AN INTEGRATED SYSTEM OF REPRODUCTIVE TRAIT IMPROVEMENT IN BEEF CATTLE UNDER COMMUNAL MANAGEMENT CONDITIONS

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AN INTEGRATED SYSTEM OF REPRODUCTIVE TRAIT IMPROVEMENT IN BEEF CATTLE UNDER COMMUNAL MANAGEMENT CONDITIONS

by

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BLOEMFONTEIN
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Declaration of independent work

I, NNDAVHELESENI DENNIS RAMANYIMI, do declare that this dissertation submitted for the degree MAGISTER TECHNOLOGIAE: AGRICULTURE is my own independent work that has not been submitted before to any institution by anyone or me else as part of any qualification.

.... 18-04-2001

Signature *Date*

Foreword

It is my wish that this dissertation serves to stimulate the breeding researchers to concentrate on the improvement of animals in a resource poor environment. The dissertation is presented in the form of two scientific publications from chapter four to chapter five. These chapters are preceded by chapter one, a general introduction that focuses on the history and origin of Nguni breeds, description of the conditions in which the animals of this study live, as well as the economic history of livestock production, and chapter two and chapter three consist of literature reviews where, chapter one concentrate on factors affecting the reproductive trait performance and chapter three focuses on the evaluation of scrotal circumference and its traits. The last chapter of this dissertation, chapter six, contains the general conclusions and recommendations. This chapter gives an overall assessment of the results obtained in this study in view of designing possible improvement strategies for beef cattle under communal management conditions.

Care has been taken to avoid unnecessary repetition. However, with the inclusion of two articles, some repetition was unavoidable.

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Dedication

I would like to direct these dedications to my family members: My mother (Munzhedzi), Judas and Ben Ramanyimi (Brothers) and lastly, my only sister, Jerminah Machaba, for their inspiration and confidence in me. To my son, Parsley Collens Ramanyimi, I will always remember you as part of my heart. Last but not least, a special dedication is directed to the memory of my late father, John Tshikhudo Ramanyimi, who passed away in 1998.

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Abbreviations

BCS	-	Body condition score
CD	-	Calving date
CR	-	Calving rate
CCETSA	-	Canon Collins educational trust for Southern Africa.
TFS	-	Technikon Free State
FSH	-	Follicle stimulating hormone
LH	-	Luteinizing hormone
kg	-	Kilogram
NRF	-	National Research Foundation
%	-	Percentage
PE TECH	-	Technikon Port Elizabeth
SC	-	Scrotal circumference
SA	-	South Africa
UNIVEN	-	University of Venda
UP	-	University of Pretoria

Chapter 1

General introduction

"The continual rise in the production cost of agricultural products of animal origin makes the question of profitable livestock mainly dependent on the fertility of the animal. In order to bring about an improvement in animal production it is necessary that one should have a sound knowledge of animal reproductive performance as a base line" (Bembridge, 1987).

There are many cattle breeds in Southern Africa. All cattle breeds may be classified into two major types, namely humpless and humped. The former group is taxonomically classified as *Bos taurus* and is exotic to Southern Africa. These breeds, introduced more recently into the country, are not necessarily well adapted to all South African environments. Humped cattle types may be classified into two groups, namely those with thoracic humps (Zebu) and those with cervico-thoracic humps (Sanga). Zebu cattle are also not indigenous to Southern Africa. All Sanga types evolved from crosses between Zebu and humpless types. Sanga cattle accompanied black tribes in their migrations towards the southern regions of Africa. These cattle are known in Zululand as the Nguni and in Northern Transvaal as the Pedi. The Sanga cattle breed in Zimbabwe and Zambia are known as Nkoene cattle and in Botswana as Tswana and Tuli cattle (Schoeman, 1989).

Livestock are raised in many different production systems or agro-ecosystems. Production systems evolve as a result of agro-ecological potential, the relative availability of land, labour and capital, and the demand for livestock products. Many production systems are currently at a sustainable equilibrium, with livestock being produced in harmony with nature and in environmentally sound systems. Livestock is a major component of agricultural production and always will be, because 80 to 85 percent of the South African can potentially be used for grazing only. Livestock production accounts for approximately 58 percent of the gross value generated by agricultural production (Bembridge, 1987). The majority of the livestock farmers are subsistence farmers. Attention is focused on large ruminants, with most emphasis on beef cattle since they offer the greatest opportunities. Approximately two thirds of the world's domesticated ruminants are found in developing regions where they produce 30 percent of the world's meat and 20 percent of the world's milk. However, their efficiency is only a quarter of that in developed communal farming due to low levels of nutrition and management in communal grazing areas (Bembridge & Tapson, 1992). Even so, 84 percent of the communal land in Southern Africa has a potential only livestock production, which contributes little to the cash economy.

There is a dearth of information on cattle production by small-scale stockowners in the less developed areas particularly of South Africa. Consequently, a considerable amount of research has been devoted to beef cattle fertility under intensive management conditions. However, little attention has been focused on the fertility of indigenous cattle under extensive communal management systems. Under extensive conditions, particularly in tropical and subtropical regions where animals are managed to survive under the stress of a resource poor environment. Cattle often experience prolonged dry seasons, nutritional deficiencies (drought) as a result of unreliable rainfall, as well as overgrazing due to overstocking, diseases and parasites, extreme temperatures and poor breeding strategies together with the utilization of traditional medicines in favour of modern medicines. These are viewed as the major factors that depress the overall herd fertility.

The objective of this study was to evaluate fertility traits as influenced by environmental factors in order to develop an integrated approach to beef cattle improvement under communal management conditions.

Chapter 2

Factors influencing the reproductive trait performance in beef cows

2. 1 Introduction

"Economic modeling of an enterprise where increases in number of calves born per year are achieved through improvement has been shown to result in an increase in profitability. " (Davis, Corbet, Mckinnon, Hetzel, Entwistle & Devon, 1988)

The level of fertility in livestock is a critically important aspect, determining overall efficiency (Rege & Famula, 1993). However, fertility is a complex process with many components. Measurements of reproductive performance in cattle include intercalving period, age at first mating, calving date, and number of progeny born per year. Calving date has traditionally been used to measure reproductive performance. A number of authors have suggested the use of calving date as a suitable reproductive measure for numerous reasons such as its association with gestation length (Lopez de Torre & Brinks, 1990 ; Ponzoni, 1992), calf growth and performance (Morris & Cullen, 1994), fertility of the dam (Buddenberg, Brown & Brown,1990) and reproductive fitness.

Lifetime reproductive performance can be potentially reduced by managing the age at which breeding female is first allowed to conceive and give birth (Schoeman, 1989). Age at first mating has been reported to be important for beef cattle producers because it affects cow size, weight, lifetime number of calves, and potential annual genetic progress. Under extensive conditions, the majority of beef heifers are mated to calve at three years of age. However, with good management, heifers may breed successfully at a much earlier age

(Schoeman, 1989). The major advantages of early mating ly in the potential increase of lifetime productivity of a cow due to the possible production of an extra calf (Scholtz,Lombard & Enslin,1991 and Van der Merwe & Schoeman, 1995).

In South Africa most heifers are not mated until they are three years of age. This is due to the fact that large areas of the country have a low and erratic summer rainfall, consequently limiting available grazing and resulting in sub-maximal pre- and post-weaning growth of calves. In this environment, replacement heifers attain the body weight that is considered adequate for mating only during the later stages of the second year, hence the delayed age at first calving (Meaker, Coetzee, Smith & Lishman,1980). It is therefore evident that the age at first calving is highly dependent on the environmental factors such as season or level of nutrition from weaning until first mating.

The aim is to review some of the female reproductive traits such as age at first mating, intercalving period, calving date and number of calves born as influenced by age, season, breed, body condition, body weight and pelvic width.

2. 2 Influence of age on the reproductive performance of cows

2. 2. 1 Age at mating

Doren, Long & Cartwright (1986) showed a positive relationship between age at first mating and days to conception, postpartum. Johnston & Bunter (1996) emphasised that the effect on reconception of age at mating is higher in one-year-old cows. Numerous researches have reported similar effects (Rege & Famula, 1993 and Ponzoni & Gifford, 1994). According to Meaker, Coetzee, Smith & Lishman (1980) mating of yearling heifers results in an increased rate of genetic improvement, the early calving of less productive animals, as well as increased total lifetime productivity. Additionally, when heifers are mated as yearlings, age at mating therefore becomes increasingly critical in heifer management demands. In contrast, Heile-Marium & Kassa-Marsha (1994) stated that the mating of heifers at such an early age might lead to a delayed onset of puberty, which leads to a reduction of reproductive performance. Similarly, around the time of puberty the reproductive mechanisms are still developing and the possibility exists that a fair proportion of the heifers may not have ovulated at the first standing heat. Heile-Marium & Kassa-Marsha (1994) found that only 30 percent of the yearlings exhibited oestrus by the start of the breeding season. These results are supported by earlier studies done by Schoeman (1989).

Mating a heifer at two or three years of age or after several oestruses may result in a higher conception rate than at the yearling age. This is supported by the results obtained by Haile-Marium & Kassa-Marsha (1994) who reported an average percentage conception for yearlings as low as 56 percent while two-year-old heifers had an 84 percent conception rate and three-year-old heifers had a 94.4 percent conception rate.

However, Nunez-Dominguez, Cundiff, Dickerson, Gregory & Koch (1991) argue that heifers never fully recover from the stress of mating if they are mated at two years of age. Similarly, heifers mated at two years of age apparently experience more nutrient demands for growth while rearing their calves. Lishman, Lyle, Smith & Botha (1984) reported that late-mated cows exhibit the poorest performance. The calf losses due to dystocia are heavier amongst the heifers mated at two years of age compared to those that are mated at three years of age.

2.2.2 Intercalving period

The age of the dam has an effect on the calving interval (Bourdon & Brinks, 1983). Young cows have a longer interval from parturition to the start of mating, thereby extending the subsequent calving interval (Garcia Palma, Alberio, Miervel, Grondona, Caorhlo & Schiersmann, 1992), i.e. three-years-old heifers have the longest calving intervals whilst cows older than six years have the shortest calving interval.

Table 2.1 indicates no precise trend in the calving interval due to sequence of calving. The first calving interval was longer than the subsequent calving intervals. This is because the cow needs more time to recuperate from the strain and stress of the first lactation (Ashok, Taylor & Gurug, 1982). Macgregor & Casey (1999) indicated that with respect to calving intervals, cows with the shortest calving intervals are the most fertile and reproductively the most efficient. Consequently, these cows are selected in preference to cows with longer calving intervals (Macgregor & Casey, 1999). Lopez de Torre & Brinks (1990); Macgregor & Swanepoel (1992) and Marshall, Mingiang & Freking (1990) found no correlation between age of dam and calving intervals. They further reported calving interval as a biased measure of reproductive performance when beef cows are mated during the restricted breeding season. This is attributed to their negative association with the previous calving date, which results in cows that calve early having the longest subsequent intervals.

Table 2.1 Average calving interval (in days) according to sequence of calving (Ashok *et al.*, 1982).

Sequence of calving	No.	Average calving interval	CV (%)
1st	112	514	27.21
2nd	76	462	25.03
3rd	51	478	34.39
4th	34	455	19.51
5th	23	462	21.96
6th	20	439	19.33
7th	13	460	25.87
8th	5	405	14.31
9th	4	406	14.44
Overall	338	478.17	27.01

2.2.3 Calving date

Ponzoni (1992) defines calving date as the number of days it takes a cow to calve within the calving season. It is a reproductive trait that is easily recorded and economically important. Buddenberg *et al*. (1990) claimed that for cows under natural mating systems, the approximate time of conception could be estimated from calving date. Calving date has also been reported to be influenced by age of dam (Bourdon & Brinks, 1983). Three-year-old heifers exhibited later calving dates than six-year-old cows (Azzam & Nielson, 1987; Buddenberg *et al* 1990; Morris, 1984; Rege & Famula, 1993 and Ponzoni & Gifford, 1994). In contrast, the effect of age on calving date is greatest for the one-year-old heifers (Johnston & Bunter, 1996). Thus selection for calving date could assist in achieving that end.

