Effect of Bioregion on the Size and Production Efficiency of Bonsmara Cattle in Semi-Arid Parts of Southern Africa

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Additional information is available at the end of the chapter

Abstract

The effects of bioregions in the semi-arid parts of Southern Africa on growth, size and reproduction efficiency of Bonsmara cows are investigated. The regional distribution of cattle influences the growth, size and reproduction efficiency of cows, and provides evidence for an optimal cow size for different bioregions. Effects of bioregion on growth and reproduction of extensive beef cattle is complex, because the proportion of variation in growth traits explained by bioregion, depends on the physiological stages of growth, e.g., birth, weaning, 12- or 18-month growth stages. For production efficiency, weaning- and yearling weights as well as age at first calving (AFC) and reproduction index (RI) were influenced most by bioregion. Management practices, such as livestock recording and improvement strategies, and better nutrition at weaning and yearling age, limit the negative effects of bioregion on cow growth and size. Genetic trends indicate that the efficiency of growth improved, but was associated with a decline in reproductive characteristics. Indiscriminate selection for growth traits in cattle adversely affects reproduction. The current data indicate that cows of medium size had the best reproduction rates. Acceptable reproduction of larger cows can be achieved with improved management and strategic feed supplementation, although more costly.

Keywords: bioregion, beef cattle, growth, size, reproduction, efficiency

1. Introduction

Sustainable livestock production is imperative on the African continent, to reduce poverty and ensure household food security. It is estimated that edible products from animal origin

account for more than 40% of the total value of South Africa's agricultural output [1]. Only 15% of South Africa is suitable for arable farming, and more than 40% of the remaining 85% receive less than 375 mm rain per annum [2], which explains the relatively low agricultural production potential of the Southern African region. The South African National Strategic Plan for Agriculture endorses the fact that there is very little room for horizontal expansion of agriculture, due to environmental constraints [1], so increased agricultural production can only be achieved by improving the efficiency of production [3] and exploiting vertical integration in regions with a moderate or higher agricultural potential [4, 5].

Long term improvement of the efficiency of animal production can only be achieved through the identification and selection of genetically superior animals for breeding purposes [3, 6]. Selection can be done based on a combination of pedigree information, appearance, and performance recorded information and breeding values [7]. Beef cow efficiency will be highest when cow size is tailored to the environment and the animals are well adapted [8–10]. Cow size has an important influence on the way the cow responds to its production environment [11] and the adaptability of the animal [8]. Adapted animals are tolerant to adverse environmental conditions and are able to maintain reproduction efficiency [6]. In order to improve beef cow efficiency in Southern Africa it is therefore important to optimize cow size, adaptability and employ effective management practices.

The adaptability of beef cattle in extensive production systems is critical and genetic gains in this regard can be best achieved by implementing some beef industry recommendations as listed in [12] namely:

- Identification and characterization of the major beef cattle production environments, and their respective nutritional, physical, climatic, management and economic characteristics,

- Defining the major physical, biotic, social and management stressors in each beef production environment.

2. Cow size and adaptability

The environmental and genetic factors that influence mature cow size include nutrition and management functions, as well as climatic factors such as rainfall and temperature and temporary environmental effects such as differences in fill when weighed and other climatic factors may also influence mature weight [3]. Mature cow weight reflects differences in size associated with skeletal size and lean growth, as well as fatness [13]. The genetic proportion of mature cow weight is mostly due to additive genetic variation, but there are differences in opinion about exactly when cows reach mature weight, e.g., at either 4.5 years, 6.5 years as in Ref. [14], or about 7 years of age [15]. It is difficult to determine exactly when animals stop growing [16], but it is accepted that cows accumulate most of their final weight at 4-years of age and final height at 3-years of age [13].

Several authors have made suggestions about which mature size should be optimal for a particular environment. The significant influence of cow size on production efficiency is also the

reason why traits such as mature weight, height and length, are included in selection criteria [13]. In the late seventies and eighties there was an international trend to select for larger cattle [17], resulting in a net increase in growth rate, but it had a negative impact on female fertility traits [18].

The maintenance overhead is one of the most important factors that determine the biological efficiency of beef cattle, for example an adult cow require more than 50% of her total energy intake for maintenance [11]. Kleiber's theory, however, states that metabolic weight = (live weight)$^{0.75}$ [19]. Larger cows therefore consume more nutrients than smaller cows but the percentage additional nutrient requirement of larger cows are less than its additional weight as a percentage. For example, a cow with mature size of 545 kg weighs 20% more than a 454 kg cow, but its maintenance requirements are only 13% higher [20].

