0</i>	<i>38.2</i>
<i>6-10</i>	<i>28.1</i>	<i>32.1</i>	<i>30.0</i>	<i>27.9</i>	<i>29.6</i>
<i>11-15</i>	<i>16.9</i>	<i>13.7</i>	<i>26.2</i>	<i>15.2</i>	<i>18.0</i>
<i>16-20</i>	<i>9.8</i>	<i>5.5</i>	<i>3.4</i>	<i>5.9</i>	<i>6.2</i>
<i>21-25</i>	<i>5.4</i>	<i>1.3</i>	<i>1.4</i>	<i>3.8</i>	<i>3.0</i>
<i>&gt;25</i>	<i>8.6</i>	<i>1.3</i>	<i>0.0</i>	<i>10.2</i>	<i>5.0</i>
	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>	<i>100.0</i>

#### MNISI AREA

The Mnisi area is one of the communal lands in South Africa. Van Rooyen (Van Rooyen, et al., 2009) did a study on farmers and the way they farm in the Mnisi area. An average herd is divided into six cows, three heifers, two calves, two bulls and one ox. In this community there are many reasons for keeping cattle. These reasons are in line with the traditional role of cattle as mentioned in the previous paragraph. The main reason for keeping cattle is to serve as a bank – i.e. as a financial reserve (45%). Another reason is to use the cattle for more purely commercial purposes. A tradition in Africa is the payment of dowry in the form of lobola, where 40% of the cattle are used for this. 54% of cattle are used for other ceremonial purposes. Furthermore, almost two-third of the farmers are milking their cows, 79% of the milk is being sold. 71% of the farmers will occasionally slaughter its cattle; most of the time for home consumption. The reasons for losing a part of the herd are often due to theft, disease or drought. Therefore, most of the farmers are using a corral (a small camp near to their home) to keep their animals during the night, mostly for security reasons (Van Rooyen, et al., 2009).



The purpose of this study is to find out what the herd structure looks like and what the distribution is in a herd. It is expected to find data similar to Van Rooyen.

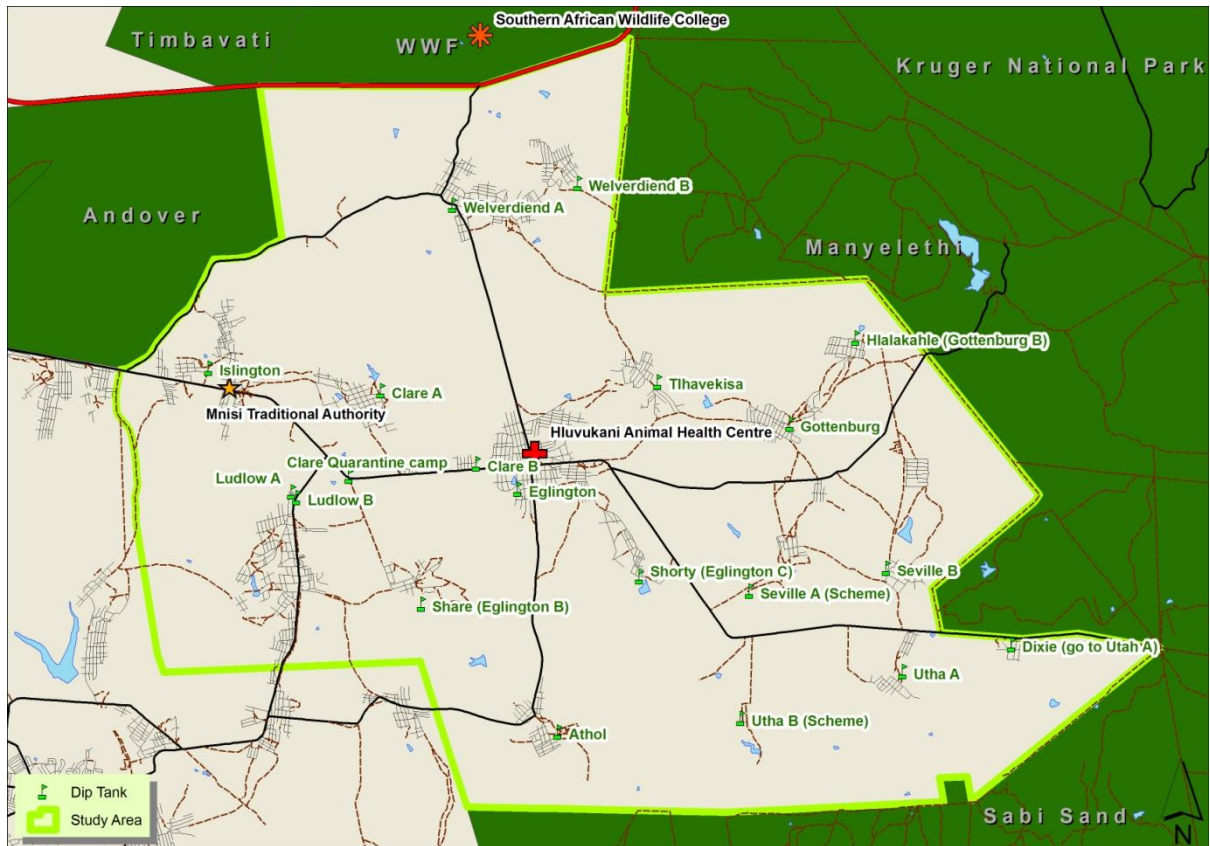


FIGURE 1 MAP MNISI STUDY AREA

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## FERTILITY

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Herd fertility is influenced by a number of factors that may, or may not, act in tandem (Chenoweth & Sanderson, 2001). One of many factors is the fertility of the bull. It contributes to the overall reproductive performance of the cattle herd (Parkinson, 2004). The results of this study may give an impression about the fertility and particularly the fertility of the bulls in the Mnisi area.

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## BULL

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For a good reproduction the bulls have to be fertile and the bulls must be in good physical condition to achieve high conception rates in the herd (Cumming, 2007). Bull fertility is influenced by numerous factors as can be seen in the Table 3 (Nqeno, 2008).

Cattle breeders that make use of natural service are reliant on the fertility of bulls for the productivity of their farming enterprises. They also seek to minimize the risk of the bulls infecting the cow herd with a disease with potentially serious consequences (Irons, Nöthling, & Bertschinger, 2007). 71% of the farmers in the Mnisi area do not use a specific bull to breed with its cows and 61% are satisfied with the quality of the bulls available (Van Rooyen, et al., 2009). In general they do not know which bulls are fertile and which ones are not.