2.2.4 Number of calves born

Heifers calving first at two-years of age produce almost 0.8 more calves per cow over their entire production lifespan when compared to those calving first at three years of age (Meaker, Coetzee, Smith & Lishman,1980). However, Scholtz *et al*. (1991) showed 0.7 more calves from early calvers after a period of four years. Preweaning survival rate of calves from two-years was reported by Nunez-Dominguez *et al. (*1991) to be 1.5 percent lower than from heifers mated at three-years. Therefore it is concluded that if breeding heifers at two-years of age has no adverse consequences on subsequent reproduction and maternal performance, then the two-year system must yield greater lifetime performance, because this will potentially produce an extra calf.

In contrast, Morris (1984) found no differences between the two-and-three year-old cows for annual calving percentage and percentage of calves weaned. But they reported that the two-year cows exceeded the three-year cows by four calves weaned per cow lifetime. The difference in the number of calves weaned between cows calving first at two-years of age compared to those calving first at three-years of age, lasts until the age of seven years before it starts to decline. This suggests that culling of females for fertility at one year of age might be more effective at improving fertility than culling for infertility for the first time at two years of age.

2.2.5 Parity number

Differences between parities for days to conception postpartum are the greatest in early-bred heifers or yearlings (Doren *et al.,* 1986). Heifers bred at three years of age produce more calves than those bred at two-years of age. This can be ascribed to the fact that third-parity cows have already approached physiological maturity (Van der Merwe & Schoeman, 1995). In general, first-parity cows produce fewer calves than subsequent-parity cows.

2.3 **Influence of season on cow reproductive traits.**

2.3.1 Intercalving period

Season has an influence on calving interval and on days to conception postpartum. Cows that conceived in the spring, summer and autumn periods have been reported to calve for the most part in the autumn, winter and spring respectively (Doren *et al.*, 1986). This can be attributed to the greater nutrient availability during the summer and spring pastures and with the exception of those cows, which calve in the autumns the cows, have access to high quality nutrients over most of the calving interval. Furthermore, cows that conceived in the winter and autumn periods may have been subjected to lower nutrient availability and quality compared to the summer forages. Conception during spring and summer may be delayed by cold conditions shortly after parturition (Doren *et al.*, 1986). These cold and humid conditions in the winter are accompanied by the fact that cows had just begun grazing on winter pastures with possible residual effects of summer and late-autumn grazing. This has an extending effect on the calving interval for the cows that conceive during the winter.

High ambient temperatures during the summer are expected to cause physiological stress, which inhibits conception as well as oestrus behavior and detection. From the study by Lopez de Torre & Brinks (1990) calving season affects the calving interval, with cows calving in the fall rebreeding earlier than those that calved during spring. Deutscher, Sttots & Nielsen (1991) discovered that cows calving in April have a shorter period from calving to reconception. This is also due to the fluctuation of temperatures and nutrient availability. In general, poor conception rates of cows are primarily caused by inadequate nutrition.

2.3.2. Calving date

According to Deutscher *et al.* (1991) cows conceiving late in the calving season are more fertile earlier in the breeding season, such as in autumn. This is attributed to the availability of quality pastures during the summer season. Thus a short breeding season may be more appropriate for cows being bred to calve in autumn than in any other season. Cows calving in summer generally calve during the following season, whereas those calving in spring are likely to remain open until the following season (Lopez de Torre & Brinks, 1990). Later calving in the spring is associated with changes in photoperiod, temperatures and pasture availability, which affect the resumption of the ovarian cycle. Montgomery, Scott & Hudson (1985) reported that early calving cows tend to calve about a month later than in the previous season. Others found that those calving early have a greater chance of higher pregnancy rates (Deutscher *et al.*, 1991).

Macgregor & Casey (1999) claimed that cows calving late during a fixed calving season would eventually not conceive. This is because the period between calving and the first subsequent oestrus will result in a very short active exposure time to the bulls. This is in line with Notter & Johnston (1988), Newman & Deland (1991) and Rege & Moyo (1993).

2.3.3 Calf survival

Calf losses shortly after birth are higher in spring due to wet and cold ambient conditions (Bagley, Carpenter, Feazel, Hemry, Huffman & Kooce, 1987 and Newman & Deland, 1991). Similarly, several late-term aborted foetuses occurred during spring calving. These losses reflect on herd fertility.

2.4 **Influence of breed differences on cow reproductive traits**

2.4.1 Age at mating

There is a high correlation between the breed and the age at mating. The Nguni breed reaches puberty at an earlier age of two-years compared to exotic breeds such as the Simmental breed, which reaches puberty at three-years (Lepen,Schoeman & Venter,1993). Also, Nguni heifers may be mated successfully between 13 and 18 months of age. This early mating of Nguni heifers may also aid at selection for early calving, which will increase cowherd productivity. Apart from Nguni breeds, Martin *et al*. (1992) reported that Brahman heifers usually attain mating age at three-years. However, Martin Brinks, Bourdon & Cundiff (1992) attributed the average difference in age at mating between breeds to the additive effects of genes present in diverse frequencies between breeds.

Lepen *et al*. (1993) stress that even if Nguni breeds reach mating age earlier, calving difficulties are rare. Nunez-Dominguez *et al*. (1991) found a 47 percent calving difficulty in the Hereford cows first mated as yearlings versus two percent in those mated at two years.

2.4.2 Intercalving period

The intercalving period amongst breeds varies. Red Angus are cows calved earlier and have been reported to have shorter calving intervals. Hereford cattle have a longer calving interval compared to Angus cattle, calving on average two to eight days later (Bourdon & Brinks, 1983). Table 2.1 clearly indicates that the fertility of Sanga and Nguni breeds is exceptionally high. Other studies conducted by Holmes, Mckinnon, Seifart, Schotter, Banniek & Malik (1992) between two breeds (Brahman and Shorthorn) found that the calving rate of Brahman cows was 98 percent while that of Shorthorn cows was 104 percent. Shorthorn heifers breed for the first time on average 134 days earlier than Brahman heifers. Calving intervals of Shorthorn cows were consistently 19 days shorter than those of Brahman cows at all parities.

2.4.3 Calving date

Rege and Famula (1993) reported a small correlation between calving date and fertility in Hereford cows. Numerous researchers obtained similar results (Macgregor & Swanepoel, 1992 ; Macgregor & Casey, 1999). However, Meacham & Notter (1987) found a genetic variation that exists for first calving date in Simmental cattle and which could be used to evaluate reproductive efficiency.

2.5 Body condition and nutrition

Body condition score (BCS) has been implicated as the most important factor influencing the reproductive performance of beef cows (Spintzer, Morrison, Wettermann & Faulkner, 1995). Cows with good body condition ensure earlier return to oestrus and earlier rebreeding than cows with poor body condition. This is in line with Richards, Spintzer & warner, 1986) who found the onset of oestrus to be delayed in heifers mated in a low BCS. From the study conducted by

Richards *et al* (1986) cows calving in BCS of at least five on the scale of one to nine have fewer days to first oestrus and therefore fewer days to conception. Cows with a low BCS, especially before parturition, have a longer postpartum interval (Bartle, Males & Preston, 1984 and Wiley, Peterson, Ansotegus & Bellows, 1991). There is an increase in numbers of calves' born and weaned as a result of good body condition. BCS also influences calf weight gain, birth weight and calf vigour (Bartle *et al.*, 1984, Goehring, Corah & Higgins, 1989 and Wiley *et al.,* 1991).

The level of nutrition influences the postpartum reproductive performance in beef cows (Rasby, Wetterman, Geisert, Rice & Wallace, 1990). Adequate nutrition both pre-and-postpartum are of vital importance in sustaining good reproductive performance, particularly in beef cows. It is also found that a rising plane of nutrition during the breeding season is the most important requirement to secure a large calf crop. This is similar to the findings of Perry, Corah, Cochran, Beal, Steveson, Mintou, Simms & Brethour (1991) who demonstrated that good body condition as a result of nutrition influence follicular growth and ovulation in cows. This is supported by Meaker, Coetzee & Lishman (1980) who supplemented the cow 's diet with hay from calving until three weeks after service and recorded a 65 percent conception rate. Goehring *et al.* (1989) found that fertility expressed, as days to conception, and number of inseminations per conception on first-service overall conception rates, did not differ between nutrition levels.

Nutrition influences the secretion of hormones such as FSH, LH and progesterone (Imakwa, Day, Garala-Winder, Zalesky, Kittok, Schanbacher & Kinder, 1986 and Nolan, Bull, Sasser, Ruder, Panlasiqui, schoeman & Reeves, 1988). Richards *et al.* (1986) found that energy restriction during the late pre-partum periods extend the interval to first postpartum oestrus and decreases the likelihood of a high percentage of cows exhibiting oestrus early in a breeding season. A low plane of nutrition will have a greater effect on interval to oestrus in early-calving cows. Macgregor & Swanepoel (1992) concluded that inadequate nutrition is a greater cause of lowered fertility in beef cows.

Table 2.2 Intercalving periods (days) of beef cattle breeds (Schoeman, 1989).

Breed	Barnard & Venter (1983) (1977-1982)	Schultz (1988) (1979-1985)	Lepen (1988) (1972-1986)
Afrikaner	460	469	
Hereford	462	423	
Sanga	372	–	
Nguni	–	412	419
Bonsmara	–	434	
Simmental	416	449	

2.6 Influence of body weight

"The ability to conceive is a function of body weight per se and not of gain during the postpartum period" (Macgregor & Swanepoel, 1992).

Body weight at the beginning and end of the breeding season influence the rate of conception especially in two-year-old cows mated for the first time (Meaker, Coetzee & Lishman, 1980). Moreover cows gaining in weight before calving have a greater likelihood of oestrus at 50 days postpartum than those losing weight. Richards *et al.* (1986) observed a calving rate of 100 percent when the weight of cows at mating was high and a rate of 60 percent when the weight of cows was low. The tendency is that conception occurs more readily as the body weight increase., Scholtz *et al.* (1991) indicated that as body weight decreased, reconception also decreased linearly from 87 to 25 percent. This relationship supports the contention that a critical or target weight must be attained before conception is likely to occur (Table 2.3). Thus, reproductive ability of cows will probably decline concurrently with a decrease in body weight below the target weight. For instance, Scholtz *et al.* (1991) found that Nguni heifers should have a weight of 215 kg at the start of the breeding period in order to conceive. If body weight increases above the target weight, cows will tend to become sub-fertile due to excessive deposition of fat. In conclusion, the greater the loss in body weight over the period the lower the subsequent calving rate.

Table 2.3 Suggested target weight for British beef-type cows at joining to ensure maximum conception rates (Meaker, Coetzee, Smith & Lishman (1980)

Age group	age and number of times mated	Suggested target weight
1	1year mated 1st time	280kg
2	2 years mated 1st time	330kg
3	2 years mated 2nd time	390kg
4	3 years mated 2nd time	410kg
5	3 years mated 3rd time	441kg
6	4 years irrespective of matings	460kg
7	Adult irrespective of mating	510kg

2.7 Pelvic width

Pelvic width is considered because it is associated with calving difficulty. Calving difficulty is a major problem in the beef cattle industry and results in considerable economic loss (Kriese, Vleck, Gregory, Boldman, Cundiff & kock,1994). According to Richards *et al.* (1986) cows that have had calving difficulty before will take longer to re-conceive and as a result need more services per conception. This is similar to Naazie, Makerechian & Berg (1989), who state that cows that have experienced calving difficulty previously have longer intervals from calving to first oestrus and from calving to conception.

2.7.1 Breed differences in pelvic width

A study conducted by Kriese *et al.* (1994) with breeds such as Charolais, Pinzgauer, Limousine, Redpoll, Hereford, Angus and Simmental reveals that there is a greater difference between breeds in pelvic width and height and consequently pelvic area. Simmental, Charolais and Pinzgauer have a smaller pelvic width and/or pelvic area and thus carry greater risk of calving difficulty.

2.8 Conclusion

The objective of this paper was to review some of the factors that influence the reproductive performance in beef cows. From the literature cited, it is evident that these factors make a major contribution to the variation of cow fertility. However, many researchers prefer cows to be mated at two years of age due to the associated lifetime productivity from an economic point of view. The Nguni cattle breed displays the potential to calve at approximately two-years of age, and lifetime fertility is positively affected by this early mating. In exotic breeds, the three-year-old mating system is preferred.