The results of [21] suggest that when nutrient availability is limited, breeds with a moderate genetic potential for growth and milk production are generally more efficient because of higher conception rates. Similar results were reported in [10] in extensively managed Santa Gertrudis cattle in a semi-arid environment. At high levels of nutrient availability breeds with the highest genetic potentials for growth and milk production are most efficient because feed availability is sufficient for the genetic potentials to be expressed. Cow efficiency is thus maximized at a level of feed intake that do not limit reproduction and also provides sufficient energy for milk production to meet the growth potential of the breed as expressed in the calf [21].

3. Functional efficiency and cow size in semi-arid regions

The Bonsmara cattle breed and the concept of "breeding for functional efficiency" was coined by [8], and this concept is effectively employed by the Bonsmara Cattle Breeders Society of South Africa. The Bonsmara is now one of the predominant beef cattle breeds in Southern Africa (>100,000 registered animals; see [27]), and it was created based on a 5/8 Afrikaner and 3/8 Exotic (Shorthorn/Hereford) breeding admixture [8]. Considerable emphasis was placed on the adaptability of the breed. The functional efficiency concept is based on the presumption that selection for phenotypic traits that influence an animal's ability to adapt to the environment, will improve the animal's ability to express its reproductive and productive potential. It was also commonly presumed that specific types or sizes of cattle are better adapted to specific production regions than animals of a different size or type, but this concept was only verified for beef cattle in Southern Africa in a recent study [22].

The natural variation in size of the same species of wild animals occurring in different locations is an indication that nature defines the "right" genetic material for efficiency in different ways in different environments [20]. The influence of production region on cattle production has been investigated by [23], and the notion of an optimal size for a specific environment was previously proposed by several other researchers [8, 11, 17, 20, 24].

The study by [22] which includes records of ca. 12,500 fully registered Bonsmara cows representative of a 20 year period, confirmed that bioregions (Central bushveld, Eastern Kalahari

bushveld, Dry Highveld grassland, and Mesic Highveld grassland) in South Africa significantly influenced the size of beef cows, and also confirmed the existence of an optimal mature cow size in different geographical regions of Southern Africa (**Figure 1**). These findings confirm the importance of the identification of production regions and characterization of optimal body size per region, in order to determine the most suitable areas to purchase breeding animals from, maximize genetic gains and improve production efficiency. A regional livestock classification system was previously published by [25] as illustrated in **Figure 2**, in which areas suitable for different types of livestock were identified.

Biological and environmental features that influence the regional adaptation of livestock as published by [25], remain as valid in modern livestock production, as 60 years ago namely:

- Hereditary differences between the characters determining the productivity of various types of livestock.

- The fundamental physiological phenomena of growth, development, reproduction and production.
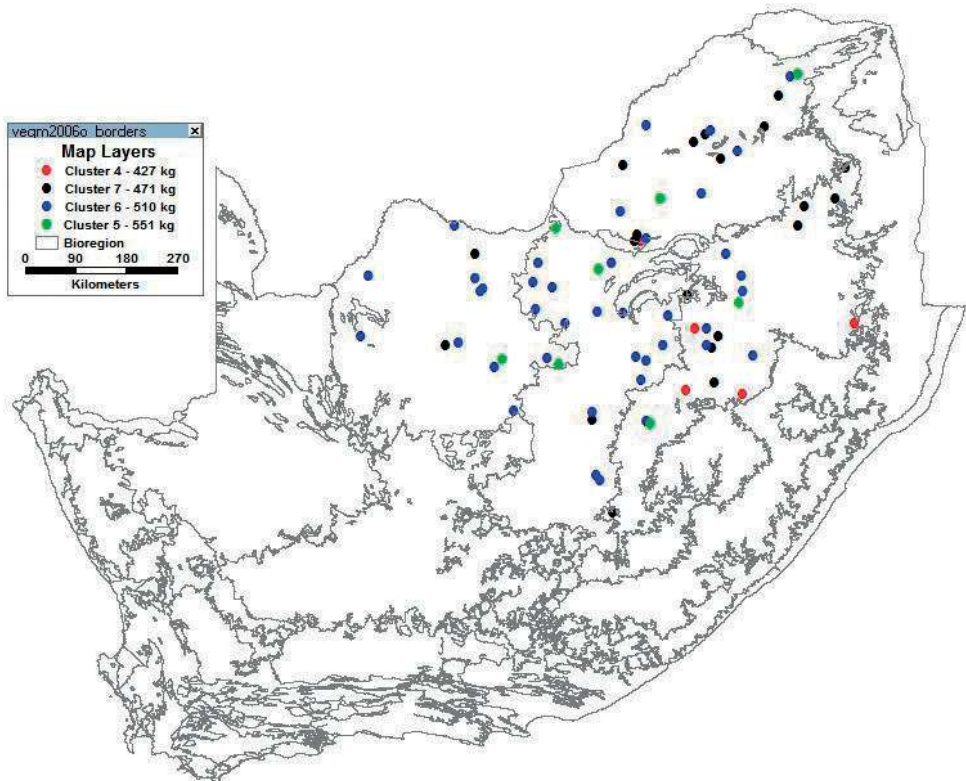