TABLE 3 FACTORS THAT AFFECT REPRODUCTIVE ACTIVITY AND FERTILITY OF CATTLE (BRANTON, 1970)

<i>PHENOTYPIC VARIATION IN REPRODUCTIVE ACTIVITY AND FERTILITY IN CATTLE</i>		
<i>GENETIC FACTORS</i>	<i>ENVIRONMENTAL FACTORS</i>	<i>INTERACTIONS BETWEEN GENETIC AND ENVIRONMENTAL FACTORS</i>
<p><b>1 Anatomical defects of the reproductive organs</b></p> <p>A Lethal genes</p> <p>B Hypoplasia</p> <p>C Freemartin</p> <p>D White heifer disease</p> <p>E Intersex</p> <p>F Semen characteristics</p> <p>(i) Sperm morphology</p> <p>(ii) Other characters</p> <p>G Miscellaneous conditions</p> <p><b>2 Physiological defects</b></p> <p>A Sexual behaviour</p> <p>B Conception and embryonic mortality</p> <p>C Length and signs of heat</p>	<p><b>1 Management</b></p> <p>A Detection of oestrus in the cows</p> <p>B Handling of the service bull</p> <p>C Time of service</p> <p>D Change of environment (transportation)</p> <p>E Size of pasture of range</p> <p>F Age of males en females</p> <p>G Others</p> <p><b>2 Nutrition</b></p> <p>A Energy</p> <p>B Protein</p> <p>C Minerals and vitamins</p> <p><b>3 Diseases and parasites</b></p>	<p>Combination of genetic and environmental factors.</p>

<i>D Gestation length</i>	<i>A Genital diseases</i>	
<i>E Hormone production</i>	<i>B Somatic diseases</i>	
<i>F Twinning</i>	<i>C Internal and external</i>	
<i>G Adaptability to the environment and disease resistance</i>	<i>parasites</i>	
	<b>4 Climate</b>	

Bull fertility is influenced by a complex interaction of factors including seminal quality and quantity, sex drive, mating ability and social interactions (dominance) among animals in the herd (Chenoweth, Farin, Mateos, Rupp, & Pexton, 1984). Dominance affects the mating performance of bulls (Chenoweth, 1981) such that bulls of high social ranking mate more cows than lower ranking animals (Rupp, Ball, Shoop, & Chenoweth, 1977; Fordyce, Fitzpatrick, Cooper, Doogan, Faveri de, & Holroyd, 2002). The dominant bull generally mates more cows than subdominant bulls. Dominance is related to age and is a problem when bulls of mixed ages are used (Makarechian & Farid, 1985), since dominance is not directly related to either libido or fertility (Blockey, 1979; Rupp, Ball, Shoop, & Chenoweth, 1977). There are breed differences in age at which a bull could service a female (Rasby, 2008). The bulls are sexual mature when the sperm production is good enough. An ejaculate with a minimum of  $50 \times 10^6$  sperm with at least 10% of progressive motility is considered fertile. This is indicative for the puberal stage (Evans, Pierson, Garcia, McDougall, Hrudka, & Rawlings, 1996; Wolf, Almquist, & Hale, 1965). Silva-Mena reported that Brahman bulls reach puberty at a age of 16-17 months (Silva-Mena, 1997). Age and/or experience of bulls can influence their mating ability and thus their perceived level of sex drive. Mating ability appears to have a learning component in bulls. In young, tropical beef bulls, libido score increased with bull age between 16 and 31 months of age (Perry, Chenoweth, & Post, 1990).

Although 20-40% of bulls in an unselected population may have reduced fertility, only a few are completely sterile. Breeding soundness refers to a bull's ability to get cows pregnant. A standard Bull Breeding Soundness Evaluation (BBSE) identifies bulls with substantial deficits in fertility, but does not consistently identify sub-fertile bulls

(Kastelic & Thundathil, 2008). Accurate conduct and reporting of BBSE enables veterinarians, bull buyers, owners, and managers to select the bulls with the best chance to produce offspring. Practically it is not possible to predict fertility by means of a breeding soundness evaluation (Irons, Nöthling, & Bertschinger, 2007). Bulls classified as satisfactory for breeding soundness achieved a 9% higher pregnancy rate in a breeding period in single-sire breeding herds than bulls of questionable breeding potential (Irons, Nöthling, & Bertschinger, 2007).

There has to be enough bulls to service all the female animals present. The recommended number of bulls for most commercial herds as a rule of thumb is 3%, so the norm for bull:female ratio's is 1 : 30 on average, in other words, 1 bull for every 30 cows and heifers that can be bred (Van Rooyen, 2010; Webb, 2010). This is similar in the report of Ainslie (2002): the bull to cow ratio is recommended within the range of 1:25-30. (Ainslie, Kepe, Ntsebeza, Ntshona, & Turner, 2002).

The aim of this study is to find out whether the bulls are old enough for breeding, whether there are enough bulls for the number of female animals and whether the bulls are healthy. It is expected that the bulls are young, that there are enough bulls but that the bulls are not very healthy.

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#### COW / CALVING RATE

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Nqeno (2008) reported that cow productivity in the communal areas is limited due to nutrition, reproductive diseases, parasites, low bull to cow ratio, low bull fertility and lack of bull exposure (Nqeno, 2008). The low percentage of cows (36%) compared to a commercial herd (50%) shows that there is a low reproduction potential (Maree & Casey, 1993). In the Mnisi area six of the fourteen animals in a herd are cows (Van Rooyen, et al., 2009); a low reproduction rate is expected in this area as well.

Wilson (1985) found in Central Mali 56% of calves were born in the period from April to June, showing a very significant correlation between these births and rainfall nine to ten months prior to the births. He shows the monthly distribution of 452 calvings in

Figure 2, which also shows the season of conception, assuming this occurs approximately nine months previously. 56% of all calves are conceived during the three months period of the rains. The correlation coefficients were calculated for the number of births per month and rainfall nine to ten months previously, and they showed a significant correlation (Wilson, 1985). It is expected that such pattern is shown in the Mnisi area as well.

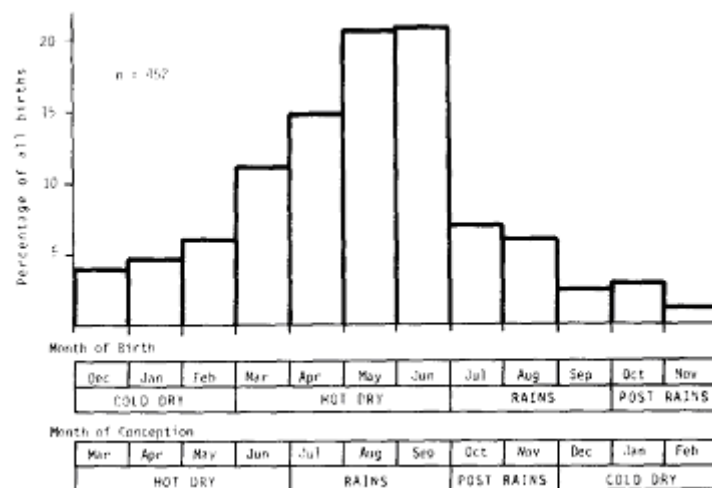


FIGURE 2 CALVINGS AND CONCEPTION (WILSON, 1985)

Most cattle herds suffer an abortion rate of 1-2%. If the abortion rate increases to 3-5% it should be of some concern. Abortion can be caused by toxins found in plants, but can also be caused by infectious diseases such as Bovine Virus Diarrhea, Brucellosis, Campylobacter (Vibrio), Chlamydia, Infectious Bovine Rhinotracheitis (IBR), Leptospirosis, Neospora, Sarcocystis or Trichomoniasis (Bagley, 1999).