Therefore, improvement in fertility of the herd has to come from improved management, which includes better data recordings, timely culling of cows with a longer calving interval, and higher age at first mating (calving). In this context emphasis must be placed on to the importance of the time of calving chosen for the herd, because it will influence the nutritional status of cattle and consequently their productive potential. Therefore the challenge to management is to seek and achieve the highest possible percentage of calving at the beginning of the calving period.

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Chapter 3

Evaluation of reproductive performance in beef bulls as influenced by environmental factors

3.1 Introduction

Scrotal circumference (SC) measurements are associated with testis development, total sperm production and quality. Clinical examinations for fertility of bulls are vital to ensure high conception rates. Kriese, Bertrand & Benyshek (1991) argue that the number of sperm produced by domestic animals is of economic importance to breeders. Sperm production rate can be used to evaluate the effects of certain stimuli upon the process of spermatogenesis. The methods used to measure sperm production have been based on testicular histology, testicular spermatid reserves, extra gonadal sperm reserves, daily sperm output in ejaculate semen, and direct recovery of sperm through a cannula in the vasa differentia. Godfrey, Lunstra, Jeckins, Berardilli, Guthrie, Neuendaff, Long & Randel (1990) stated that the fertility of a bull could be predicted from semen morphology. The sperm motility and morphology are two important traits used along with SC in a breeding soundness evaluation to evaluate a bull's breeding potential.

The objective of this paper is to evaluate bull reproductive performance as influenced by factors like age, breed and season. Traits that will receive attention are SC, testicular parameters and semen characteristics while some interaction between the traits will also be discussed.

3.2 The effect of age on the reproductive performance of the bull.

3.2.1 Scrotal circumference

The age of an animal has a positive influence on its SC. This influence was found to be quadratic by Bourdon & Brinks (1986). Three-year-old bulls were found to have the largest SC, subsequently increasing at a diminishing rate, as the bull gets older, heavier and taller. At the age of 10 to 12 months, there is a rapid proliferation of testicular parenchyma development (Quirino & Bergmann, 1998). This supports the evidence that the SC of a young bull is an important trait in a selection programme. The study by Makarechian, Farrd & Berg (1985) recorded that the two-year-old bulls was 25 percent smaller while the SC was only 64 percent larger than that of yearlings. Similarly, Swanepoel & Heyns (1986) recorded a mean of 37.8cm at 13 months of age with a coefficient variation of 5.34 percent. Therefore it is proposed that bulls older than 12 months and with an SC of less than 32cm be culled when exotic breed bulls are selected (Latimer, Wilson, Cain & Stricklin, 1982).

Scrotal circumference is also reported to be the best indicator of puberty in bulls. Toelle & Robinson (1985) obtained results that show a favourable relationship between SC and age at first mating. Kriese *et al.* (1991), however, disagree with this correlation. They reported a negative correlation between SC and age at puberty in both males and females, while, Bourdon & Brinks (1986) proposed that further research is needed to determine whether this measure of SC has value as an indicator of age at puberty in bulls and whether it has any particular advantages in this regard.

There is also a relationship between the age of the dam and SC (Bourdon & Brinks, 1986). Quirino & Bergmann (1998) found all dam age group categories an important source of variation in SC. Moreover, this effect of dam age on SC is different for bulls whose dams differ in age. Scrotal circumference increases with increasing age of the dam, but starts to decline from about six years of age (Toelle & Robinson, 1985 and Martin, Brinks, Bourdon & Cundiff, 1992). A similar trend has been reported by Kriese *et al.* (1991) and Kriese, Vleck, Gregory, Boldman, Cundiff & Kock (1994), namely that cows at the age of eight to ten years of age start to produce bulls with smaller SC.

3.2.2 Testicular parameters

Scrotal circumference is correlated with testicular parameters such as testis length and weight (Neely, Johnson, Dillard & Robinson, 1982). This correlation is in line with those reported by Latimer *et al.* (1982) and Toelle & Robinson (1985). The rate of testicular growth starts at a lower rate at one year of age and then increases in pace with development after one-year of age. The increase of testis weight results from an increase in the proportion of the parenchyma tissue occupied by the total length of the semniferous tubules per testis and increases in testicular diameter. However, this is more visible at the age of between 24 and 32 weeks. The sertoli cells appear first at 20 weeks of age when testis weight averages 31 grams and their formation are completed at the age of 28 weeks (MacDonald & Deaver, 1993). This results in the initiation of spermatogenesis. Sertoli and germ cell functions are different in the pubertal bull, and the morphology of sertoli cell nuclei changes as the first four generations of spermatocytes degenerate, thereby resulting in low efficiency of sperm production.

3.2.3 Scrotal circumference and semen quality and quantity

Scrotal circumference is also correlated with total sperm production, especially in growing bulls. It plays an important role in breeding soundness examination (Kriese *et al.*, 1991). There is an improvement of sperm production with the aging of the bull (Neely *et al.,* 1982; Bourdon & Brinks, 1986 and Ying-Tsorn-

Haung & Johnson, 1996). From the study conducted by Mathevan, Dekkers & Burr (1998) it has been found that semen concentration is lower at 13 to 16 months of age and then increases until the age of 50 months. Similarly, the efficiency of sperm quantity in bulls reaches the adult level approximately at six years of age after the initiation of spermatogenesis. These results correspond significantly with those reported by Garner *et al.* (1996) and Curtis & Amann (1981). Semen concentration generally increases to 20 months of age and remains constant until 38 months (Rathjie, Johnson & Lunstra 1995, Mathevan *et al.*, 1998 and Ying-Tsorn-Huang & Johnson 1996).

Mathevan *et al.* (1998) found a quadratic relationship between age of the bull and semen quality where semen quality is based on sperm motility, morphology and biochemical parameters. This relationship however, was found by Ying Tsorn Haung & Johnson (1996) to be negative with regard to sperm volume. Humblot, Ducrog & Nemeth (1993) reported a lower effect of age on sperm motility. Semen characteristics of two-year-old bulls are generally superior to those of yearlings, but this difference is significant only for concentration and percentage of acrosomes. Makarechian *et al.* (1985) argue that the value of SC as a predictor of semen quality and quantity is still controversial.

3.3 The effect of breed differences on bull reproductive traits

3.3.1 Scrotal circumferences

Major differences exist between the SC of the different breeds. Hereford, Angus, Nguni, Shorthorn breed and PeeWee have a smaller SC while Charolais; Simmental and Brahman breed bulls have a larger SC. But the scrotal length of Hereford, Angus and Charolais bulls has been reported as being similar, although the mean scrotal width of the Simmental is greater than that of Angus and Charolais bulls (Latimer *et al.*, 1982 and Makarechian *et al.*, 1985). It has been reported that even though the Nguni breed has the smaller SC it can still produce more calves, which can be attributed to its high fertility competency. This breed difference reflects a considerable opportunity to use genetic differences among breeds to optimise additive genetic value in order to meet a wide range of production situations. Several researchers found a genetic correlation between additive and maternal effects for SC among breeds (Gregory, Lunstra, Cundiff & Koch, 1991 and Kriese *et al.*, 1991).

Scrotal circumference, average testicular length and paired testicular volume are larger for Pinzgauer, Simmental, Brown Swiss and Gelbviech breeds, and smaller for Limousin, Hereford and Nguni breeds. Brahman bulls have smaller testes than Hereford bulls.

3.3.2 Semen characteristics

Breeds like Brahman bulls have been found to have smaller testes than Hereford bulls. This explains the difference in sperm concentration as there is less spermatogenic tissue in Brahman bulls at a specific age (Godfrey *et al.*, 1990). The testicular size of Holstein bulls is greater than in Angus bulls. The larger testis size is favourably correlated with increased sperm output and semen quality (Lunstra, Gregory & Cundiff, 1988; Keeton, Green, Golden & Anderson, 1996; Latimer *et al.*, 1982 and Gregory *et al.*, 1991). Brahman bulls have a lower sperm quality and motility and a higher abnormal sperm concentration than Hereford bulls. This is also similar in Angus bulls. Hereford bulls have lower ejaculate volume than Brahman and Angus bulls (Godfrey *et al.*, 1990). However, Brahman bulls have a lower daily semen production than Hereford bulls.

3.3.3 Breed and age interaction with sperm characteristics

According to Fields, Hentges & Cornelise (1982) 15-to-16 month-old Hereford and Brahman bulls have more abnormal sperm cells than Angus bulls of the same age. This difference in percentage of sperm cells between breeds is also described in the study by Godfrey *et al.* (1990). The percentage of normal sperm cells increases with age in certain breeds, as has been observed in Brahman and Angus bulls. Generally, there is no difference in sperm concentration between these breeds at any age (Fields *et al.*, 1982).

3.4 **Seasonal influence on bull reproductive traits**

3.4.1 Scrotal circumference

Season influences the SC, as well as the scrotal length, width and total scrotal volume (Neely *et al.*, 1982). The effect of season on SC was more pronounced in yearlings than in three-year-old bulls. The season as well as the length of the photoperiod are known to influence testicular size in many mammals (Curtis & Amann, 1981). Bulls born in summer and spring tend to have a greater SC due to the availability of good pastures.

3.4.2 Semen characteristics

Season and the length of the photoperiod are also known to influence the spermatogenesis. Seasonal variation on semen production and semen quality has been observed by Mathevan *et al.* (1998), but no clear pattern of the effect of season on volume of the sperm was found. When season affected the concentration of sperm, poorer results were obtained in late winter to spring. This could be due to environmental factors such as ambient temperature, humidity, nutrition quality and availability, as well as day length. Mathevan *et al.* (1998) argue that there is a slight increase in semen output during summer and a decrease in semen volume during an exceptionally dry summer. Furthermore, seasonal changes could also be accompanied by a modification in diet, which might influence semen production.

Semen quality can be influenced by temperature or stress (Godfrey *et al.,* 1990 and Wildeus & Entwistle, 1984). Futhermore, raising the scrotal temperature of bulls increased the percentage of sperm cells with ectoplasm droplets. Heat stress may have an effect on epipidymal function and sperm maturation. This seasonal influence on fertility may be amplified where winters have shorter day lengths and cooler temperatures.

3.4.3 Season and breed interaction with semen characteristics

Brahman bulls are more susceptible than Hereford bulls to seasonal influences, especially on semen quality. Semen quality was found to decrease in Brahman bulls in the winter. This is due to the shorter day lengths and cooler temperatures. According to Godfrey *et al.* (1990), even though the Brahman bull has lower semen viability during winter it is able to return to higher levels at a time of year when the sperm-producing capability of a bull is most critical for spring calving. Sperm concentration in Hereford bulls increases to levels greater than that of Brahman bulls during the winter, but during the warmer periods the sperm concentration of Brahman bulls becomes comparable to that of Hereford bulls.

3.5 **Conclusion**

Environmental factors are a source of variation in SC and testicular development as well as semen characteristics. Thus SC is a good indicator of semen quality and quantity and bull fertility. Therefore selection for increased SC is an effective way to increase sperm concentration, and together they are generally considered in breeding soundness examination. The use of breeding bulls with a large SC and good-quality semen is advantageous and such bulls are recommended for use, particularly under heavy breeding pressure. This knowledge of the correlation of environmental factors such as season on bull fertility will help the breeder(s) to adjust and adapt the management of their bulls in order to improve the fertility in the herd.

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Chapter 4

Evaluation of adaptive and reproductive performance of beef cattle under communal management conditions.

4.1 Introduction

It has been speculated that the reproductive performance of indigenous breeds is extremely low (Schoeman, 1989). The main reason for this low performance was later recognised to be environmental rather than due to communal grazing. As a result, the majority of past studies have been limited to the assessment of effects of environmental factors (Heile-Mariam & Kassa-Marsha, 1994). High rates of reproduction in a beef herd are directly related to the profitability of beef production. Houghton, Ducrog & Nemeth (1990) describe this profitability as influenced largely by the percentage of cows in the herd that consistently are able to maintain a short calving interval. Therefore, before reproductive performance can be improved, it is essential that a suitable measure of reproductive performance is found. This study focused on the body condition score, scrotal circumference and calving rates (fertility), as well as skin thickness (adaptability).