Figure 1. Effect of geographical region on the mean cow size of Bonsmaracows in Southern Africa.
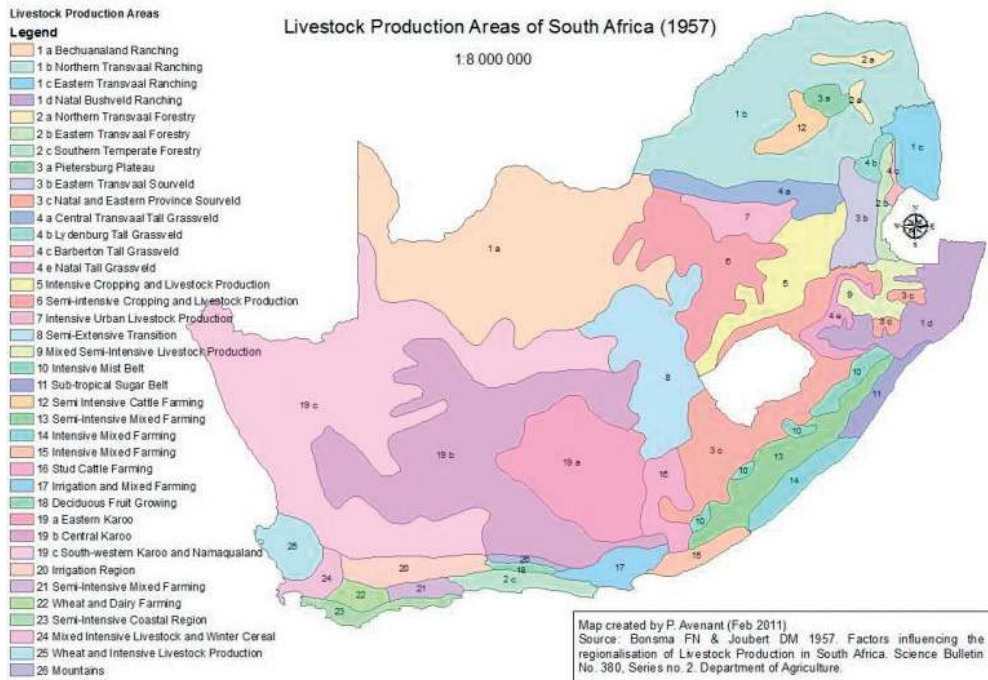
Figure 2. Livestock production areas of South Africa [25].

- The relation between the nutritional requirement of different classes of livestock during successive stages of their existence, as well as their reaction to the climate.

- Geographical and physical features of the various regions and their potential for providing favorable conditions of nutrition in order to promote the optimal expression of the animal's productive ability.

- Information on the distribution of enzootic and epizootic diseases in relation to physical and biological factors which promote the spread of, or assist in its control.

Most pedigree breeds of cattle have a hierarchical breeding structure (**Figure 3**), in which elite breeders furnish breeding material to each other and to middle order breeders. Middle order breeders in turn sell breeding material among themselves and to the lower group of breeders (also referred to as multiplier breeders), but seldom sell animals back to the elite breeders [26]. Analysis of the breed structure of the Bonsmara breed indicates that the combined genetic contribution of elite breeders constitute as much as 30.4% of the genetic composition of this breed. This means that elite breeders have a large influence on the genetic make-up of cattle breeds, which directly affects the types of cattle kept by multiplier and commercial breeders.
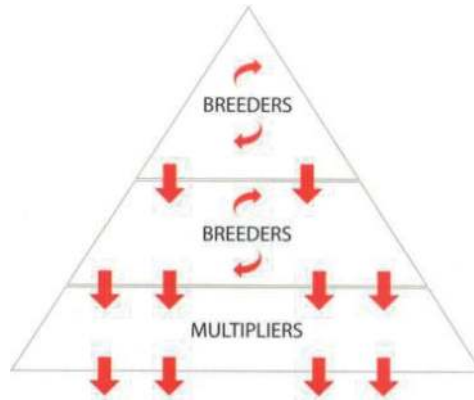
Figure 3. Pedigree breed hierarchy [26].

