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Reproductive Performance of Extensively Managed Beef Heifers Mated at 14 Or 26 Months in the Central Bushveld Bioregion

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ABSTRACT

In South Africa, little local information is available on the value of early mating of extensively kept beef heifers. In contrast, international information is mainly restricted to dairy cattle and intensive production systems. The research was undertaken to evaluate the calving percentage of Bonsmara heifers mated for the first time in an extensively managed beef herd at either 14 or 26 months. Fifty percent of the heifers were mated at 14 months, while the other 50% were mated at 26 months of age for 90 days during the summer mating season (January to March). The research was conducted over six years (2009 to 2014). A 2^3 factorial analysis of variance (ANOVA) was performed using the six years as block replications. This was done because different animals were evaluated every year. The calving percentage of heifers mated at 26 months was significantly higher than heifers mated at 14 months. From the current study, it seems unlikely that mating heifers at 14 months of age can improve on the traditional extensive system of mating heifers at 26 months on natural veld in the Central Bushveld Bioregion.

Keywords: Age at mating, Bonsmara heifers, Calving percentage

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1. INTRODUCTION

Within-herd sourcing of replacement heifers is an important component in small-scale, communal, and commercial beef production systems in South Africa (Bergh, 2012). These heifers are better acclimated to the production system and accustomed to the herd management strategy. Growth, phenotype, robustness, and temperament can also be better evaluated from heifers born on-farm. In addition, health risks (e.g., venereal diseases, bovine viral diarrhoea, and respiratory diseases) can be minimised and better controlled when fewer animals are brought in from unknown origins (Schulz & Gunn, 2014).

A heifer's lifetime productivity as a productive beef cow is influenced by puberty, age at first conception, and calving interval (Wathes, Pollott, Johnson, Richardson & Cooke, 2014). When a heifer calves for the first time, it marks the beginning of her productive life. One of several ways suggested to improve beef-cow lifetime productivity is to reduce the age at first calving (van der Merwe & Schoeman, 1995). However, this may be less economical if seasonal conditions are poor, as extra feed costs may not be compensated for by the additional return when heifers are fed to calve at two years of age (Kroker, Clarke & Clarke, 2022).

The sustainability of different types of beef production systems differs between countries and climatic zones due to differences in available natural resources, rainfall distribution, access to livestock feed, as well as the robustness of the economy (Smith, Gotoh & Greenwood, 2018). This highlights the need for local research results and information. In South Africa, extensively kept heifers are usually mated for the first time at 26 months. However, various previous studies advocate the mating of heifers at one year of age (Fahmy, Lalande & Hidiroclou, 1971; Meaker, Coetsee & Lishman, 1980; Nunez-Dominguez, Cundiff, Dickerson, Gregory & Kock, 1991; van Niekerk, Kernick & Lishman, 1990). The theoretical advantage of mating heifers one year earlier lies mainly in the potential increase in lifetime productivity and the expectation of an extra calf (Meaker, Coetsee & Lishman, 1980). However, while extension officers may be confronted with this question, little new information on the biological or economic value of early mating of extensive beef heifers in South Africa is available.

Most of the literature available is restricted to dairy cattle (Abin, Visser & Banga, 2018; Mostert, Theron & Kanfer, 2001; Muller & Botha, 2000) and intensive production systems. In addition, most South African studies were done more than 30 years ago (Morris, 1980; Scholtz, Lombard & Enslin, 1991; van der Merwe & Schoeman, 1995). There seems to be no consensus among farmers on the

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advantages of early mating of extensively managed beef heifers in South Africa, which makes it challenging for extension officers to give reliable advice to farmers. Although results obtained from projects under research station conditions can take years to be fully adopted by farmers (Conradie, 2019), agricultural extension officers are uniquely positioned to strengthen farmers' capacity to innovate by providing access to knowledge and information (Hameed & Sawicka, 2016). This is especially important regarding on-farm decision-making for sustainable production.

The aim of this study was thus to establish whether mating replacement heifers at 14 months of age have a reproductive performance advantage over mating heifers at 26 months of age in an extensively managed beef herd grazing natural veld in the Central Bushveld Bioregion. This study formed part of a much larger project, which included two rotational grazing strategies, among others (Grobler, 2016; Grobler, Scholtz, Neser, Greyling & Morey, 2019). However, the current paper only focuses on heifer age at mating. Although they were obtained at a research station simulating an extensive commercial beef production system, the results from this study are equally relevant to small-scale and communal beef producers farming in the Central Bushveld Bioregion of South Africa.