Body condition is defined as the ratio of the amount of non-fatty matter in the body of the living animal. Terms such as 'lean', 'store' and 'fat' have been and continue to be used to describe the body condition of various classes of livestock (Wright & Russell, 1984). Many studies have indicated that the reproductive performance of beef cows varies according to body condition at specific stages of a production cycle (Spintzer, Morrison, Wettermann, & Faulkner, 1995). In agreement, body condition influences interval from calving to first oestrus, as well as pregnancy rate (Houghton *et al.*, 1990 and Richards, Spintzer & Warner, 1986). These findings mean that body condition of the beef cow both before and after parturition is important in predicting the rate of reproductive success of the cow (Wiley, Perterson, Ansotegus & Bellows, 1991). The calving rate (CR) in a beef herd is one of the greatest factors influencing success in the ranching operation. The calving rate influences the economic returns and also the genetic improvement of the herd (Warnick, Kirst, Burns & Kroger, 1967). This implies that a cow must calve every year.

Scrotal circumference (SC) is a potentially useful indicator of reproductive potential in bulls. This is because it is highly correlated with total sperm production and quality and therefore plays an important role in breeding soundness examination (Bourdon & Brinks, 1986). Similarly, Mcneil, Newman, Enns & Steward-Smith (1994) and Mcneil & Newman (1994) stated that a major factor affecting a bull's reproductive performance is the measurement of testis size, and it is the simplest approach for selecting bulls especially at a young age (Quirino & Bergmann, 1998; Humblot, Ducrog & Nemeth,1993).

The objective of this study therefore is to evaluate the influence of environmental factors on Body condition score (BCS), Calving rates (CR), Scrotal circumference (SC) and Skin thickness (ST) for beef cattle under communal management conditions.

4.2 Materials and methods

4.2.1 *Study site*

The study was conducted at Muledzhi communal dipping tank, which is composed of four villages, namely Tshithuthuni, Muledzhi, Vuvha and Mapate. This dipping tank is located 50km north of Thohoyandou in the Northern Province, approximately at 22,41^{0}s latitude and 30,16^{0}e longitude. The average rainfall is approximately between 1200 and 1400mm annually with a high percentage of this rain falling during the months of January to March. The climate is generally referred to as semi-tropical (seasonal rainfall with hot, wet summers and cool, dry winter). The vegetation type is savanna mixed with bushveld.

4.2.2 *Animals and management*

The area is dominated by Nguni-type breeds. However, there are a few other breed types such as Simmental, Brahman, Bonsmara, Jersey, Friesian and Afrikaner as well as crosses. All these animals were earmarked with ear tags at the beginning of the study for identification purposes during subsequent measurements.

4.2.3 *Data*

Data for BCS and SC were collected over a period of five months i.e. September, October, December (1999) and May and July (2000). Data for ST were collected over the period of three months i.e. September, October and December, and for calving rates collected from 1997 to 2000 (October). Data consisted of 1374 records of BCS, 209 of SC and 452 of ST. The estimated herd composition for the animals used for calving rates (in percentage): Bulls (9%), dams (33%), young animals (34%) and oxen (18%).

Body condition score was assessed on the scale ranging from one to five (1 = emaciated and 5 = obese). Scrotal circumference was measured in a greater diameter using a flexible measuring tape, and skin thickness was measured by skin caliber. All these measurements were done by the same person from the beginning to the end of the study. Measurements were taken from cattle of all ages (<1 to >5 years of age).

4.2.4 *Statistical analyses*

The analyses were performed using the General Linear Models procedure of SAS (Statistical Analysis System) (1989). The models included the effects of village, age, month and sex, as well as their interaction. The following models: I for BCS,and II for SC and ST were used to analyse sources of variation.

Model I Yijkl = $\mu + R_i + S_j + M_k + A_l + S_jA_l + E_{ijkl}$

Model II Ykl = $\mu + M_k + A_l + A_lM_k + E_{kl}$

Where:
- μ = Overall mean
- R = Effect of village
- S = Effect of sex
- M = Effect of month
- A_l = Effect of age
- S_jA_l = Interaction between sex and age
- A_iM = Interaction between age and month
- E_{ijkl} = Random error effect

4.3 Results and Discussion

4.3.1 Factors affecting body condition score

The results of Analysis of Variance are presented in Table 4.1. These results indicate that all the effects (village, age, sex and month) included are a significant source of variation for BCS. Least square means and standard errors for the effects of village, sex, age and month are given in Table 4.2.

Village. The body condition score of cattle was found to vary ($P<0.1$) between villages. Cattle from Vuvha village had a high BCS compared to other villages. This was mainly due to the differences in the type of pastures and vegetation, as well as the low stocking rate in Vuvha village compared to others. Low stocking rate results in efficient utilisation of veld in this village. The results are supported by the findings of Nelsen, Short, Reynolds & Urick (1985) who found that BCS is lower in cattle grazing pastures of lower nutritional level when compared to those grazing pastures of a high nutritional level.

Sex. The sex of the animal has a significant influence (P<0.01) on the body condition of the cow. As reported in other studies, male animals are usually fatter than the females. This is because male animals, especially oxen, have a greater ability to deposit high-energy reserves due to their reduced level of activity compared to females. Bellows, Saignller, Carr & Short (1982) attributed this to the direct additive genetic effect in prenatal growth in males, which also increases the body composition. In support of the above, male animals always exceed the females in all body dimensions except the body length. The main reason for these differences is that male animals do not give birth and suckle calves, and consequently stand a better chance of storing high-energy reserves compared to females. Females always give birth and are suckled by their calves and as result struggle to maintain the calves as well as their body composition. This results in cows losing more condition. This was observed by Houghton *et al.* (1990) who indicated a possible interactions between nutritional status and body condition of the cows and suckling. Donaldson (1969) found a lower BCS in lactating cows. Furthermore, Houghton *et al.* (1990) observed that when energy intake is marginal, suckling and subsequent nutritional stress of lactation may reduce the energy available for reproduction. This suckling status of a cow, which affects the BCS, may reduce the reproductive performance. Other researchers reported a slight advantage in pregnancy rate for cows subjected to a once-daily suckling management procedure compared to normal suckled cows.

Age. Age cause variation (P<0.0001) in BCS. The Least Square Means (Table 4.2) show that BCS fluctuates as the cattle age increases. Thus there is a considerable decline in body condition from the age of one year to the age of two-years and also a significant improvement in BCS up to the age of three-years after which it starts to decline slightly (Annett, Holland & Totusek, 1983). Results of this study indicated that cattle at the age of one year have a greater chance to deposit fat when compared to two-years-olds as first calvers. Cattle breds such as the Nguni often attain the age for first mating at two years of age (Meaker, Coetzee & Lishman, 1980). At this stage animals start to face many challenges such as mating, calving and suckling processes and as a result tend to lose condition. This is in line with results reported by Houghton *et al. (*1990). Cattle at the age of three years begin to gain condition as this is during or after the weaning of their calves, and from the age of four they again follow the process of mating until suckling. Goehring, Corah & Higginis (1989) added that heifers have the higher body condition at calving and a greater increase in body condition thereafter. It would appear that skeletal development of first-calf heifers is not as sensitive as is soft tissue development to prepartum energy nutrition (Goehring *et al.*, 1989). Donaldson (1969) reported a further trend of BCS from the age of four to the age of greater than five. The BCS of cows at parturition together with a change in BCS prior to breeding affects pregnancy rates. Thin cows at calving that lost condition and fat cows that gained condition, exhibited lower pregnancy rates compared with cows that maintained moderate condition (Houghton *et al.*, 1990). Richards *et al.* (1986). Stated that the onset of oestrus is delayed especially in heifers receiving a low level of energy before calving and during calving at a low BCS.

Month. Body condition score of the animals is highly influenced ($P<0.0001$) by the month. This influence is due to the difference in nutritional status and availability of grazing material throughout the season. May seems to be the best month, judging by the condition of the animals (Table 4.2,). The survey of the area indicated that there is an abundance of grazing material such as crop residues available from the autumn season. This may boost the condition score of the cattle and result in a short calving interval. In agreement supplementation of energy intake has pronounced effects on body condition changes and improves both rate and efficiency of gain in finishing cattle (Goehring *et al.*, 1989).

4.3.2 The calving rate

The data of calving rates are presented in Table 4.4.

Month. The calving rates of these beef cattle under communal management conditions were greatly influenced by month. This influence was mainly caused by body condition among the animals as a result of grazing pasture variability and availability and rain distribution. The previous results reported that cattle are in good condition during the month of May. These results are in line with the data of calving rate of the Nguni type cattle in Table 4.4, as the majority of the cattle calved during month of January. Thus May is the best mating period for these cattle. Bembridge (1987) supported the findings that an autumn breeding season leading to summer calving depends on grazing quality and fodder flow. The advantages of an autumn breeding season are that fertility and ovulation rates are high and therefore offspring are weaned on good quality pastures. Additionally, autumn herbs especially during autumn, and early spring are highly palatable and nutritious which therefore supply the basis of production. Deutscher, Sttots & Nielsen (1991) found that cows introduced on summer pasture before the initiation of the breeding season can have a advantage on fertility. Furthermore, September has a considerable high calving rates and this emphasis the best condition found in late summer to early autumn season as a result of high abundant of dry matter. Montgomery, Scott & Hudson (1985) supported that later calving in the spring is associated with changes in photoperiod, temperature and pasture availability that influence resumption of ovarian cycles. These findings are also in line with those of Wagner, Lusby, Oltjien, Rakestraw, Wettermann & Walters (1988) who indicated that poor body condition is generally associated with reduced conception rates and longer intervals from calving to oestrus. Deutscher, Sttots & Nielsen (1991) argue that conception rates of cows are primarily influenced by nutrition level as it increases the postpartum interval (Gregory, Lunstra, Cundiff & Koch, 1992). Deutscher *et al.* (1991) suggested that a short breeding season might be more appropriate for cows being bred to calve in April. From the findings it can be said that autumn and spring are favoured as a calving time because of quantity of grazing available.

There is a tendency for greater seasonal effects on postpartum intervals to first ovulation, first oestrus and conception in cows (Selk, Wetterman, Lusby, Oltjien, Mooble, Rasby & Garmedia, 1988). Selk *et al. (*1988) believe that reduced environmental stress and greater forage availability probably contributed to the greater pregnancy rates as influenced by BCS from autumn. The average calving percentage recorded is as follows 1997 are (29%), 1998 (38%), 1999 (11%) and 2000 (32%). In contrast other studies reported an average calving percentages of between 64 and 91 percent in various herds of Sanga cattle in Southern Africa as a result of good body condition amongst the breeding cattle. Lepen, Schoeman & Venter (1993) reported an average calving percentage of 83 percent in the Nguni herd.

Despite the effect of month, the calving percentage may also be due to the number of bulls available. The estimated percentage bulls was considerably lower (9%) than the percentage of oxen (18%) and the high percentage of young animals (34%). From this comparison it can be concluded that this calving percentage is in correspondence with the percentage of dams.

4.3.3 **Factors affecting scrotal circumference (SC)**

The results of Analysis of Variance are presented in Table 4.1. The results indicate that only the effects of age and interaction of age with month are a source of variation for SC. Least Square Means and Standard Errors for the effects of age and month are given in Table 4.5.

Age. Scrotal circumference was positively (P<0.0001) affected by the age of the animals (Fig. 4.2). The data are in accordance with the results of Curtis and Amann (1981) who reported that age influences the SC, the scrotal width, as well as the testicular histology. Bourdon and Brinks (1986) and Lunstra, Gregory & Cundiff (1988) reported a similar trend of relationship between SC and age of the bull. They found that SC starts to increase from a young age until the bull reaches the age of around five years, and declines thereafter, as the bull gets older. This effect is due to the rapid proliferation of testes parenchyma development (Quirino & Bergmann, 1998). In support of the above contention, Makarechian, Farrid & Berg (1985) recorded that two-year-old bulls were having 64 percent larger SC than that of the yearlings. Similar records by Swanepoel and Heyns (1986) found a mean SC of 37.8cm at 12 months of age with the coefficient variation of 5.43 percent. Generally this supports the conclusion that SC in young bulls is an important trait for selection programmes and is a useful indicator of fertility.