4. Components of beef cow efficiency

An efficient cow herd is sexually precocious, with a high reproductive rate, low dystocia and has longevity with minimum maintenance requirements [24]. A herd's ability to reproduce in a given nutritional environment is the most important contributing factor to efficiency. Selection goals for efficiency in the cow-calf production systems include early sexual maturity
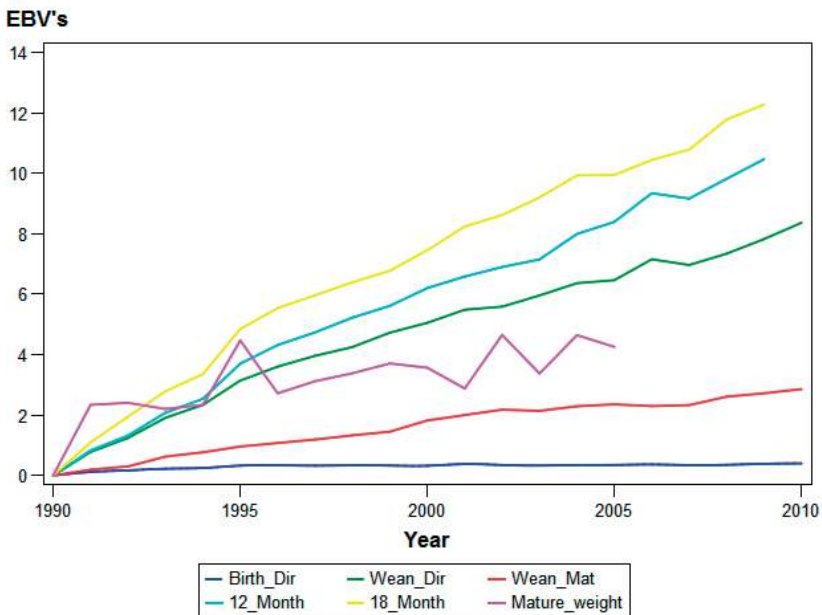

Figure 4. Estimated breeding values (EBV) for growth traits in the Bonsmara cattle breed from 1990 to 2010 (source: ARC-API) (*Birth_Dir ~ EBV for birth weight direct; Wean_Dir ~ EBV for weaning weight direct; Wean_Mat ~ EBV for weaning weight maternal; 12_Month ~ EBV for 12-month weight; 18_Month ~ EBV for 18 month weight; Mature_weight ~ EBV for mature weight*).
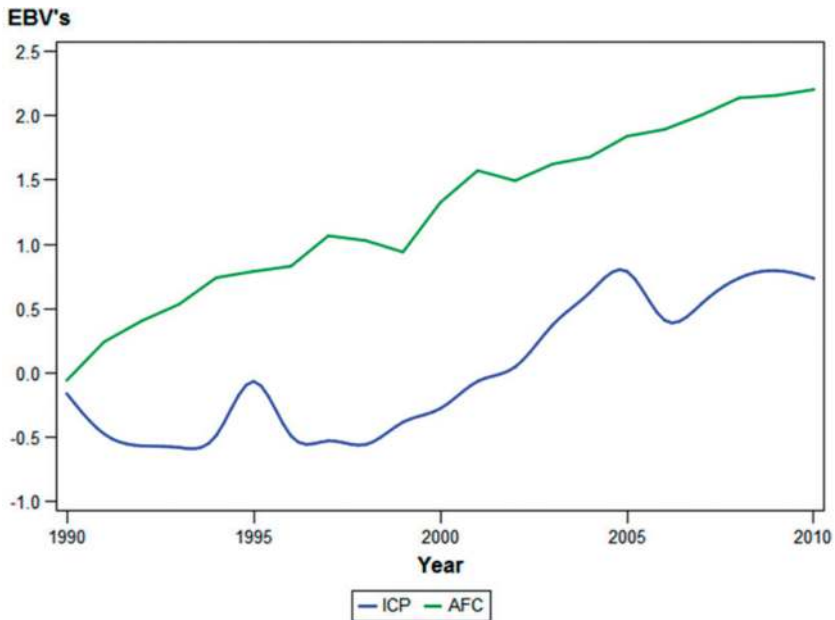
Figure 5. Estimated breeding values (EBV) for reproductive traits in Bonsmara cows from 1990 to 2010 (source: ARC-API) (*ICP ~ EBV of Inter-calving period; AFC ~ EBV for age at first calving*).

with lean growth and minimal increase in mature weight [24]. The most efficient beef cow is therefore the one with the highest milk production that can yearly wean a calf with the growth and carcass characteristics required by the market [20].