2. MATERIALS AND METHODS

2.1. Study Area

The study was conducted from 2009 to 2014 at the Roodeplaat Experimental Farm (REF) (25°34'11.27''S; 28°22'05.36''E) of the Agricultural Research Council (ARC). Bonsmara heifers were used as the experimental animals. The vegetation in the study area has been described as Savanna (Rutherford & Westfall, 1994), Sourish Mixed Bushveld (Veld Type 19) (Acocks, 1988), and Marikana Thornveld (Mucina & Rutherford, 2006) in the Savanna Biome of the Central Bushveld Bioregion. The average annual rainfall for the specific study period was 858 mm (AgroClimatology Staff, 2015), with mean daily minimum/maximum temperatures ranging from 16°C (minimum) to 32°C (maximum) in February (summer) and 1°C (minimum) to 23°C (maximum) in July (winter).

2.2. Research Design

All the Bonsmara heifers and the available multiparous cows were randomly divided into two herds and subjected to two grazing strategies (traditional rotational grazing and low selective grazing). The grazing strategies did not impact animal production (P = 0.44) and are therefore not discussed in further detail (Grobler, 2016). Within each herd, the heifers were divided into two sub-herds where half of the available heifers were mated at 14 months of age – relating to between 8 and 12 animals

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– while the other half were mated at 26 months of age – relating to between 8 and 18 heifers (see Table 1). Half of the heifers in each sub-herd were subjected to oestrus synchronising before mating, while the other half were mated naturally without oestrus synchronisation. The synchronisation protocol followed the principle of keeping the animals off heat with a progestogen device (CIDR®, manufactured by Pfizer Laboratory, Sandton, RSA). The resultant flushing effect of oestrogen and luteinising hormone after removal of the device caused ovulation.

One fertility-tested breeding bull was used in each sub-herd (2009–2011) for 90 days after the onset of the mating season. The ratio of bulls to females (multiparous cows and heifers included) varied between 1:21 and 1:34. From 2012 onwards, two breeding bulls were used in each group as no animals were culled from 2012, and animal numbers increased, leading to a ratio of 13–21 females per bull. It must be noted that the heifers were kept with multiparous cows throughout the study and received no additional feed or special managerial treatment.

2.3. Statistical Analysis

To evaluate the calving percentage of the heifers, a 2^3 factorial analysis of variance (ANOVA) was performed using the six years as block replications. This was done because different animals were evaluated every year (Snedecor & Cochran, 1967). To evaluate heifer body weight at calving, a four-factor ANOVA was performed. The Shapiro-Wilk test was performed on the standardised residuals to test for deviations from normality (Shapiro & Wilk, 1965). In cases where significant deviation from normality was due to skewness, outliers were removed (n = 3) until the standardised residuals were normal or symmetrically distributed (Glass, Peckham & Sanders, 1972). Fisher's Least Significant Difference (LSD) was calculated at a 5% significance level to compare means of significant source effects. All analyses were performed using SAS version 9.4 statistical software (SAS Institute, 1999).

3. RESULTS AND DISCUSSION

There was no significant difference between the two herds for calving percentage ($P = 0.6643$) and heifer weight at calving ($P = 0.9673$). Furthermore, no significant difference ($P = 0.8078$) could be found between heifers being synchronised and those not synchronised before the mating season. There was, however, a significant difference between years for heifer body weight at calving ($P < 0.0001$) as well as calving percentage ($P = 0.0245$).

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The calving percentage of heifers mated at 26 months was significantly higher than that of heifers mated at 14 months of age ($P < 0.0001$). The calving percentage of 14-month-old mated heifers varied between 0 and 67%, and the calving percentage of 26-month-old mated heifers ranged between 58% and 100% over the six-year project period (Table 1).

The average calving percentage over the six-year project period was 74% for the heifers mated at 26 months – much higher than the 18% for heifers mated at 14 months (Table 1). Studies have shown that up to 46% of heifers calving as 2-year-olds may experience calving difficulty (Bellows, 1968). However, in the current study, only one dystocia case was reported in the 14-month-old group. The calving percentage of heifers mated at 26 months was in line with the average calving percentage of 71% of multiparous cows within the same herd (Grobler, 2016). These results are in line with van der Merwe and Schoeman (1995), who concluded that early mating of extensively managed Simmentaler heifers should not be considered a standard management practice. It must be noted that this project was conducted in an extensive production system, and available literature indicates that conception rates of 14-month-old heifers may be higher in semi-extensive production systems (Lepen, Schoeman & Venter, 1993; Meaker, Coetsee & Lishman, 1980; Nunez-Dominguez *et al*., 1991). The economic advantage of early mating is therefore counterbalanced by biological limitations (breed and body weight), and management constraints of the environment (Ahmadzadeh, Carnahan & Autran, 2011; Patterson, Wood & Randle, 2000; Short, Bellows, Staigmiller, Berardinelli & Custer, 1990), as well as financial input (Kroker, Clarke & Clarke, 2022). As shown by Meaker (1986), optimising rather than maximising, and the impact thereof on efficiency and sustainability, is still of imperative value.