Month. Although the effect of the month was found to be statistically non-significant (P>0.05) on the influence of SC, scrotal circumference seems to increase during the month of September and then decline slightly towards October to December (Table 4.5). This may be the function of body condition, which is influenced by nutritional status.

Age x Month. The effect of month being interacted with the effect of age was found to (P<0.0001) influence the scrotal circumference of bulls.

3.3.4 **Factors affecting skin thickness (ST)**

The results of Analysis of Variance are presented in Table 4.1. These results indicate, that only the effects of age and interaction of age with month are a significant source of variation for ST. Least Square Means and Standard Errors for the effects of age and month are given in Table 4.5.

Age. Skin thickness is highly correlated ($P<0.0001$) with the age of the animal. It increases with age until the animal reaches the age of around four years and declines thereafter (Figure 4.3). This means that skin becomes thicker at four years of age and this boosts the advantage of less external parasitic infestation by ticks, mosquitoes and flies.

Month. Although no relationship ($P>0.05$) was observed between the ST and month of the year but, with the inclusion of age it starts to increase ($P<0.01$) (Table 4.6). This boost the adaptability of the animal to harsh environmental factors such as extreme temperatures, etc.

4.5 Conclusion

These results generally reveal that the reproductive performance of communal management beef cattle is affected by the differences between the villages as well as the month of the year (for BCS). These communal cattle are known to produce even at a low BCS of 2.5 points. This may be attributed to differences in environmental conditions within the villages during different seasons. This emphasises their ability to produce and reproduce under harsh environmental conditions. All traits were found to be influenced by age and this suggests that in all communal cattle management programs, the age of the animal must be given high priority in order to improve the production efficiency. Results reveal the importance of continuous supply of feeds throughout the season in order to maintain the body condition of the animals, as this will improve the calving percentage due to the shortening of the calving interval.

Table 4.1: Analysis of Variance for body condition score, scrotal circumference and skin thickness of beef cattle.

	BCS		SC		ST	
SOURCE	**DF**	**MS**	**DF**	**MS**	**DF**	**MS**
Village	3	1.22*	-	-	-	-
Sex	1	3.92**	-	-	-	-
Age	4	10.84***	4	19.29***	4	190.78***
Month	4	46.39***	3	12.06^{ns}	1	7.48^{ns}
Sex X Age	4	3.22*	-	-	-	-
Age X Month	-	-	12	92.81***	4	18.08**
R^2		0.17		0.50		0.25

*** (P<0.0001)

** (P<0.001)

* (P<0.01)

ns not significant

Table 4.2 : Least Square Means and Standard Errors (LSM±SE) for body condition score on the effects of village, sex, age and month.

EFFECT	NO.	LSM ± SE
μ	1374	2.44 ± 0.72
Village		
Tshithuthuni	637	2.38 ± 0.03
Muledzhi	337	2.48 ± 0.04
Vuvha	124	2.51 ± 0.05
Mapate	276	2.43 ± 0.07
Sex		
Male	515	2.51 ± 0.04
Female	859	2.38 ± 0.03
Age		
<1 year	195	2.06 ± 0.05
2 years	362	2.39 ± 0.04
3 years	322	2.62 ± 0.04
4 years	229	2.57 ± 0.05
>5 years	266	2.60 ± 0.07
Month		
May	345	2.95 ± 0.04
July	258	2.26 ± 0.05
September	302	2.28 ± 0.05
October	158	2.40 ± 0.06
December	311	2.35 ± 0.07

Table 4.3 : Least Square Means and Standard Errors (LSM±SE) for the interaction of sex and age for body condition score.

EFFECT		NO.	LSM ± SE
Sex X Month			
1	1	92	207 ± 0.08
1	2	164	2.34 ± 0.06
1	3	150	2.67 ± 0.06
1	4	82	2.65 ± 0.08
1	5	27	2.83 ± 0.14
2	1	103	2.05 ± 0.07
2	2	198	2.44 ± 0.05
2	3	172	2.57 ± 0.06
2	4	147	2.49 ± 0.06
2	5	239	2.38 ± 0.05

Table 4.4 : Calving rates of the beef cattle under communal management conditions in the Muledzhi area.

	1997		1998		1999		2000	
Month	**Cattle**	**Calves**	**Cattle**	**Calves**	**Cattle**	**Calves**	**Cattle**	**Calves**
January	547	22	652	53	820	-	799	15
February	544	3	696	-	820	13	791	-
March	556	16	696	3	812	14	791	-
April	575	2	692	9	810	-	791	-
May	577	-	695	-	810	9	791	22
June	592	7	631	-	814	3	803	12
July	582	15	7 52	-	802	-	815	-
August	645	-	783	30	802	-	815	-
September	413	33	785	6	802	-	815	41
October	637	10	784	24	802	-	867	16
November	659	8	788	13	802	3	887	9
December	652	1	820	13	799	-	887	11

Table 4.5 : Least Square Means and Standard Errors (LSM±SE) for the scrotal circumference (cm) and skin thickness (cm) on the effects of age and month.

SC			ST	
EFFECT	**N**	**LSMSE**	**NO.**	**LSM ± SE**
μ	209	23.84 ± 2.60	452	10.82 ± 2.60
Month				
May	74	24.66 ± 0.78	-	-
July	50	24.95 ± 0.95	-	-
September	57	26.19 ± 1.05	52	9910.44 ± 0.17
October	28	25.12 ± 0.39	153	10.73 ± 0.21
Age				
<1 year	46	17.32 ± 0.96	52	7.96 ± 0.37
2 years	80	24.47 ± 0.60	114	9.69 ± 0.26
3 years	52	26.57 ± 0.81	120	11.62 ± 0.30
4 years	22	27.91 ± 1.32	97	12.23 ± 0.30
>5 years	9	29.87 ± 0.86	69	11.41 ± 0.31

Table 4.6 : Least Square Means and Standard Errors (LSM±SE) for scrotal circumference and skin thickness for the effect of interaction between age and month.

		SC		ST	
EFFECT		**NO.**	**LSM ± SE**	**NO.**	**LSM ± SE**
Age x Month					
1	5	23	18.43±1.05	-	-
1	7	11	11.64±1.52	-	-
1	9	3	17.33±2.92	21	7.24±0.57
1	10	9	21.89±1.69	31	8.68±0.47
2	5	25	24.96±1.01	-	-
2	7	21	21.38±1.10	-	-
2	9	23	22.74±1.05	75	9.10±0.30
2	10	11	28.82±1.52	39	10.23±0.42
3	5	12	24.92±1.46	-	-
3	7	12	25.42±1.46	-	-
3	9	3	28.57±1.05	96	11.90±0.27
3	10	5	27.40±2.26	24	11.33±0.53
4	5	11	23.00±1.52	-	-
4	7	3	30.33±2.92	-	-
4	9	6	30.83±2.06	70	12.13±0.31
4	10	2	27.50±3.37	27	12.33±0.50
5	5	3	32.00±2.92	-	-
5	7	3	36.00±2.92	-	-
5	9	2	31.50±2.57	37	11.81±0.45
5	10	1	20.00±5.05	32	11.00±0.46

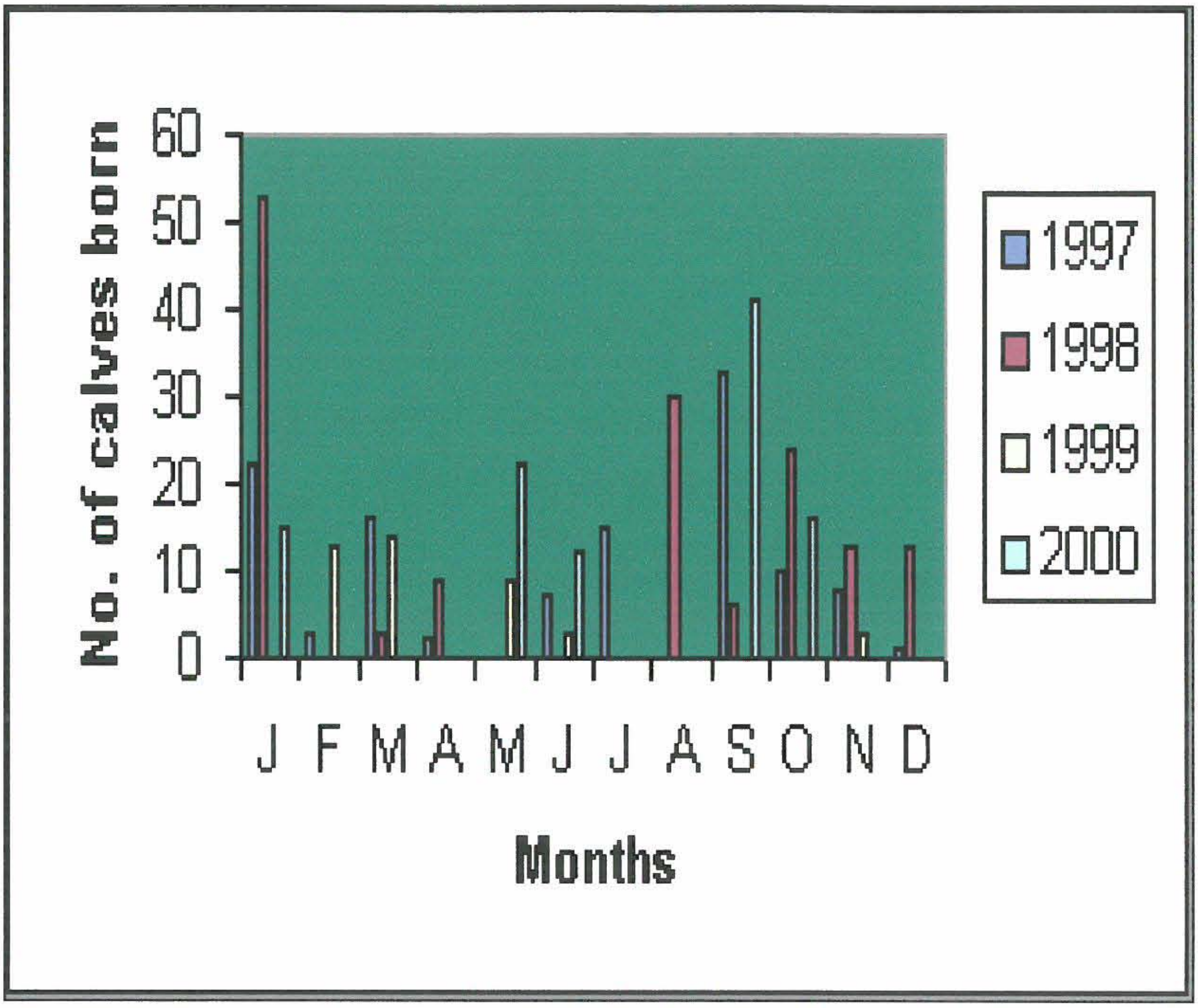

Figure 4.1: The calving rate of beef cattle under communal management conditions in Muledzhi area.