Genetic trends for growth and maternal traits in the Bonsmara breed studied by [22] are shown in **Figure 4**. In this study, the genetic trends are presented for a 20 year period (1990–2010), which illustrates the consistent improvements in estimated breeding values for weaning weights (direct and maternal), 12- and 18-month weights, while estimated breeding values for birth and mature weights remained nearly constant. These improvements were obtained in well-managed cattle herds, which generally exhibit regional differentiation in mature size (e.g., optimum body size relative to bioregion, as illustrated in **Figure 1**).

Genetic trends for reproduction traits of the 20 years of Bonsmara breed data studied, are presented in **Figure 5**. Estimated breeding values for both age at first calving and inter-calving period increased since 1990–2010. It follows that the reproductive ability of cows decreased marginally during the same period during which marked progress was made in terms of growth traits, possibly since cow size still exceeded to production potential of the main beef cattle production regions in Southern Africa.

5. Reproduction of extensive beef cattle

Reproduction and calf survival rates are the most important factors that determine the efficiency of a beef herd [10, 24]. In spite of the importance of reproduction it is generally

accepted that in South Africa the calf crop averages between 60 and 65% per annum [27]. Conception rates of cow herds are influenced by a number of interacting factors such as (a) plane of nutrition of bulls and cows, (b) the age of the breeding animals, (c) herd health, (d) libido and (e) semen quality of bulls as well as (f) the ability of cows to conceive and maintain pregnancy [28, 29].

The reproductive ability of a cow is determined by her performance in terms of a number of different reproductive functions that occur throughout her lifecycle. These functions can be divided into component and aggregate traits. A component trait is a single event while aggregate traits are composites of more than one reproductive event [28]. Some of the component traits that can be measured, include time to first oestrus, number of services per conception, pregnancy rate, heifer pregnancy, gestation length, days to calving, age at first calving, calving date, calving ease, calving interval and days open. A combination of these traits are often used to form aggregate traits such as, calving rate, lifetime pregnancy rate, calving success, calf survival and lifetime production. Although these traits might reflect an indication of reproductive performance there are unfortunately no completely satisfactory measure/s of reproduction efficiency [30, 31]. This is due to the influence that the age structure of the herd as well as the prevailing environmental and management conditions have on reproductive recording [28]. Traits that are most frequently used to evaluate reproductive performance are AFC and ICP as well as Reproduction Index (RI), and post-partum anoestrus remains one of the most limiting factors [22, 28, 29].

Age at first calving (AFC) is an important production parameter for commercial beef cattle producers, since it affects the size of cows as well as weight and number of calves produced. AFC also affects the potential annual genetic progress for stud farmers [32]. Beef heifers are generally managed to calve for the first time at either 2 or 3 years of age [32, 33]. Mating heifers earlier may increase dystocia and there are conflicting reports on the lifetime production span of early mated heifers. Some authors reported an increase in the number of calves and weaned kilograms (see [32, 34]), while others reported no increase in the weaned weight, despite the birth of an extra calf [33]. Nevertheless, the success of mating heifers at a younger age depends on nutritional and management levels (see [33]), and most heifers have the potential to reach puberty and breed satisfactorily in such systems [35].

There is a great deal of controversy regarding the use of AFC as a measure of female reproductive ability in the literature. The biggest advantage of AFC is that it can be easily recorded because the birth date of the cow and its first calving date are generally known, while the main disadvantage is that it only represents a single component in the reproductive life of a cow [28]. The general consensus is that in a variable seasonal environment, management decisions often have a greater effect on AFC than genetic merit. Researchers increasingly question the use of AFC, because AFC and the probability of heifers to reconceive are determined by different genes.