The aim of the study is to find out what the calving rate is in the Mnisi area, whether there is a serious abortion problem and to look for a relationship between rainfall and calves born, which is expected.

In a communal grazing system there is usually little known about the herd structure, its fertility and the bulls available, for example about the number of bulls or their health. An investigation into the basic stratification of herds and its fertility on

communal grazing in this area could give remarkable insights and give direction to further research. The findings of this study may be used to formulate recommendations for amendment of the management of herds in the area, with the ultimate aim of improving the socioeconomic status of the herd owners.

## MATERIALS AND METHODS

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### INTRODUCTION

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A field study into the basic stratification of herds, its bulls and fertility on communal grazing was carried out in the Mpumalanga Province. The model used in this research is an animal population model. Because the lack of available records typical of a communal farming system a questionnaire survey is necessary. In order to get information about as many animals as possible, the questionnaire-based survey is carried out at fifteen dip tanks in the Mnisi area. The time it takes to dip the cattle is a good opportunity to carry out the survey amongst the owners. Most of the farmers come weekly to a dip tank (it is compulsory) in their village for the inspection as part of the control of Foot-and-Mouth-disease (FMD). At the same time the cattle have a plunge dip against tick-borne diseases (free service by government as incentive to visit inspection points weekly for FMD surveillance) . The officials at the dip tank are the Animal Health Technicians. They look for Foot-and-Mouth-disease and record the number of animals in the cattle register; how many in total, how many are born, sold and/or bought. The dipping starts usually when the sun rises.

Two weeks before the survey, the Animal Health Technicians were informed about all the aspects of the research project. The Animal Health Technicians were requested to inform the cattle owners about the study at the various dip tanks, the week before the survey took place.

Dipping takes place only on working days. Three weeks were allocated to carry out the survey. The first five days, the dip tanks were selected at random out of fifteen dip tanks in the study area. The following days the research site was depending on where the doctor of the Animal Health Clinic in Hluvukani was going with the students, because a supervisor had to be present. Finally, twelve dip tanks were visited. The schedule of the visited dip tanks is shown in Table 4, together with the number of questionnaires and examined bulls per dip tank.

TABLE 4 SCHEDULE VISITS DIP TANKS

<b>Week 1</b> <b>(18/10/2010)</b>	<b>Monday</b> <i>Gottenburg</i>	<b>Tuesday</b> <i>Clare A</i>	<b>Wednesday</b> <i>Utha</i> <i>Scheme</i>	<b>Thursday</b> <i>Wilverdiend</i> <i>B</i>	<b>Friday</b> <i>Thlavekisa</i>
<b>#Questionnaires</b>	8	9	3	12	14
<b>#Bulls</b>	8	8	9	16	10
<b>Week 2</b> <b>(25/10/2010)</b>	<b>Monday</b> -	<b>Tuesday</b> <i>Utha A</i>	<b>Wednesday</b> <i>Wilverdiend</i> <i>A</i>	<b>Thursday</b> -	<b>Friday</b> <i>Hlalakahle</i>
<b>#Questionnaires</b>	0	5	16	0	15
<b>#Bulls</b>	0	5	10	0	3
<b>Week 3</b> <b>(01/11/2010)</b>	<b>Monday</b> <i>Clare B</i>	<b>Tuesday</b> <i>Share</i>	<b>Wednesday</b> -	<b>Thursday</b> <i>Shorty</i>	<b>Friday</b> <i>Athol</i>
<b>#Questionnaires</b>	10	9	0	10	14
<b>#Bulls</b>	4	8	0	4	8

At the end of each day's fieldwork results of the questionnaires were uploaded via internet onto a safe and secure server hosted by SurveyToGo. The results were exported in an SPSS-file and Excel-file, and analyzed. In SPSS a descriptive overview was made of the data from the questionnaire.

#### HERD STRUCTURE

A questionnaire was compiled before the survey started. All the questions were programmed in a software program called SurveyToGo. An interpreter was trained prior to the onset of the survey exactly what was meant by the various of the questionnaire and which data were needed. At the twelve dip tanks, as many owners as possible were included in the study, resulting in 126 completed questionnaires. After a



questionnaire was completed, the first owner of those who were waiting for their cattle to be dipped, was asked if he was willing to participate with the questionnaire. The interpreter translated the questions from English to Shangaan. For the questionnaire see Appendix 1.

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## POPULATION DISTRIBUTION

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From the cattle register the total number of cattle at each diptank (N=15) was calculated: the mean of the number of cattle attending the dip tanks at the end of October 2009 and the number of cattle at the end of October 2010 was taken. The sum of cattle of all the dip tanks, to be found in the cattle register, was called “total number of cattle in the Mnisi area”. Also the total number of cattle owners was found in the cattle register.

The total number of cattle of the questioned owners at the dip tanks (N=12) was calculated as well as the total number of all the separate groups (bulls, oxen, cows, heifers, calves). Consequently the percentages per group could be calculated. The results were reflected to the “total number of cattle in the Mnisi area” and a population distribution could be made.

The herd size was calculated and was divided in three groups: Small (10 or less head of cattle per herd), Medium (more than 10 but less than 21 head of cattle per herd) or Large (more than 20 head of cattle per herd).

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## RATIO

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### BULL:FEMALE

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The sum of the total number of cows and the total number of heifers in the Mnisi area (15 dip tanks) are the female animals. The total number of females was divided by the total number of bulls in the area creating a bull:female ratio. The same calculation was done per dip tank instead of the whole area.

## COW: CALF

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The total number of cows in the Mnisi area was divided by the total number of calves in the area resulting in the cow:calf ratio. The same was done per dip tank instead of the whole area.

## GENERAL HEALTH EN GENITAL SYSTEM BULL

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A list of observations was made before the survey started. All the aspects were programmed in a software program called SurveyToGo. At the same time, Drs. Claessens carried out a study on *Tritrichomonas* on bulls. He isolated the bulls at the dip tank in the crush by blocking the way with poles, restrained them and performed his sampling. At the same time the list of observations could be rated. Information about the breed and the age of the bulls was obtained from the owners or herdsman. The bulls were identified by color, brands and ear tags. The general impression consisted of behavior, posture, locomotion, body condition score (scale 1-5), lacrimation, salivation and nasal discharges. The genital system was also looked at. The sheath was evaluated by conformation (X-, Y-, or V- shape) and how low or high the sheath was positioned. The presence of a protruding prepuce and/or penis outflow was observed. The testes/scrotum was evaluated if there were scars, abscesses or other abnormalities observable, and if the shape was either symmetrical or asymmetrical. How these components were evaluated exactly is shown in Appendix 2. In the questionnaire (see Herd Structure) were two questions for the owners regarding their bulls. The questions, B5 and B6 were listed in Appendix 1. In total 92 bulls were examined.