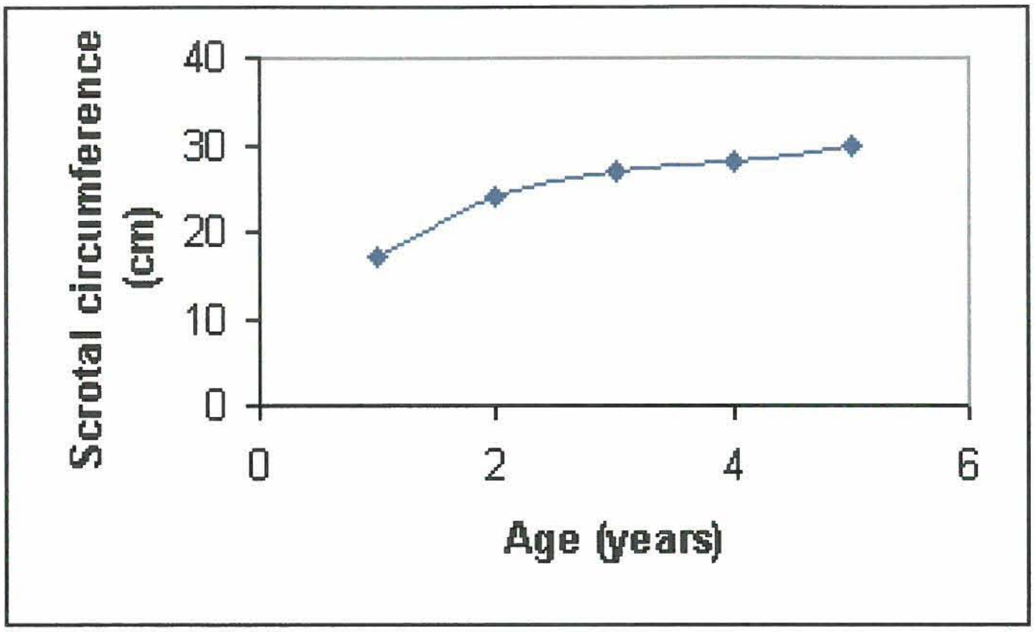

Figure 4.2 : The relationship between the age and scrotal circumference of the beef cattle under communal management conditions.

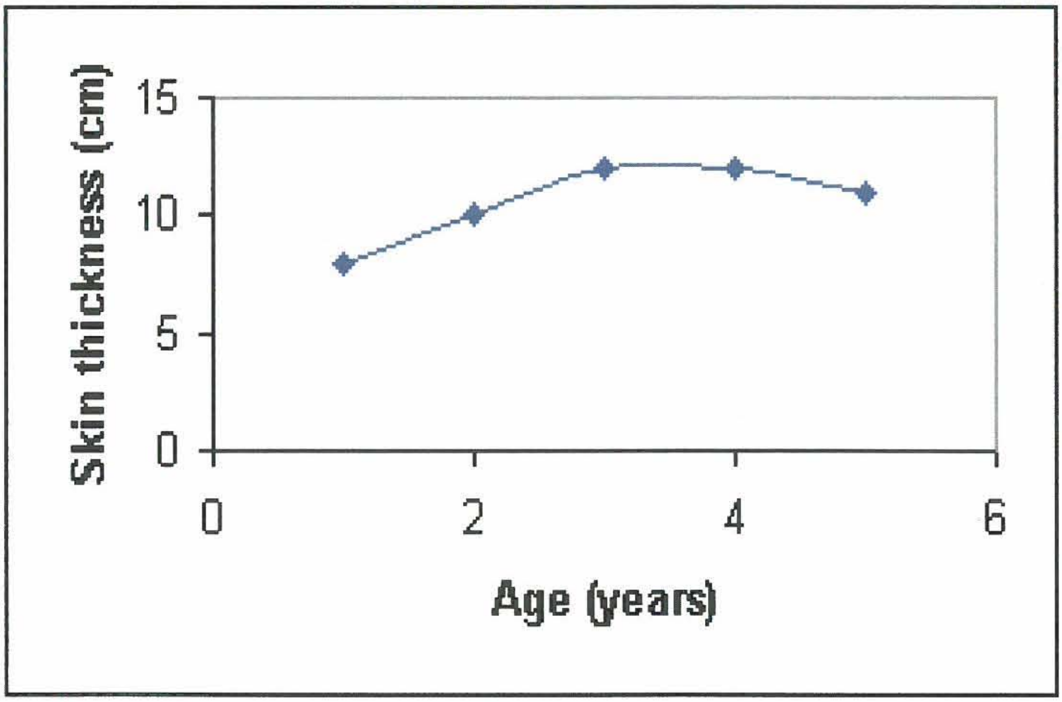

Figure 4.3 : The relationship between the age and skin thickness of the beef cattle under communal management conditions.

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Chapter 5

Estimation of scrotal circumference from heart girth and wither height in beef cattle under communal management conditions

5.1 Introduction

Selection of bulls for increased scrotal circumference is considered to be the most rapid method to genetically improve the inherent fertility in a herd of cattle (Keeton, Green, Golden & Anderson, 1996). Thus selecting bulls that are genetically superior in body measurements can double genetic change (Kriese, Bertrand & Benyshek, 1991). For example, Vargas, Elzo, Chase, Chenoweth & Olson (1998) argue that wither height (WH) is probably the most convenient way of describing skeletal size in beef cattle. Scrotal circumference is an important component in examining beef bulls for breeding soundness. Various researches have indicated that SC is genetically and phenotypically correlated with important growth traits and other body measurements used in most selection programmes (Kriese *et al.*, 1991; Makarechian, Farrid & Berg, 1985 and Keeton *et al.*, 1996). Lunstra, Gregory & cundiff (1988) suggested that SC in yearling is essentially a measure of age at puberty in bulls. The primary reason for adjusting SC is to increase the accuracy of selection for age at puberty in bulls.

The objective of this study was therefore to derive prediction equations for SC using heart girth (HG) and wither height (WH).

5.2 Materials and methods

5.2.1 *Study site*

Records on body measurements were collected from the Muledzhi communal dipping tank situated 50km north of Thohoyandou in the Northern Province at approximately 22,41^{0}s latitude and 30,16^{0}e longitude. This dipping tank served four villages, namely Tshithuthuni, Muledzhi, Vuvha and Mapate. The average rainfall is approximately 1200 to 1400mm per annum with a large percentage of this rain falling during the months of January to March. The climate is generally referred to as semi-tropical (seasonal rainfall with hot, wet summers and cool, dry winters). The vegetation type is characterised as savanna mixed with bushveld.

5.2.2 *Animals and Management*

The body measurements were taken from predominantly Nguni-type breeds and a few other breed types such as Simmental, Brahman, Bonsmara, Jersey, Friesian and Afrikaner, as well as crosses. All these animals were eartagged at the beginning of the study for identification purposes during the subsequent measurements.

5.2.3 *Data*

Data were collected over a period of five months, namely September, October and December (1999) and May and July (2000). A total of 1374 animals were measured, consisting of 1374 HG, 982 WH and 209 for SC. Scrotal circumference was measured at its largest diameter using a flexible measuring tape. Wither height (WH) was measured using a wooden tape attached to a horizontal sliding bar of the restraining chute above the animal and calculated as the difference between the height of the bar above the floor of the chute and the vertical distance between the bar and WH. Heart girth (HG) was measured using a flexible measuring tape. This method is similar to that used by Morsy *et al.* (1997). Measurements were taken from cattle of all ages (<1 to >5 years of age).

5.2.4 *Statistical analysis*

Regression of SC on each of the independent variables was performed using the regression analysis procedure of the Statistical Analysis System (SAS, 1989). Linear, quadratic and cubic effects on the independent variables were considered. Scrotal circumference was also regressed to the combination of HG and WH. The general model used was -

$Y_i= b_0+b_1x_i+b_2x^2; +b^3x_i+e_i$

Where:

Y = SC observation 1

b_0 = intercept

$b_i, b_2; b_3$ = Corresponding linear, quadratic and cubic regression coefficients

x_1 = Body measurements i (HG, WH)

e_1 = Residual error term

5.3 Results and discussion

5.3.1 Adjustment factors for scrotal circumference

Age. There are no (linear, quadratic and cubic) relationships of age, HG and WH to SC at yearlings (Table 5.1). The HG and WH have a significant (linear) influence on SC (P<0.0001) in two-years-old bulls, however the model accounted for only a small proportion of the total variation of SC, R^2=0.21 HG and R^2=0.32 for WH. In contrast, when HG and WH in combination were fitted as both quadratic and cubic effects, the results show slight improvement R^2=0.38 HG and R^2=0.42 WH to SC. Scrotal circumference (cubic) can be predicted successfully from the combination of both HG and WH at two-years-old. Thus the best predictor models seem to be the third-degree polynomials in combination than the linear and quadratic measure of other traits (SC_4, SC_7 & SC_8) (Table 5.2). This indicates that selection in beef cattle for increased HG and WH at a young age should result in animals that are taller and older. They therefore suggested that these HG and WH should be considered in selection programs for reproductive traits. In agreement, Vargas *et al.* (1998) obtained an estimates of R^2=0.32 of WH and SC which indicates that heifers that reach puberty earlier were associated with bulls of large SC at young age. These results are also supported by numerous reseachers (Lunstra *et al.*, 1988 and Gregory, Lunstra & Cundiff, 1991). The influence of age on the prediction of SC using HG and WH (linear, quadratic and cubic) has a poor contribution to SC in three-years-old bulls, as they showed a negative variation accounted in the models (Table 5.3). However, very little contribution was observed after the combination of HG and WH in the model (R^2=0.18 from the R^2 of –0.04).

Scrotal circumference increases at a diminishing rate with an increase in HG at four-years of age (Table 5.4). Conversely, SC influenced by HG at similar trend from linear (R^2=0.39), quadratic (R^2=0.40) and cubic (R^2=0.43) at four-years of age. However a improvement of 0.04 R^2 was realised after the inclusion of WH in the same model SC_4. These results were consistent with those reported by Bourdon and Brinks (1986) who obtained a similar contribution (R^2=0.42) (SC_4, SC_7 & SC_8) (Table 5.2). There is no linear influence to SC by WH in bulls at four-years of age when fitted as alinear effect (R^2=0.14), but it shows a considerable influence with the inclusion of both quadratic and cubic effects in the model, R^2=0.54 and R^2=0.58 respectively. In supporting the previous statement, using (quadratic and cubic) HG and WH in combination also caused a positive variation to SC (R^2=0.58) as opposed to linear combination (R^2=0.38). Though no statistically (P>0.05) linear, quadratic and cubic effects of HG and WH as well as their combination to SC in the bull of five-years-old or greater than five-years, but the R^2 values indicated a high proportion contributed by these body measurements to SC (Table 5.5).

Month. There is a linear statistical influence (P<0.0001) of HG and WH to SC during the month of May found when they were fitted as separate linear effect, however the model accounted for only a small proportion to SC (R^2=0.37) HG and (R^2=0.36) WH (Table 5.6). This is also similar when both HG and WH were fitted as quadratic and cubic effect. The fair proportion was observed when HG and WH combined in the same model as quadratic and cubic effects, R^2=0.49 (HG) and R^2=0.42 (WH). Generally this suggests no significant prediction of SC by using HG and WH during the month of May, as this was evident by the very low proportion contributed. Linear effects (P<0.0001) of HG and SC were also found during the month of July, (R^2=0.51) and low in WH (R^2=0.45) (Table 5.7). Similarly, there is also a positive quadratic effect of HG on SC during month of July (R^2=0.50) and less in WH (R^2=0.43). The HG and WH accounted a similar proportion (R^2=0.59) to SC when fitted as a cubic effect during July month. Furthermore, the inclusion of cubic HG and WH in combination also resulted in the same proportion to SC during this month (R^2=0.59). This indicates that SC can be predicted from HG and WH even in combination during July. This is mainly due to the consistency of body condition score from winter pastures. There is poor influence (linear, quadratic and cubic) of HG to SC during the month of September, (Table 5.8). However, the data shows only a statistical linear influence (P<0.0001). Conversely, SC possessed a similar variation (linear, quadratic and cubic), which resulted from WH. This is supported by the significant influence (P<0.0001) showed in this data. Additionally, the combination of HG and WH in the same model exhibited a fair variation accounted in the model (R^2=0.49) and (R^2=0.48) respectively. Among these body measurements, WH was slightly lower compared to HG. The month of October seems to have a significant linear influence (P<0.001) on the influence of HG to SC, although the model accounted for a smaller variation of the phenotypic SC (R^2=0.25). However the poorest variation was found in the WH and SC relationship (R^2=0.08). Generally there is no linear, quadratic and cubic relationship between HG, WH and SC during this month (Table 5.9). This was concluded by the poor amount of variation accounted in the models.