It was argued by several that reducing the AFC is one of only a few means of improving lifetime production efficiency in the beef cow herd [33, 34]. Shorter AFC values naturally reduce the generation interval, and thus contribute to the annual genetic gain of the herd [36]. Another common but erroneous belief is that scrotal circumference in yearling bulls may be an indicator of reproductive fitness in female offspring [35, 37]. Scrotal circumference was

therefore often included in selection programs to improve heifer fertility. However, recent datasets indicate that the association between scrotal circumference and heifer fertility traits is low [36, 38].

5.1. Inter-calving period

ICP or calving interval is an aggregate reproductive trait, composed of more than one reproduction event, and is defined as the time that elapsed between two successful calving's [28]. ICP is regarded as an important fertility trait, especially if one considers the importance of reproduction in a calf production system [39]. The ideal would be that every cow should calf every year and that the ICP of a beef cattle herd should be less than 365 days [38, 40]. This means that a cow should conceive within at least 80–90 days after calving, but it is accepted that the ICP in many breeding herds often exceeds 365 days in the tropical or subtropical areas due to high humidity and temperature and lower forage quality [41]. According to the SANBRIS, the current ICP average for the different breeds in Southern Africa ranges between 398 and 477 days. The Hereford and Shorthorn breeds have the shortest (398 days) and the Huguenot the longest (477 days) ICP, while the average ICP of the Bonsmara breed is 405 days [27].

The use of ICP as a measure of reproductive efficiency in a fixed breeding season has been questioned by several authors [28, 30, 42]. The major criticism against ICP as a selection criterion for reproductive performance is the negative correlation that exists between ICP and previous calving date as well as the large influence that the previous calving date has on the ICP [42]. This means that cows that calve early in the season have the longest ICP while those that calve late in the season have the shortest ICP.

The low heritability of ICP is also another question raised. The estimated heritability ranges between 0.02 (see [43]) and 0.12 (see [31]), with a low repeatability of 0.14 [43]. The repeatability estimate for ICP suggests that female culling based on first calving interval is not accurate and there is a risk of culling animals with other desired traits. Selection for shorter ICP's could result in indirect selection for a later age of puberty as cows with the shortest calving interval, are often those who calved late in the season [30]. It also does not take information from the first parity or the end of a cow's life span into account when the ICP of the herd is determined [28].

The analysis of ICP is also problematic because it is only available for cows that calve repeatedly and should therefore be treated as a censored trait. Fortunately ICP is based on the period between two calving's; it can therefore be easily computed with a minimum of data, and this data will be lost from the reproductive information for the first parity as well at the end of a cow's lifespan if no calf is born [28, 29].

5.2. Post-partum anoestrus

Post-partum anoestrus (PPA) is the period after parturition during which cows do not show behavioral signs of oestrus, which is one of the main causes of extended ICP [40]. Although PPA is caused by static ovaries, there might be follicular development, but none of the ovarian follicles become mature enough to ovulate. PPA may be caused by a number of factors, such as pre-partum feeding level as reflected by body condition at calving, post-partum nutritional

status and parity of the cow, suckling interval (see [40, 44]), cow-calving season due to nutritional factors and or light and temperature and dystocia (see [44, 45]), the presence of a bull (see [45]) breed and age of parity also has an influence (see [45, 46]) as well as sire breed.

Although many factors affect postpartum anoestrus, nutrition and suckling are the major influences on the resumption of postpartum ovarian cycles, as it affect hypothalamic, pituitary and ovarian activity and therefore inhibit follicular development [47, 48]. Under-nutrition contributes to prolonged postpartum anoestrus, particularly among cows dependent upon forage to meet their food requirements [40]. The nutritional status or balance of an animal is evaluated by means of the Body Condition Score (BCS) parameter. BCS reflects the body energy reserves available for metabolism, growth, lactation and activity. There is a relationship between energy balance and time to the resumption of postpartum ovarian activity.

Inadequate nutrition cause excessive weight loss, followed by a decrease in BCS and finally cessation of the oestrus cycle. Suckling probably interferes with the hypothalamic release of GnRH and suppresses the pulsatile release of LH which leads to an extended postpartum anoestrus [40]. However, the exact interaction by which suckling extends post-partum anoestrus is uncertain [49]. The huge benefits of 12- or 48 hour calf removal prior to the onset of breeding were clearly demonstrated [47, 48]. This research disclosed significant improvements in conception rates from 55 to 76% in Brahman-type cows in a semi-arid environment. Such strategies are beneficial in terms of beef cattle production, but are not widely employed in Southern Africa.