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## FERTILITY

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### CALVING RATE

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The Animal Health Technicians counted every week how many calves were born over the week, which were administered in the cattle register. An Excel-file was made about how many calves were born in which week at which diptank. Finally, the number of calves born per month was counted and a figure was made. Also the number of owners per diptank and the total number of cattle was collected from the cattle register. As the percentage of the cows per owner was calculated before (see Herd Structure), the total number of cows belonging to a certain dip tank could be calculated/estimated, which could be used to calculate how many calves were born per cow per dip tank. The total sum of cattle and the total number of calves born the last 12 months, from all the dip tanks (N=15) in the area, helped calculating the calving rate in the Mnisi area.

Using the information of the questionnaire the total number of cattle, the number of cows and the number of calves that were born the last 12 months were obtained. The number of calves per cow per year and the calving rate was calculated. This was calculated per dip tank (N=12) and for the Mnisi area. The calving rate in percentage was achieved by a quotient of the calves that were born according to the questionnaire, and the total number of cattle. The total number of cattle was found in the cattle register and is the mean of the number of cattle at the end of October 2009 and the number of cattle at the end of October 2010.

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### RAINFALL

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The rainfall data for the period of February 2009-January 2010 was obtained from the South African Weather Service. The weather station that was used is called Allandale, which is a weather station in the middle of the Mnisi study area. The data were supplied in an Excel-file. The monthly rainfall in millimeters was calculated for the given year. A Spearman's rho was used to find out if there was a nonparametric correlation between calves born and rainfall nine months prior to the birth of the

calves. A scatter plot and a Wincolox Signed Ranks Test was performed to find out if the calving rate obtained from the register was equal to the calving rate obtained from the questionnaire.

## RESULTS/DISCUSSION

### HERD STRUCTURE

#### POPULATION DISTRIBUTION

According to the cattle register the Mnisi area consists of 1,097 owners and they all together have 12,005 head of cattle in the Mnisi area (= 15 dip tanks), shown in Tabel 5. The average number of cattle that belong to a certain dip tank is 801 (SD  $\pm$  292) ranging from 436 in Hlalakahle to 1604 in Welverdiend A. The average number of owners that belong to a certain dip tank is 73 (SD  $\pm$  34) ranging from 11 in Utha Scheme to 140 in Welverdiend A.

TABLE 5 NUMBER OF CATTLE AND OWNERS PER DIP TANK

	<b>Number of Cattle</b>	<b>Number of Owners</b>
<b>Athol</b>	971	102
<b>Clare A</b>	715	57
<b>Clare B</b>	934	86
<b>Eglington</b>	1,073	126
<b>Gottenburg</b>	941	100
<b>Hlalakahle</b>	436	47
<b>Seville A</b>	750	51
<b>Seville B</b>	760	57
<b>Share</b>	649	57
<b>Shorty</b>	472	46
<b>Thlavekisa</b>	513	63
<b>Utha A+Dixie</b>	826	82
<b>Utha Scheme</b>	571	11
<b>Wolverdiend A</b>	1,604	140
<b>Wolverdiend B</b>	793	72
<b>Totaal</b>	<b>12,005</b>	<b>1,097</b>

An average herd in the Mnisi area in South Africa consists of 17,3 (SD  $\pm$  18,7) head of cattle, divided into 1,8 bulls (SD  $\pm$  2,3), 1,0 oxen (SD  $\pm$  2,0), 8,1 cows (SD  $\pm$  10,7), 3,4 heifers (SD  $\pm$  4,0) and 3,0 calves (SD  $\pm$  4,1) respectively. The maximum number of cattle, bulls, oxen cows, heifers and calves is respectively 94, 13, 10, 61, 23 and 24 (Table 6). 17 head of cattle is 3 head of cattle more than found in the survey of Jacques van Rooyen (Van Rooyen, et al., 2009). Van Rooyen carried out a questionnaire in the same study area. A difference is that all the 140 owners of 10 dip tanks in the study area were included in his survey and he carried out the survey one year ago and in a different time of the year (August). This reason may be cause the difference between these two numbers.

TABLE 6 CATTLE DISTRIBUTION

	<b>Min.</b>	<b>Max.</b>	<b>Mean</b>	<b>Std. Deviation</b>
<b># Cattle</b>	1	94	17,28	18,71
<b># Bulls</b>	0	13	1,83	2,29
<b># Oxen</b>	0	10	0,98	1,97
<b># Cows</b>	0	61	8,08	10,74
<b># Heifers</b>	0	23	3,42	3,95
<b># Calves</b>	0	24	2,96	4,09

As the herd size differed a lot among the owners, another classification was made: Small herd (1-10 head of cattle), medium herd (11-20 head of cattle) and large herd (more than 20 head of cattle). 52% of the owners had a small herd, 22% of the owners had a medium herd and 26% of the owners had a large herd. The results from Maree & Casey (1993) differed; 68% of the owners have a small herd and 8 % of the owners have a large herd. Thus, the percentage of small herds in Maree & Casey (1993) is higher and the percentage of large herd is much lower than found in this study.

The chart (Figure 2) below shows the breakdown of the groups (bull, oxen, cow, heifer, calf) at the dip tank. The average percentage of bulls at a certain dip tank is 11% (SD  $\pm$

3,8%) ranging from 2% in Utha Scheme to 17% in Gottenburg. The average percentage of oxen is 6% (SD  $\pm$  3,4%) ranging from 1% in Share to 10% in Welverdiend. The average percentage of cows is 46% (SD  $\pm$  4,9%) ranging from 38% in Thlavekisa to 55% in Welverdiend B. The average percentage of heifers is 19% (SD  $\pm$  4,0%) ranging from 10% in Utha A+Dixie to 25% in Thlavekisa. The average percentage of calves is 18% (SD  $\pm$  5,6%) ranging from 10% in Gottenburg to 27% in Utha A+Dixie. In Figure 3 the overall population distribution for the sampled dip tanks is shown.