5.4 Conclusion

When HG was included in the model WH was no longer a significant effect on yearlings bulls, suggesting that HG affects SC through its association with WH. Scrotal circumference appears to be most affected by HG and WH at two, four and five-years of age. In some cases the effects of quadratic and cubic terms were positive, indicating that SC increases at a diminishing rate, as animals get older, heavier and taller. In this situation SC can best be predicted (quadratic and cubic) from HG and WH when bulls are at those ages. However, the best prediction can be done at five years of age as is evident by the variation shown in the models. The significant effect of month in the prediction of SC from HG and WH was observed in July (linear, quadratic and cubic). This suggests that July is the best month for prediction of SC using HG and WH. This is mainly due to thin cattle being in low BCS during this month as a result of poor pastures, as the information of prediction may not be biased due to obesity. Therefore, this information on the relationship between body measurements and SC would be useful when they are both considered in the selection, and prediction of SC especially important in circumstances where there is lack of labour to take all the measurements. Generally a favourable association seems to exist between SC in bulls and HG and WH. Thus selection for increased SC should provide a useful means for making progress in a beef enterprise.

Table 5.1: Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height in yearlings.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	16.20	0.07HG	_	_	_	-0.01
SC_2	15.96	0.01HG	_	$8.87x10^{-6}HG^2$	-	-0.05
SC_3	16.40	-0.00HG	_	$1.18x10^{-4}HG^2$	$2.29x10^{-7}HG^3$	-0.09
SC_4	9.88	0.02HG	0.06WH	$6.24x10^{-3}HG^2$	$4.52HG^3$	-0.13
SC_5	11.88	0.06WH	_	_	_	-0.02
SC_6	-111.90	2.50WH	_	$1.19x10^{-1}WH^2$	-	0.08
SC_7	-151.21	3.66WH	_	$2.31x10^{-2}WH^2$	$3.62x10^{-5}WH^3$	0.05
SC_8	66.74	-3.02WH	-0.01HG	$4.46x10^{-2}WH^2$	$1.28x10^{-4}WH^3$	0.02
SC_9	13.16	0.04WH	7.08HG	_	_	-0.05

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

Table 5.2 : Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height at two-years of age.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	17.62	0.03HG	_	_	_	0.21
SC_2	14.37	0.06HG	_	$-6.37x10^{-5}HG^2$	-	0.21
SC_3	23.67	-0.13HG	_	$-9.52x10^{-4}HG^2$	$1.52x10^{-6}HG^3$	0.38
SC_4	2.58	-0.05HG	0.18WH	$-5.29x10^{-4}HG2$	$-9.42x10^{-4}HG^3$	0.42
SC_5	-6.76	0.30WH	_	_	_	0.32
SC_6	-98.32	2.07WH	_	$8.56x10^{-3}WH^2$	-	0.35
SC_7	930.15	-28.39WH	_	$2.90x10-1WH^2$	$9.67x10^{-4}WH^3$	0.42
SC_8	819.84	-25.10WH	0.01HG	$2.57x10^{-1}WH^2$	$8.62x10^{-4}WH^3$	0.42
SC_9	-3.05	0.23WH	0.01HG	_	_	0.34

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

Table 5.3 : Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height at three-years age.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	25.35	0.00HG	_	_	_	-0.01
SC_2	26.81	-0.01HG	_	$1.72x10^{-5}HG^2$		-0.03
SC_3	24.39	0.04HG	_	$-1.56x10^{-4}HG^2$	$1.93x10^{7}HG^3$	0.18
SC^4	-31.04	0.08HG	0.51WH	$3.9x10^{-4}HG^2$	$3.99x10^{-H}G^3$	-0.04
SC_5	4.99	0.19WH	_	_	_	0.09
SC_6	8.81	0.13WH	_	$2.90x10^{-4}WH^2$	_	0.07
SC_7	78.32	-1.67WH	_	$1.57x10^{-2}WH^2$	$4.35x10^{-W}H^3$	0.04
SC_8	480.79	-12.00WH	-0.02HG	$1.03x10^{-1}WH^2$	$2.83x10WH^3$	0.10
SC^9	-11.39	0.39WH	-0.02HG	_	_	0.14

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

Table 5.4 : Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height at four-years of age.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	15.64	0.04HG	_	_	_	0.39
SC_2	12.04	0.07HG	_	$6.84x10^{-5}HG^2$	_	0.40
SC_3	14.03	0.01Hg	_	$2.56x10-4HG^2$	$4.33x10^{-7}HG^3$	0.39
SC_4	-30.24	0.19HG	0.35W	$-5.70x10^{-4}HG^2$	$5.43x10^{-7}HG^3$	0.43
SC_5	-2.95	0.26WH	_	_	_	0.14
SC_6	-312.17	5.99WH	_	$2.62x10^{-2}WH^2$	_	0.54
SC_7	291.11	-10.81WH	_	$1.28x10^{-1}WH^2$	$4.67x10^{-4}WH^3$	0.53
SC_8	-494.57	11.73WH	0.02HG	$8.54x10^{-2}WH^2$	$1.96x10^{-4}WH^3$	0.58
SC_9	6.05	0.10WH	0.03HG	_	_	0.38

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

Table 5.5 : Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height in five-years of age.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	23.38	0.02HG	_	_	_	0.38
SC_2	28.08	-0.06HG	_	$1.42 \times 10^{-4} HG^2$	_	0.66
SC_3	30.02	-0.14HG	_	$5.56 \times 10^{-4} HG^2$	$-4.187 \times 10^{-7} WH^3$	0.70
SC_4	27.55	-0.13HG	0.02WH	$5.07 \times 10^{-4} HG^2$	$4.37 \times 10^{-7} HG^3$	0.63
SC_5	-9.45	0.34WH	_	_	_	0.58
SC_6	-5.17	0.26WH	_	$3.72 \times 10^{-4} WH^2$	_	0.52
SC_7	1700.07	-47.23WH	_	$4.33 \times 10^{-1} WH^2$	$1.30 \times 10^{-3} WH^3$	0.55
SC_8	2096.70	-58.04WH	0.01HG	$5.30 \times 10^{-3} WH^2$	$1.58 \times 10^{-3} WH^3$	0.72
SC_9	-4.55	0.26WH	0.01HG	_	_	0.65

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

Table 5.6 : Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height during the month of May.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	13.96	0.03HG	_	_	_	0.37
SC_2	13.17	0.04HG	_	$1.07 \times 10^{-5} HG^2$	_	0.35
SC_3	9.98	0.09HG	_	$2.06 \times 10^{-4} HG^2$	$2.23 \times 10^{-7} HG^3$	0.36
SC_4	-30.74	0.19HG	0.35WH	$6.21 \times 10^{-7} HG^2$	$6.28 \times 10^{-7} HG^3$	0.49
SC_5	-10.81	0.32WH	_	_	_	0.36
SC_6	-63.94	1.31WH	_	_	_	0.36
SC_7	-402.09	10.90WH	_	$2.76 \times 10^{-4} WH^2$	$2.76 \times 10^{-4} WH^3$	0.36
SC_8	-574.94	16.10WH	0.02HG	$4.39 \times 10^{-4} WH^2$	$4.39 \times 10^{-4} WH^3$	0.42
SC_9	-0.84	0.17.WH	0.02HG	_	_	0.41

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

Table 5.7 : Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height during the month of July.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	12.00	0.05HG	_	_	_	0.51
SC_2	9.23	0.07HG	_	$-3.58x10^{-5}HG^2$	_	0.50
SC_3	-21.69	-0.47HG	_	$1.55x10^{-3}HG^2$	$1.67x10^{-6}HG^3$	0.60
SC_4	-14.20	0.51HG	-0.13WH	$1.62x10^{-3}HG^2$	$1.72x10^{-6}HG^3$	0.59
SC_5	-18.44	0.39WH	_	_	_	0.45
SC_6	-53.65	1.06WH	_	$-3.08x10^{-3}WH^2$	_	0.44
SC_7	-250.34	6.66WH	_	$-5.57x10^{-2}WH^2$	$1.63x10^{-4}WH^3$	0.43
SC_8	-487.32	13.01WH	0.08HG	$1.10x10^{-1}WH^2$	$2.97x10^{-4}WH^3$	0.58
SC_9	9.30	0.03WH	0.04HG	_	_	0.50

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

Table 5.8 : Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height during the month of September.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	20.20	0.03HG	_	_	_	0.28
SC_2	20.84	0.02HG	_	$1.05x10^{-5}HG^2$	_	0.27
SC_3	23.14	-0.03HG	_	$-1.69x10^{-4}HG^2$	$-2.72x10^{-7}HG^3$	0.30
SC_4	-14.31	0.04HG	-0.31WH	$8.91x10^{-5}HG^2$	$4.98HG^3$	0.50
SC_5	-8.06	0.32WH	_	_	_	0.48
SC_6	-42.04	0.94WH	_	$-2.79x10^{-3}WH^2$	_	0.48
SC_7	-99.97	2.51WH	_	$-1.69x10^{-2}WH^2$	$4.16x10^{-5}WH^3$	0.47
SC_8	-75.56	1.81WH	0.01HG	$-1.03x10^{-2}WH^2$	$1.94x10^{-5}WH^3$	0.48
SC_9	-5.04	0.27WH	0.01HG	_	_	0.48

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

Table 5.9 : Regression equations for predicting scrotal circumference in beef cattle using heart girth and wither height during the month of December.

Model	Intercept	Linear	Combination	Quadratic	Cubic	Adj. R^2
SC_1	20.15	0.03HG	_	_	_	0.25
SC_2	17.27	0.05HG	_	$-6.10x10^{-5}HG^2$	_	0.26
SC_3	18.53	0.02HG	_	$1.01x10^{-4}HG^2$	$-2.30x10HG^3$	0.24
SC_4	7.10	0.07HG	0.09WH	$-1.59x10^{-4}HG^2$	$9.99HG^3$	0.21
SC_5	11.37	0.14WH	_	_	_	0.08
SC_6	-113.28	2.50WH	_	_	_	0.17
SC_7	394.05	-11.90WH	_	$-4.19x10^{-4}WH^2$	$-4.19x10^{-}WH^3$	0.16
SC_8	252.40	-7.63WH	0.02HG	$-2.82x10^{-4}WH^2$	$-2.82x10^{-}WH^3$	0.26
SC_9	19.36	0.01WH	0.03HG	_	_	0.22

SC=model, HG= Heart Girth, WH=Wither Height, Adj. R^2= Adjusted R^2

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Chapter 6

General conclusion and recommendations

The main objective of this study was to investigate the reproductive performance of beef cattle under communal management conditions as affected by environmental factors. The reproductive performance was affected by the village. This effect was mainly caused by the difference in environmental factors such as nutritional level and vegetation type, temperatures, rainfall, humidity and parasites. Among these factors, nutrition was found to play a vital role in fertility. This was evident by the influence caused by the body condition score within the cattle. Body condition was found to increase with the age of the animals, but differed between cattle of different sexes. Male animals scored a higher body condition compared to females. Additionally, month influenced the body condition of the animals. This is mainly due to the difference in grazing pasture caused by the unreliability of rainfall within the month of the season. Age also influences the scrotal circumference and skin thickness. In conclusion, the influence of environmental factors was clearly evident in the better calving percentage of these cattle.

These overall results generally suggest a greater need for improvement in the fertility of these cattle under communal management conditions. Thus this improvement should be concentrated on those factors determining efficient and economic production. This means that nutrition, breeding strategies and management should be considered. This involves the use of low-cost supplementary feeding during the drought months, such as the winter months of June and July, to encourage full reconception. The primary purpose is to enhance the body condition throughout the season, as this will encourage oestrus and thereby improve the pregnancy rate. There is a further need for the use of proper breeding strategies and selection as well as the purchasing of good quality bulls in order to improve the progeny. Further, the keeping of records must be encouraged among the cattle farmers.

In circumstances where there is a shortage of time and labour to do the measurements for scrotal circumference, alternative body measurements such as heart girth and wither height can be used to predict the scrotal circumference. Thus selection based on heart girth and wither height for improvement would also improve the scrotal circumference. Given that the data reported is baseline information prior to any attempt to intervene, there is a great potential to improve fertility of beef cattle under communal management conditions. This means that further evaluation of this fertility performance on beef cattle under these conditions is therefore recommended.