Other factors that influence the anoestrus period after calving and cause a longer inter-calving period are: general infertility, uterine involution, short oestrus cycles and post-partum anoestrus [45]. Management practices play an important role in the ICP of a herd and the following practices may decrease PPA:

- Introduce a short breeding season.
- Make use of BCS to monitor nutritional management.
- Minimize dystocia distress.
- Use a sterile teaser bull with cows during the early postpartum period before the breeding season starts.
- Synchronize oestrus.
- Decrease suckling stimulus.

Although there are numerous objections to the use of inter calving period (ICP) as a measure of female reproductive performance, there is no alternative to ICP as a measure of reproductive performance [50].

6. Maternal component of growth

Growth traits like birth and weaning weights are determined by the animal's own additive genetic merit as well as the maternal component, which can be further separated in an

additive genetic and a permanent environmental component [51]. The maternal component mainly represents the dam's milk production and mothering ability, although the uterine environment and extra-chromosomal inheritance may also have an effect. The dam's genotype therefore has an effect on the phenotype of the young through a sample of half her direct, additive genes for growth as well as through her genotype for maternal effects on growth [52].

Postnatal calf growth and physiological development are initially influenced by stimuli experienced *in utero* [53]. Maternal nutrition therefore potentially affects not only cow productivity but also post-weaning calf productivity [54]. Protein supplementation during late gestation, as well as increased total nutrient supply throughout gestation, may increase calf birth weight [54]. Another major component of the maternal environment created by the dam is the nutrition the calf receives through milk. There is a positive relationship between the breeding value for milk for the dam, actual milk production and the weaning weight of calves [55]. A high correlation (0.8) was reported between direct milk yield and maternal weaning gain (see [56]).

Milk intake also influences forage intake of nursing calves, e.g., calves of dams with lower milk production are more reliant earlier in lactation, on alternative feed sources of lower nutritional value than milk [57]. Calf body weight and forage dry matter intake are correlated with calf milk intake, and nursing calves generally become increasingly dependent on forage after 60–90 days of age to maintain normal growth. It follows that the forage quality of rangeland systems affect growth rates of calves through influences on the milk yield of dams and quality of the forage portion of a calf's diet.

7. Effectiveness of selection for reproduction efficiency

Fertility is a complex trait that has many components [28, 29]. Both male and female traits contribute and show considerable variability. Selection for both male and female fertility is therefore desirable [56]. Although the aim is usually to maximize the reproductive potential of beef cattle, more is achieved by optimizing rather than maximizing reproduction because the gross margin per cow increases parallel with the calving rate, but the margin per cow does not necessarily show the same response [58]. Fertility traits are heritable, but relatively few heritability estimates have been reported for fertility in beef cattle [28, 38]. In a review of fertility traits the heritability estimates for fertility ranged from ≤0.10 to ≥0.60 [38]. Unfortunately genetic improvement of fertility is hampered by a lack of information, low heritability and the delayed expression of the trait.

The heritability's of fertility traits are difficult to estimate because the expression of the reproductive potential is often constrained by management systems [29, 56]. Moreover, the underlying genetic merit for fertility is often not expressed, due to the threshold nature of fertility traits. There are only two outcomes possible for successful reproduction: Whether the cow is pregnant or not, degrees of pregnancy are not observable. The environment has a strong influence on which side of the threshold trait an individual falls [35]. The general consideration is that selection has a limited potential to improve fertility in beef cattle, while improvements in cow

and environmental management hold much promise to optimize cow reproduction [22]. One of two approaches is often recommended when selecting for improved fertility [35] namely:

Step 1. The *direct* approach involves the physical selection for fertility traits. This should include traits such as scrotal circumference, age at puberty, age at first calving as well as calving date and the proportion of heifers in production at a given age. The use of any prospective fertility trait depends on the ease of measurement and the inherent relationship with fertility.

Step 2. The second or *indirect* method proposed is to use an array of traits that indirectly affect fertility, such as milk production, growth rate, calving ease and body condition. Selection for optimum combinations of these traits should create a favorable "genetic environment" for fertility.

8. Influence of selection for growth on beef cow efficiency

Growth traits are highly heritable, with heritability's ranging from 0.24 to 0.61, so fast genetic progress is possible when animals are selected for growth rate [59]. Selection for growth is complex, since traits like birth and weaning weight are determined by the animal's own additive genetic merit as well as the maternal component, which can be further separated into an additive genetic and a permanent environmental component [51]. It is well known that selection for a higher growth rate eventually increases the mature size of animals, which is due to the positive correlation between weights at different ages [59]. There is also a negative correlation between mature size and age of maturation, which means that selection for larger size in the long run increases the time taken to reach maturity.