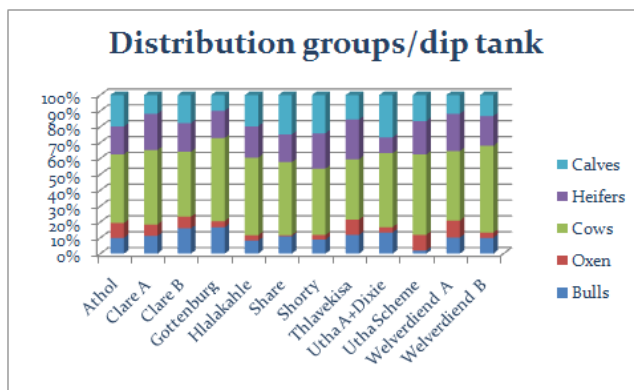


FIGURE 3 DISTRIBUTION GROUPS/DIP TANK

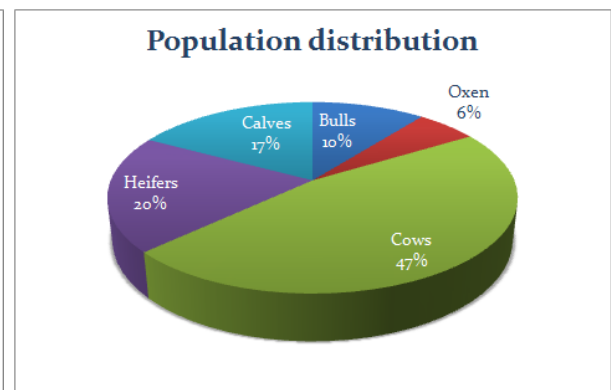


FIGURE 4 POPULATION DISTRIBUTION

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## RATIO

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The ratio bull:female and the ratio cow:calf is shown in Table 7. At the dip tank Utha Scheme substantial more female animals per bull than at the other dip tanks can be identified. This is remarkable. Generally, bull to cow ratio in the sweet rangeland was 1:28 whereas in the sour it was 1:32 and the respective cow-calf ratios were 5:2 and 3:1 (Mapiye, Chimonyo, & Dzama, 2009). According to Van Rooyen (Personal communication, 2010), Webb (Personal communication, 2010) and Ainslie (2002) the number of bulls in Utha Scheme is too low for a good reproduction, as the ratio has to be 1:25-30. Four of the twelve dip tanks have too little calves per cow in comparison to other communal rangelands.

TABLE 7 RATIO'S PER DIP TANK

	<b>Ratio</b> <i>Bull:Female</i>	<b>Ratio</b> <i>Cow:Calf</i>
<b>Athol</b>	1:6	2:1
<b>Clare A</b>	1:6	4:1
<b>Clare B</b>	1:4	2:1
<b>Gottenburg</b>	1:4	5:1
<b>Hlalakahle</b>	1:8	2:1
<b>Share</b>	1:6	2:1
<b>Shorty</b>	1:7	2:1
<b>Thlavekisa</b>	1:5	2:1
<b>Utha A+Dixie</b>	1:4	2:1
<b>Utha Scheme</b>	1:37	3:1
<b>Wilverdiend A</b>	1:7	4:1
<b>Wilverdiend B</b>	1:7	4:1

#### GENERAL HEALTH AND GENITAL SYSTEM BULL

The results give an impression of the fertility in bulls, but it was not possible to determine which bulls are fertile or infertile. It is therefore necessary to advocate the use of BBSE. The application of minimum standards to a set of acknowledged procedures will enable one to make a decision with regard to the breeding potential of the bull (Fordyce, Entwistle, Norman, Perry, Gardiner, & Fordyce, 2006; Irons, Nöthling, & Bertschinger, 2007). The BBSE requires that a bull must meet minimum standards in four categories namely: a general and reproductive physical examination, a scrotal circumference indexed for age, semen motility, and sperm morphology. These four categories are to be passed or failed individually; thus a bull must pass all four categories to be classified as a satisfactory potential breeder (Alexander, 2008).



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## BREED/BREEDING

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The breed of the examined bulls in the Mnisi area was for 42% Brahman (*Bos indicus*). The other breeds were Nguni, descendant of *Bos indicus* and *Bos taurus*, (33%), mixed (22%), Bonsmara, descendant of *Bos indicus* and *Bos taurus*, (1%) or Afrikaner, *Bos indicus*, (1%). 1% of the owners did not know the breed of their own bull. The identification of the breed was based on the owners' knowledge. It is possible that the owner thought that the bull is from a certain breed but actually it is not a pure breed but cross-breed. The main original breed is definitely the *Bos indicus*. *Bos taurus* bulls generally show higher, and less variable, levels of libido in test settings than do those of *Bos indicus* breeds (Chenoweth, 1997).

For a good reproductive performance the bulls have to be fertile. There are breed differences in age at which moment a bull will be able to service a female (Rasby, 2008). The majority of the bull population is Brahman (*Bos indicus*). *Bos indicus* cattle are known to be sexual mature at a later age than *Bos taurus* (Fields, Hentges Jr, & Cornelisse, 1982). Most of the bulls in the Mnisi area are over the age of 16-17 months, so they have to be fertile already (Silva-Mena, 1997).

40% percent of the owners use a specific bull or specific bulls for breeding. 72% of the owners are convinced that the bulls used in their herd are good enough for breeding in their herd, whereas 19% of the owners do not think that the bulls are good enough, 9,7% had no opinion. When an owner uses more than one bull for breeding there are social interactions (dominance) between bulls. Dominance is related to age and is a problem when bulls of mixed ages are used (Makarechian & Farid, 1985), since dominance is not directly related to either libido or fertility (Blockey, 1979; Rupp, Ball, Shoop, & Chenoweth, 1977).

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## AGE

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Most of the owners had to think hard about the age and in general did not know when the bulls were born. So the age is an estimate. The mean age, according to the owners,

is 3,7 years. This equals 3 years and 8 months. It ranges from 1 to 10 years with a standard deviation of 1,7 years. For a more precise age determination the teeth method should be used. This was tried but impossible to achieve information because it was too time consuming (delaying the dipping process) and even more important the bulls were not well restrained.

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#### GENERAL IMPRESSION

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To find out if the bulls were healthy, a general impression was inspected. The bulls have to be in a good physical condition to achieve high conception rates in the herd (Cumming, 2007). All the bulls behaved alert, the locomotion was in 99% of the cases good and 99% of the bulls had a good posture. Conditions such as chronic lameness, sole abscesses, arthritis, severe quarter cracks, interdigital fibroma's, and footrot can adversely affect mobility, mating ability, and libido (Chenoweth & Sanderson, 2001). The body condition score (BCS) had a normal distribution and is showed in Table 8. The mean BCS is 2.6 (SD  $\pm$  0.5) ranging from 1.5 to 4. The body condition of bulls is related to their reproductive activity. Extremely fat or thin bulls may have problems with semen quality, libido, or mating ability as well as bull fertility in general (Coulter & Kozub, 1989). Although the general impression was simple and quick, the results are valuable.

TABLE 8 BODY CONDITION SCORE BULLS

BCS	Frequency	%
1	0	0
1.5	2	2
2	18	20
2.5	41	45
3	18	20
3.5	10	11
4	3	3
4.5	0	0
5	0	0

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#### SHEATH

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The ideal sheath of the penis is light, loose, firmly and evenly attached to the underline for its whole length, does not have large areas of loose skin at the navel area (= X-shaped) or around the sheath. Bulls with X-shaped sheaths may have problems with accurately controlling the sheath during service. A penis hanging close to the ground increases risk of injury. The closer the sheath hangs to the ground, the more likely it is that the sheath will be irritated or injured (Want, 2005). Injuries to the penis and sheath may also prevent the bull from serving. The injuries may cause pain and swelling, and the penis and the sheath occasionally become infected, preventing the bull from extending the penis (Cumming, 2007). The sheath position was in 36% of the cases low, in 34% the position was on line and 22% of the sheaths was positioned high. Only 2% was lower and 6% was higher positioned. 49% percent of sheaths was Y-shaped, 34% was V-shaped and 17% was X-shaped. Although the total percentage of low+lower sheath is 38% and the X-shaped was 17%, mating was not observed if problems during mating were possible caused by sheath position.