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AN INTEGRATED SYSTEM OF REPRODUCTIVE TRAITS IMPROVEMENT IN BEEF CATTLE UNDER COMMUNAL MANAGEMENT CONDITIONS

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Abstract

Records for this study were collected at Muledzhi communal dipping tank located 50km north of Thohoyandou in the Northern Province. Traits evaluated were: Body condition score (BCS), scrotal circumference (SC), calving rates (CR) (fertility) and skin thickness (ST) (adaptability). A total record of 1374 for BCS, 209 for SC, and 452 for ST and CR, collected from 1997 to 2000, were used in this study. All these measurements except the CR were done by one person. The animals were all earmarked with ear tags at the beginning of the study, except regard to CR. The scale for BCS was one to five and a flexible measuring tape was employed to measure the SC and skin caliber for ST as a means of accumulating the data. Data were accumulated over a period of five months (BCS & SC), three months ST and four years for CR. The independent variables are village, age, sex and month.

The study was conducted primarily for two reasons firstly, to evaluate the adaptive and reproductive performance of beef cattle under communal management conditions, and secondly to derive a prediction equation for scrotal circumference (SC) using the heart girth (HG) and wither height (WH) under communal management conditions. The effect of village on body condition score (BCS) was a significant ($P<0.1$) source of variation. Cattle from Vuvha village had a high BCS compared to other villages. Sex also had a significant influence ($P<0.001$) on the BCS. Male animals had a higher BCS than females. Age caused a variation ($P<0.0001$) on BCS. Body condition increases at a diminishing rate with the age of the cattle. Nguni attain high BCS at four years of age and decline thereafter. Month also influences the BCS. Cattle had a high BCS during the month of May compared to other months. The calving percentage was generally better for these communal beef cattle, and it was found to be influenced by month and number of bulls available. High rates were observed during the month of January and September. Age also influenced the SC and ST.

The heart girth (HG) and wither height (WH) had a significant ($P<0.001$) effect on SC in two-years-old bulls, but the model showed a small proportion, namely R^2=0.21(HG) and R^2=0.32(WH). Using quadratic and cubic HG and WH in combination resulted in 0.15 (SC_4) and 0.10 (SC_7 & SC_8) improvements to R^2 as compared to the linear models. The better prediction (quadratic & cubic) of SC was also observed at four-years of age, R^2=0.40 and R^2=0.43 respectively. However, high quadratic and cubic variation was found at five-years of age R^2=0.70 (HG), and R^2=0.72 (WH) in combination with HG when fitted as quadratic and cubic effects. Scrotal circumference had a high variation (R^2=0.50) from HG and R^2=0.59 from WH in combination, when fitted as both quadratic and cubic respectively during the month of July.

Uittreksel

`N GEÏNTEGREERDE SISTEEM VIR DIE VERBETERING VAN VOORTPLANTINGSEIENSKAPPE IN VLEISBEESTE ONDER TOESTANDE VAN GEMEENSKAPLIKE BESTUUR

deur

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		Dr. C. van der Westhuizen

Die rekords vir hierdie studie is by die Muledzhi-gemeenskaplike dip versamel, 50km noord van Thohoyandou in die Noordelike Provinsie. Die volgende eienskappe is evalueer: Kondisietelling (KT), skrotale omvang (SO), kalfpersentasie (KP) (vrugbaarheid) en huiddikte (HD) (aanpasbaarheid). Hierdie studie het gebruik gemaak van `n totaal van 1374 rekords vir KT, 209 vir SO, en 452 vir HD en KP, versamel vanaf 1997 tot 2000. Al die diere is by die aanvang van die studie met oorplaatjies gemerk, behalwe in die geval van KP. Die skaal vir KT was een tot vyf, en `n buigsame maatband is gebruik vir die meting van die SO as `n metode van data-insameling. Data is versamel oor `n periode van onderskeidelik vyf maande (KT & SO), drie maande (HD) en vier jaar (KP). Die onafhanklike veranderlikes was nedersetting, ouderdom, geslag en maand.

Die studie is hoofsaaklik om twee redes uitgevoer: Eerstens om die aanpasbaarheid en voortplanting van vleisbeeste onder toestande van gemeenskaplike bestuur te evalueer, en tweedens om `n voorspellende vergelyking vir skrotale omvang (SO) af te lei deur gebruik te maak van die hartomvang (HO) en skofhoogte (SH) onder toestande van gemeenskaplike bestuur. Die invloed van die nedersetting op die kondisietelling (KT) was `n beduidende bron ($P<0.01$) van variasie. Beeste uit die Vuvha-nedersetting het `n hoë KT getoon in vergelyking met dié van ander nedersettings. Geslag het ook `n beduidende invloed ($P<0.001$) op die KT gehad. Manlike diere het `n hoër KT as vroulike diere getoon. Ouderdom het `n variasie op die KT getoon ($P<0.0001$). Kondisie neem al minder toe met die ouderdom van die beeste. Die Nguni-ras bereik `n hoë KT op vierjarige ouderdom, en daarna neem dit af. Die maand beïnvloed ook die KT. Die beeste het `n hoë KT gedurende die maand van Mei in vergelyking met ander maande getoon. Die kalfpersentasie van daardie gemeenskaplike vleisbeeste was oor die algemeen hoër, en daar is gevind dat dit deur die maand en die aantal beskikbare bulle beïnvloed word. Hoë persentasies is gedurende die maande van Januarie en September waargeneem. Ouderdom het ook die skrotale omvang (SO) en huiddikte (HD) beïnvloed.

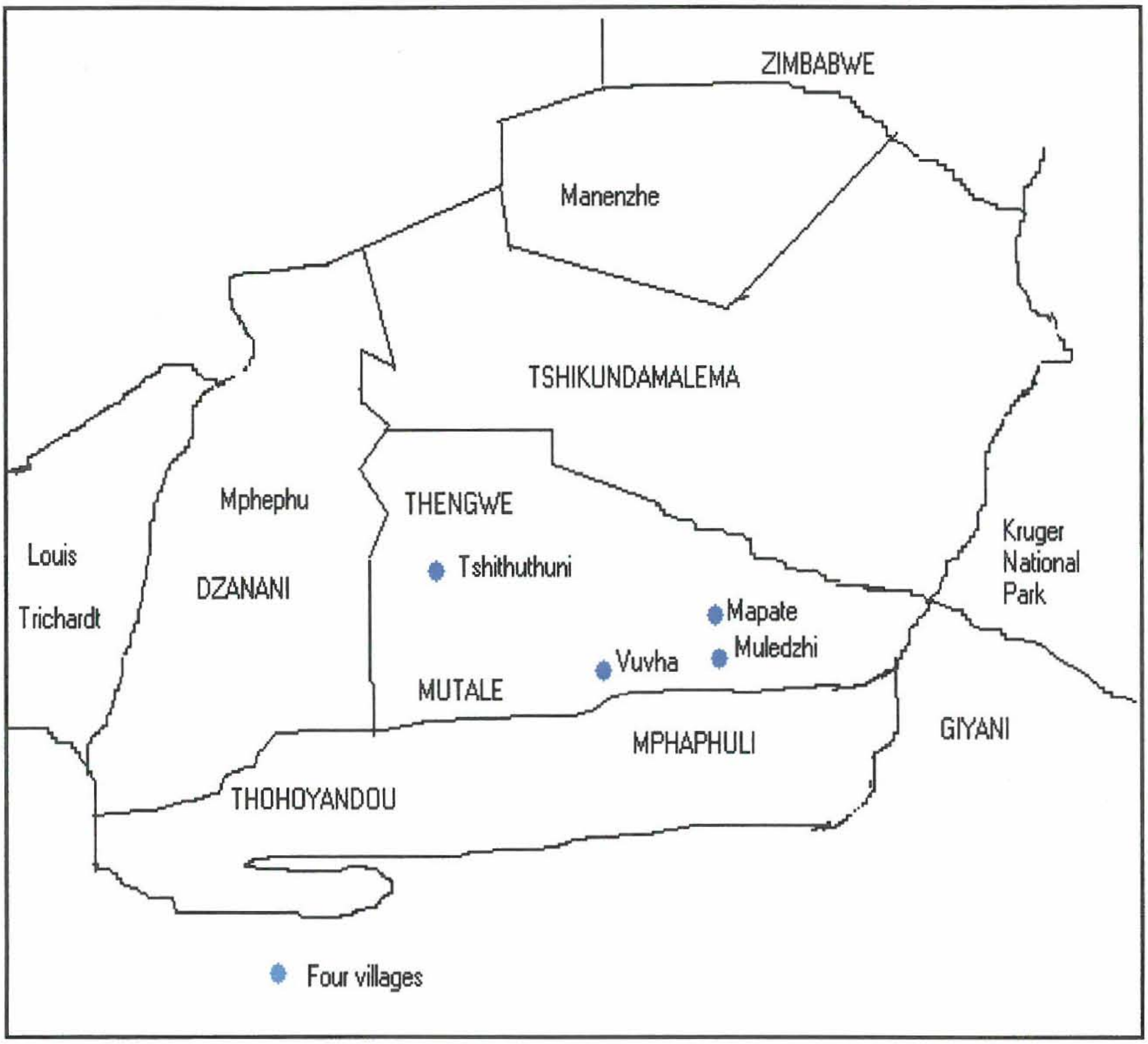
Die hartomvang (HO) en skofhoogte (SH) het `n beduidende effek ($P<0.001$) op SO by twee-jaar-oue bulle gehad, maar die model het `n klein verhouding getoon, naamlik $R^2=0.21$ (HO) en $R^2=0.32$ (SH). Die gebruik van kwadratiese en kubieke HO en SH in kombinasie het gelei tot verbeterings van 0.15 (SC_4) en 0.10 (SC_7 & SC_8) op R^2 soos vergelyk met liniêre modelle. Die beter (kwadratiese & kubieke) voorspelling van SO is ook op vierjarige ouderdom waargeneem, met $R^2=0.40$ en $R^2=0.43$ onderskeidelik. Hoë kwadratiese en kubieke variasie is egter op vyfjarige ouderdom gevind – $R^2=0.70$ (HO) – en liniêr $R^2=0.58$ (SH) wanneer dit as kwadratiese en kubieke effekte toegepas word. Skrotale omvang het `n hoë variasie ($R^2=0.50$) van HO getoon, en $R^2=0.59$ van SH in kombinasie, wanneer as beide kwadraties en kubiek toegepas word gedurende die maand van Julie.

Appendix 1

Summary statistics of the data

Trait	No	Mean±Std error	Std dev	C.V
BCS	1374	2.44±0.72	3.79	29.44
SC	209	23.84±2.60	7.17	21.20
ST	452	10.82±260	123054	24.05

Appendix 2



Study area comprised of four villages

Appendix 3

Breed classification according to adaptability and physiological and anatomical traits:

A. Adaptability to climate and environment

Trait	British Beef Breeds (Hereford, Sussex, Angus	Dual Purpose (Simmental, Brown Swiss)	Bos Indicus Breeds (Afrikaner, Sanga, Brahman	Synthetic Breeds (Drakensberger, Bonsmara	Specialised Beef Breeds (Charolais)
1. Tropics and subtropics	Poor	Moderate	Well	Good variable	Poor, crosses are better
2 Temperate	Good	Good	Disadvantaged maintenance increases	Good	Good
3. Low level management	Poor	Poor	Good	Moderate	Poor
4. Ideal feed environment	Intensive and semi-intensive	Intensive and semi-intensive	Extensive	Intensive to extensive	Intensive

B. Physiological ability

Trait	British Beef Breeds (Hereford, Sussex, Angus)	Dual Purpose (Simmental, Brown Swiss)	Bos Indicus Breeds (Afrikaner, Sanga, Brahman)	Synthetic Breeds (Drakensberger, Bonsmara)	Specialised Beef Breeds (Charolais)
1. Puberty	Early	Generally early	Late, excluding Nguni	Early	Moderate, dystocia
2. Fertility and lactational anoestrus	Good	Good	Moderate Nguni/ Afrikaner	Good	Moderate nutritional level important
3. Milk production and weaning weight	Low	High	Moderate	Moderate to high	Moderate, high inherent growth
4. Mothering ability	Moderate	Moderate	Good	Good	Moderate
5. Loss of weight during lactation	Generally good, depends on milk production level	Good	Variable	Excellent	Moderate