Genetic change in the shape of the growth curve is limited by the degree of genetic flexibility in the shape of the curve, which depends on the degree of interdependence of the size, rate and inflection of the growth parameters [3, 60]. Although theoretically possible, the basic shape of the sigmoidal growth curve as well as the sequence of physiological events remains virtually unchanged. The rate of these processes has however increased remarkably over the past few decades [3]. In fact, selection for increased body weight or growth rate may have an adverse effect on body composition, fertility and survival rate [27]. It was suggested that selection should rather be focused on increased feed efficiency because it may lead to fewer adverse effects. Some researchers also postulated that selection for growth and efficiency may have reached the physiological limits of animals to cope with the demands of maintenance, accelerated growth, development, adaptation and reproduction [3].

9. Growth rate and reproduction

Information on the effects of selection for body weight or growth rate on reproductive fitness in cattle is unfortunately limited [27]. In a fundamental theorem of natural selection in the 1930s it was already postulated that reproductive fitness and body weight will be near the peak of fitness in a natural population [61]. However, when selection for growth takes place, the population is no longer in a natural equilibrium, so the reproductive fitness may in fact

decline when the mean of a population is moved in either direction due to selection pressure [62]. The antagonistic relationship between fertility and milk production in dairy cows and the resource allocation theory support this theory [63]. The general consensus is that selection for increased body weight or growth rate may have an adverse effect on fertility [27] for the following reasons namely:

- Increased infertility is the result of the deviation from an optimum body weight that is associated with an optimum degree of fitness.

- Pleiotropic genes with opposite effects on growth rate and fertility may become important as a result of prolonged selection.

- Major changes in body weight or growth rate may upset the natural homeostasis and endocrine balance which developed in each species over its evolutionary history.

- Selection for increased growth rate may result in indirectly selecting for feed intake and this may lead to the breeding of animals with a predisposition for high feed intake. Gluttonous animals can become obese at maturity, which may influence fertility.

There is therefore a concern that selection for high growth rate might have negative effects on the fertility of cows [64]. However, contrasting results have been published which indicate that cows with a high pre-weaning growth, reared more calves over their lifetime, had lower calf mortalities and also calved earlier than cows with lower pre-weaning growth [65]. In another unrelated study the reproductive performance of Angus females selected for a high growth rate was similar to those of females where there was no deliberate selection pressure at all. The EBV trends obtained and presented in **Figures 4** and **5** for growth and reproduction traits in Bonsmara cows, indicate a negative correlation and warns against excessive selection for growth traits in extensive beef cattle, especially if the natural resources are limited [22].

10. Conclusions

This study investigated the effects of different bioregions in the semi-arid parts of Southern Africa on the growth, size and reproduction efficiency Bonsmara cows. This study employed novel techniques to investigate the influence of production environment on the growth, size and reproduction efficiency Bonsmara cows. Results indicate that bioregions affect the growth, size and reproduction efficiency of beef cows, and provide evidence for the existence of an optimal cow size for different bioregions. Results revealed a complicated relationship between bioregion and the growth, size and reproduction efficiency of Bonsmara cows. The proportion of variation in cow growth traits due to the regional distribution of cows, depended on the physiological stages of growth, e.g., birth, weaning, 12- or 18-month growth stages. In terms of production efficiency, weaning- and yearling weights as well as AFC and RI were influenced most by differences in regional distribution of cattle. Management practices and breeding objectives have a major effect on the efficiency of beef cow production

efficiency. The effective implementation of management practices, such as the provision of nutritional supplementation at weaning and yearling age, limits the negative influence of regional effects on cow growth and size.

Genetic trends indicate that the efficiency of growth improved remarkably during the past 20 years in the Bonsmara cattle breed. However, improvements in growth and efficiency, were associated with a decline in reproductive characteristics. Reproduction efficiency is the single most important aspect of beef cow efficiency and breeders should guard against indiscriminate selection for growth traits, which may adversely affect reproduction performance, especially since much research endorse the existence of a negative relationship between growth and reproduction traits. Although the common belief is that smaller cows reproduce better in more resource constrained regions, the current data indicate that composite type cows of medium size had the best reproduction rates. The reproductive ability of larger size cows improves markedly with improved management and strategic feed supplementation.

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