10% of the bulls had a protruding prepuce. Prolapse of the prepuce is a serious condition causing infertility as it makes the bull unsuitable for mating (Cumming, 2007). However, all the bulls had a moist, fresh, pink prepuce that could be retracted and although it is not a problem it is a warning that the bull may prolaps in the future (Want, 2005). A protruding prepuce is most common in the *Bos indicus* breeds (Cumming, 2007). Only 5% of the bulls had outflow, whereof 3 bulls had blood outflow. For a proper assessment of the penis, it should protrude in total; only then an observation for shape and abnormalities is possible.

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### SCROTUM/TESTIS

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Four bulls showed abscesses on their scrotum and two bulls had wounds. 70% of the bulls had ticks on the balls. Some bulls (10%) seemed to have small balls. The scrotum and testes were asymmetrical in 70% of the bulls, 30% of the scrotum and testes were visible symmetrical. Zong-han did a study on the testis of mammals, birds, reptiles and amphibia and found that mammals show inconsistent asymmetrically sized testes. There was no regular pattern which testis left of right was heavier. He could not find an explanation for the observed asymmetry in testicular weight (Zong-Han, 1998). Although some variation in size between the two testicles in the bull is common, significant differences in size and shape of either testicle should be cause for further evaluation. A difference of more than 25% in the size of either testicle should be regarded with suspicion. The most common cause of marked scrotal asymmetry is unilateral testicular hypoplasia- a condition that might be presented as a putative “undescended” testicle (Chenoweth & Sanderson, 2001). For a detailed examination of the testes, a palpation should be carried out as well as a measurement of the scrotum circumference. It is a good method to determine the fertility of the bulls and it is an important part of the BSE. Scrotal circumference is a good indicator of sperm output. Testis size is highly correlated with daily sperm output, since sperm production per unit of testis volume is a constant figure (Coulter & Keller, 1982; Almquist, Branas, & Barber, 1976). Many reports have demonstrated that scrotal circumference is positively related to conception and/or pregnancy rates (Coulter & Kozub, 1989; Makarechian & Farid, 1985; McCosker, Turner, McCool, Post, & Bell, 1989).

## FERTILITY

### CALVING RATE AND RAINFALL

The cattle register shows the weekly newborns. From November 2009 until October 2010 2058 calves were born at fifteen dip tanks. On average a cow gives birth to 0,37 calve a year. That equals one calf in 2 years and 9 months. 41% of the calves were born in the first three months of 2010. See Figure 4. According to the questionnaire, 69% of the cattle calves at a specific time a year. 88,5% of cows calves in summer.

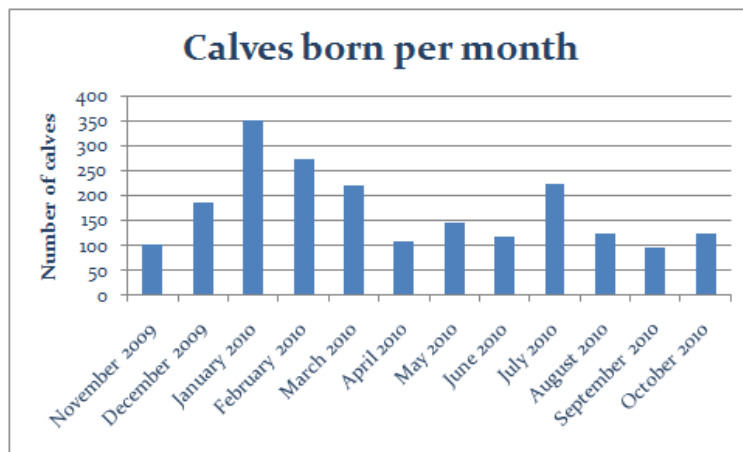


FIGURE 5 CALVES BORN PER MONTH MNISI AREA

An explanation has been sought in the rainfall. There is a strong relationship between rainfall, feed availability and cattle population dynamics (Agenas, Heath, Nixon, Wilkinson, & Phillips, 2006; Bebe, Udo, Rowlands, & Thorpe, 2003; Boone & Wang, 2007).

Perry et al. (1987) also suggested a seasonal tendency in calving pattern (Perry, Mwanuamo, Schels, Eicher, & Zaman, 1984). In Swaziland, both Brown (1959) and Butterworth (1983) have reported the marked seasonality in calving. The latter author found a normal unimodal curve of calf births with 57% and 55% of the annual total occurring in October to December in the High Veld and Middle Veld respectively (Brown, 1959; Butterworth, 1983).

Reed (1974) reported that it is clear that the majority of the calves in Botswana are born in the warm wet months between October and March and that the incidence of calving during the cold winter months is low. This cycle is not geared towards management practices but to seasonal climatic changes. During this rainy season the perennial and annual grasses grow rapidly, adequate grazing becomes available and the problem of getting the animals to watering points is less acute. As a consequence the cattle improves markedly in body condition and older calves which are suckling depend less and less on their dam for food and wean themselves. These factors predispose towards a much greater ovulation rate in breeding females. Therefore the bulk of pregnancies occur towards or just after the end of the rainy season when the cattle are in good physical condition. (Reed, et al., 1974)

The rainfall in the Mnisi area was measured from February 2009 until January 2010. Only 5% of the rain fell between April and October. See Figure 6. There is a significant correlation between rainfall nine months before calves were born en calves born:  $P=0,033$ .

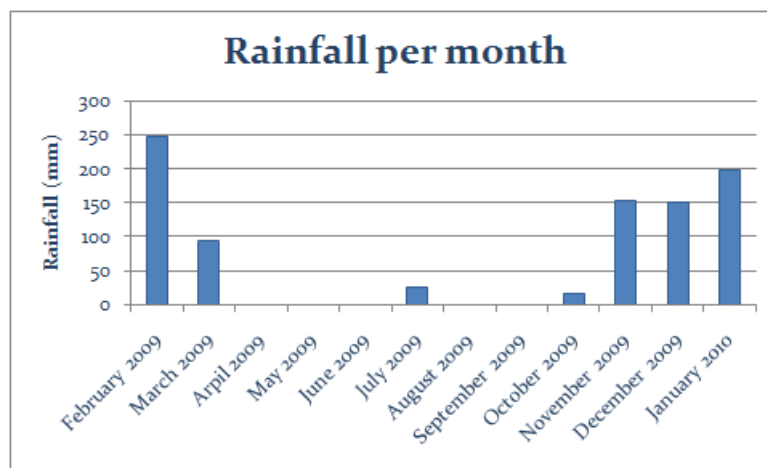


FIGURE 2 RAINFALL PER MONTH MNISI AREA

The calving rate was calculated from two different sources of data. One calving rate was based on the data of the register and the other calving rate was based on the data obtained from the questionnaire with the owners. According to the register the average calving rate is 17,1% (SD  $\pm$  2,5%) ranging 13,1% to 21,2%. According to the questionnaire the average calving rate is 21,2% (SD  $\pm$  7,4%) ranging 8,3% to 35,0%. The calving rate per diptank based on the cattle register is shown in Figure 7.

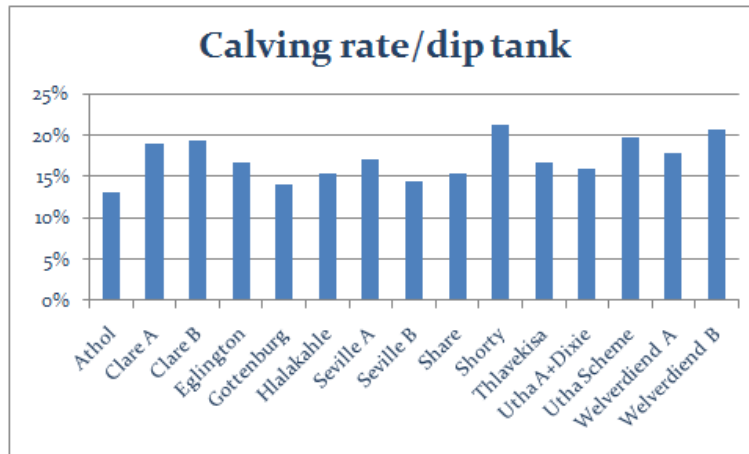


FIGURE 3 CALVING RATE / DIP TANK

The calving rate obtained from the cattle register is expected to be more reliable than the calving rate obtained from the questionnaire. Owners answered the question by giving the total number of calves born over the whole past year, but in the cattle register they have to tell the Animal Health Technician every week how many calves were born. Assuming that it is easier to remember the number of calves for a week than for a year, the calving rate obtained from the cattle register is the most reliable. According to the scatter plot, made to measure a difference in calving rates obtained from the register and from the questionnaire, there is no similarity between those two calving rates. There is no correlation,  $P = 0,681$ , between the cattle register and the questionnaire. At four of the twelve dip tanks the owners gave a lower number of calves born than the cattle register did.

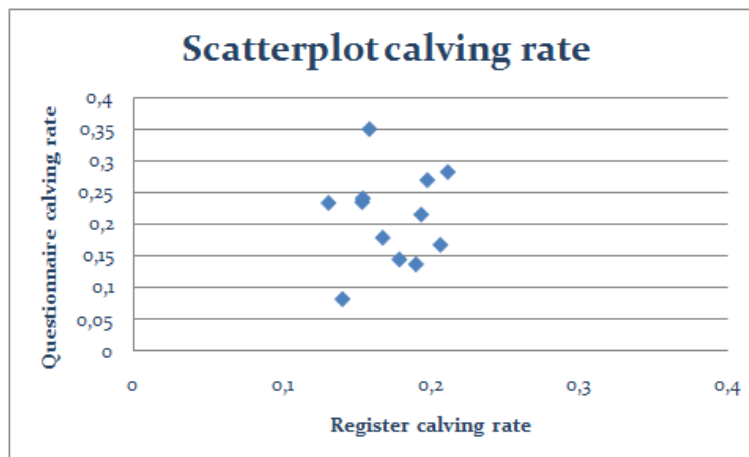


FIGURE 4 SCATTERPLOT CALVING RATE

A calving rate of 17,1% is quite low in addition to the following rates that were found in the countries mentioned in Table 9.

TABLE 9 CALVING RATES IN AFRICA

Country	Calving rate	Reference
<b>Botswana</b>	36% to 50%	(Reed, et al., 1974)
<b>Ethiopia<sup>1</sup></b>	55%	(Agenas, Heath, Nixon, Wilkinson, & Phillips, 2006)
<b>Mali</b>	55%	(Coulomb, 1970)
<b>Niger</b>	60%	(Coulomb, 1971)
<b>Niger</b>	63%	(Wilson & Wagenaar, 1983)
<b>Sudan</b>	40%	(Wilson & Clarke, 1976)
<b>Zambia</b>	44 to 88%	(Perry, Mwanuamo, Schels, Eicher, & Zaman, 1984)
<b>Zimbabwe<sup>1</sup></b>	40% to 52%	(GFA, 1987; Gubbins & Frankherd, 1983)

Overall, the average annual calving rate for the Mnisi communal herds was 17,1%. There was a positive relationship between calves born and mean monthly rainfall nine months before. Also Angassa (2007) found there were positive relationships between calving rates and mean annual rainfall. Calving rates for the regional herds were strongly correlated with mean annual rainfall. Also Angassa (2007) also found that in general bulls were less affected by inter-annual rainfall variability than reproducing cows and immature cattle (Angassa & Oba, 2007).

<sup>1</sup> Communal rangelands



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## ABORTUS

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The questionnaire showed that 39 cows had an abortion in that specific year. This is 4% of the cows. Most cattle herds suffer an abortion rate of 1-2%. If the abortion rate increases to 3-5% it should be of some concern (Bagley, 1999). 4% of aborted cows gives some concern, but is not that high that it gives a serious direction for the low calving rate. Furthermore, as the abortion rate is based on answers from the owners, it is not that reliable.

## CONCLUSION

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The survey gives an impression of the population distribution in the Mnisi area in South Africa. The Mnisi study area (=15 dip tanks) has 1,097 owners and they all together had 12,005 head of cattle at the time of the study. The average number of cattle that belong to a certain dip tank is 801. The average number of owners that belong to a certain dip tank is 73. The number of cattle and number of owners differs a lot between the various dip tanks. An average herd in the Mnisi study area consists of 17 head of cattle, divided into 2 bulls, 1 ox, 8 cows, 3 heifers and 3 calves. 52% of the owners have a small herd, 22% of the owners have a medium herd and 26% of the owners have a large herd. The average percentage of bulls, oxen, cows, heifers and calves at a certain dip tank are 11%, 6%, 46%, 19%, 18% respectively. The bull:female ratio ranges from 1:4 to 1:8 per dip tank, except in Utha Scheme, they have 1 bull for 37 cows; they have too little bulls for a good reproduction. Four out of twelve dip tanks did have a too low number of calves per cow in comparison to other communal rangelands.

Fertility is important to increase the cattle herd. Various factors do have an influence on the fertility: the bull, the female, the environment, nutrition and management. There has to be a balance of the aspects mentioned before for a good reproduction.

Many aspects influence good fertility of the bull. A few aspects were examined in this study. Differences in breed may expose differences in libido. In the Mnisi area the breed *Bos indicus* is particularly present. In general, this breed shows lower levels of libido compared to the *Bos taurus* breed. When a specific bull is used for breeding, dominance is not a problem, provided that one bull does not have to service too many females (>30). In that case the bulls are used optimally. 40% of the owners in the Mnisi area are using a specific bull. 72% of the owners believe that the bulls are good enough for breeding. Also the age is important for a good fertility. The bulls in the area have an estimated average age of three years and eight months, which means that they are sexual mature. They are old enough to be experienced. To achieve high conception

rates good physical health is important. The bulls in the area seem to be healthy. The sheath may be a threat for mating in cases the sheath is positioned too low or in cases where there is too much loose skin at the navel (X-shaped). 17% of the bulls had an X-shaped sheath and 38% of the sheaths was positioned low or even very low. The sheath may be damaged or causing problems during mating. 10% of the bulls had a protruding prepuce. It is not a problem yet but it is a warning because the protruding prepuce might become a prolapse. Consequently the bull is not suitable for mating. A marked discrepancy was the number of bulls, which had ticks on their scrotum. To measure whether bulls are fertile, a measurement of scrotum circumference has to be performed, or even a BBSE.

A result of the present fertility is the low calving rate. The calculated calving rate in the area is with a 17,1% quite low. A cow gets a calf every two years and nine months. A major share of the calves is born in the first three months of the year (January-March). There is a relationship between calves born and the rainfall nine months previously.

To find out more about reasons for the low calving rate, an extended survey should be carried out which includes both bulls and cows.

## ACKNOWLEDGEMENT

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I would like to thank Peter Vos, Professor of the Faculty of Veterinary Medicine at the University of Utrecht for giving me the opportunity to go to South Africa for my research internship and also for his support before and during the research internship.

I also would like to thank the people at the Department of Reproduction Animals of the Faculty of Veterinary Science at the University of Pretoria in Onderstepoort who did a lot of work behind the scenes for us. Particularly, Pete Irons en Gert Rautenbach, both professors of the Faculty of Veterinary Science, for their help in South Africa and with the research as our supervisors.

A great thanks for the always interested Jacques van Rooyen who showed us the study area, so we could make a better plan for carrying out the survey. He also supported me with the questionnaire.

Thanks to Dr. Dawie Blignaut, Dr. Louise Biggs and Dr. Koba Globbler for transporting us around in the Mnisi area while they had a lot of work to do. Thanks also for the tips and the helping hand.

Thank you to the incredible Animal Health Technicians: Gipsy, Jerry, Solly, PB, who informed the owners, explained 'why' to the owners, gave me the register and helped restraining the animals at the dip tanks.

Thank you, Philemon for being the interpreter and helping me out with the number of cattle, especially with the difficult ones.

I want to thank Dr. Louis van Schalkwyk, Station Manager Hans Hoheisen, for his advice at the research center. He gave many tips and facilitated us.

And last but not least, I really would like to thank Drs. Sebastian Claessens, the student who did research as well, for working and living together. It was a wonderful time in South Africa.

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### **Personal Communion**

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## APPENDIX

### 1. QUESTIONNAIRE HERD

#### SECTION A. INTRODUCTION

A1. Surveyor:

1	2	3
Emma Strous	Sebastian Claessens	Dawie Blignaut

A2. Owner: What is your full name?

*FREETEXT*

A3. What is your stockcard number?

*NUMERIC*

#### SECTION B. HERD STRUCTURE

B1. At what diptank do your cattle dip?

1	2	3	4	5	6	7	8
Athol	Clare A	Clare B	Eglington	Gottenburg	Hlalakahle	Seville A	Seville B

9	10	11	12	13	14	15	16
Share	Shorty	Thlavekisa	Utha	Utha Scheme	Wolverdiend A	Wolverdiend B	Other

B2. What breed(s) do you have in your cattle?

*DROPDOWNLIST*

1	2	3	4	5
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None	Indigenous breed	Mixed Breed	Bonsmara	Nguni
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6	7	8	9	10
Brahman	Afrikaner	Simmental	Don't know	Other: <i>FREETEXT</i>

B3. How many cattle do you own?

*NUMERIC*

B4. How many bulls do you own?

*NUMERIC*

B5. Do you use a specific bull for breeding?

1	2	3
Yes	No	Don't know

B6. Do you think your bulls are good enough for breeding in your herd?

1	2	3
Yes	No	Don't know

B7. How many oxen do you own?

*NUMERIC*

B8. How many cows do you own?

*NUMERIC*

B9. How many heifers do you own?

*NUMERIC*

B10. How many calves do you own?

*NUMERIC*

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SECTION C. REPRODUCTION

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C1. How many calves were born last 12 months? (since October last year)

*NUMERIC*

C2. How many calves were born alive last 12 months?

*NUMERIC*

C3. How many calves died the last 12 months?

*NUMERIC*

C4. How many cows got pregnant but had an abortion?

*NUMERIC*

C5. Does your cattle calve at a specific time a year?

1	2	3	4
Yes, summer	Yes, winter	No	Other: <i>FREETEXT</i>

C6. Did you cattle had any diseases during the last 12 months?

1	2	3
Yes	No	Don't know

C7. Can you name the diseases your cattle had?

*FREETEXT*

## 2. OBSERVATION BULL

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### SECTION A. IDENTIFICATION

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A1. Owner: What is your full name?

*FREETEXT*

A2. What is the name of the bull?

*FREETEXT*

A3. What is the age of the bull? How many persistent teeth does he have?

1	2	3	4	5	6
0	2	4	6	8	Other: <i>FREETEXT</i>

A4. What is the breed of the bull?

*DROPDOWNLIST*

1	2	3	4	5
None	Indigenous breed	Mixed Breed	Bonsmara	Nguni

6	7	8	9	10
Brahman	Afrikaner	Simmental	Don't know	Other: <i>FREETEXT</i>

A5. Colors bull:

*TICKBOX*

1	2	3	4	5
Red	White	Black	Brown	Other: <i>FREETEXT</i>

A6. Tattoos:

1	2	3
Yes	No	Don't know

A7. Brands:

1	2	3
Yes	No	<i>FREETEXT</i>

A8. Ear tags:

1	2
Yes	No

1	2	3	4
Left	Right	Both	<i>Description: FREETEXT</i>

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SECTION B. GENERAL IMPRESSION

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B1. Behaviour:

*MULTIPLE CHOICE*

1	2	3	4	5
Alert	Lethargic	Soporeus	Coma	Don't know

B2. Posture:

1	2	3
Ok	Not ok	Don't know

B3. Locomotion:

1	2	3
Ok	Not ok	Don't know

B4. Bodycondition score:

1	2	3	4	5	6	7	8	9	10
1	1.5	2	2.5	3	3.5	4	4.5	5	Don't know

B5. Lacrimation:

1	2	3
Yes	No	Don't know

B6. Salivation:

1	2	3	4
None	Low	Medium	High

B7. Nasal discharges

1	2	3	4
None	Low	Medium	High

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SECTION C. GENITAL SYSTEM

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C1. Sheath:

1	2	3	4	5
Lower	Low	On line	High	Higher

1	2	3
V	Y	X

## C2. Penis

### TICKBOX

1	2	3
Protruding prepuce	Outflow	Nothing visible

## C3. Scrotum/Testes

### TICKBOX/FREETEXT(6)

1	2	3	4	5	6
Symmetrical	Asymmetrical	Scar(s)	Abcessen	Fibromen	Other abnormalities: <i>FREETEXT</i>