TABLE 1: C**alving Percentage of Heifers ± SD Over the 6-Year Project Period (2009-2014)**

	14-Month-old heifers calving %			**26-Month-old heifers calving %**		
Year	**Sub-herd A**	**Sub-herd B**	**Mean***	**Sub-herd A**	**Sub-herd B**	**Mean***
2009	50.0 ± 23.6 (n = 6)	83.3 ± 23.6 (n = 6)	66.7 ± 27.2 (n = 12)	50.0 ± 70.7 (n = 4)	100 (n = 4)	75.0 ± 50.0 (n = 8)
2010	33.3 ± 0.0 (n = 6)	16.7 ± 23.6 (n = 6)	25.0 ± 16.7 (n = 12)	100 (n = 6)	100 (n = 6)	100 (n = 12)
2011	16.7 ± 23.6 (n = 6)	0 (n = 6)	8.33 ± 16.7 (n = 12)	100 (n = 6)	58.3 ± 11.8 (n = 7)	79.2 ± 25.0 (n = 9)

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2012	0 (n = 4)	0 (n = 4)	0 (n = 8)	58.3 ± 11.8 (n = 5)	83.3 ± 23.6 (n = 5)	70.8 ± 21.0 (n = 10)
2013	0 (n = 6)	0 (n = 6)	0 (n = 12)	33.3 ± 47.1 (n = 6)	83.3 ± 23.6 (n = 6)	58.3 ± 41.9 (n = 12)
2014	16.7 ± 23.6 (n = 6)	0 (n = 6)	8.33 ± 16.7 (n = 12)	75.0 ± 0.0 (n = 9)	50.0 ± 14.1 (n = 9)	63.3 ± 20.2 (n = 18)
Mean	19.4 ± 22.3[a]	16.7 ± 33.3[a]	18.1 ± 27.8[a]	69.4 ± 36.6[b]	80.9 ± 23.3[b]	74.3 ± 30.3[b]

SD = Standard deviation

[a,b] Means with different superscripts in the bottom row differ significantly ($P \leq 0.05$)

*$LSD_{(p = 0.05)}$ = 16.106

The average body weight at calving for heifers mated at 14 months was 322 kg ± 21 kg. For heifers mated at 26 months, it was 357 kg ± 58 kg. Heifers mated at 14 months had a significantly lower body weight at calving ($P \leq 0.05$) compared to heifers mated at 26 months, except for 2014, where heifers mated at 26 months had an exceptionally low weight at calving (292 kg ± 29 kg). Although body weight at calving differed slightly from year to year, there was no significant difference over the years for heifers mated at 14 months of age. Body weight at calving for the heifers mated at 26 months differed ($P \leq 0.05$) over the six-year project period. Heifer body weight at calving was the highest in 2009 (417 kg ± 36 kg) and 2010 (411 kg ± 33 kg), while the lowest weight at calving was recorded in 2014 for both 26-month-old mated heifers (308 kg ± 29 kg) and 14-month-old mated heifers (292 kg). It must be noted that rainfall was well below average in 2014 (664 mm) and above average in 2009 (1,324 mm). The subsequent forage availability may therefore have influenced heifer weight.

According to Sprott and Troxel (1988), heifers can be mated successfully at an early age when they are separated from the mature cowherd and fed to reach a target weight of 65% of mature weight before mating. In the current study, heifers were managed within the mature cowherd with no extra feed provided to reach target weights. In the case of 14-month-old mated heifers, they weighed 56% of mature cow body weight at mating, whereas the 26-month-old mated heifers weighed 78% of mature cow body weight. This may be one of the reasons why the conception rate of the 14-month-old heifers was low.

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4. RELEVANCE TO EXTENSION SERVICES

Currently, due to the difficult economic conditions, there is an awareness among farmers of becoming more efficient producers (Foster, Fourie & Neser, 2014). Many are turning to extension services for advice on production systems and ultimate profitability. Due to the well-known fact that the reproduction rate directly affects income, one of the common suggestions is to mate heifers at 14 months instead of 26 months of age (Nunez-Dominguez *et al*., 1991). Although this practice is viable with additional feed and input, it must be noted that most beef production in South Africa is dependent on natural rangeland. In addition, the rangeland used for cattle production usually has limited agricultural potential due to high ambient temperatures, low and unpredictable rainfall, and low soil fertility (Meaker, 1984), leading to nutritional limitations. Extension services should not suggest the early mating of extensively managed heifers to extensive farmers as a standard management practice. This is especially true for producers farming on marginal rangeland without additional feed resources.

5. CONCLUSION

The reproductive performance of both the heifers and multiparous cows influences a beef production system's profitability. Theoretically, mating heifers at 14 months instead of at 26 months of age may increase lifetime productivity. However, this may not be viable in extensive systems under local conditions. In the current study, the calving percentage of heifers mated at 14 months (18.1% ± 27.8%) was very low compared to the calving percentage of heifers mated at 26 months (74.3% ± 30.3%). This demonstrates that mating Bonsmara heifers a year earlier is not a practical solution to increase lifetime productivity and profitability under extensive local conditions.

When farmers confront extension officers with the issue of early mating of beef heifers under extensive conditions, the following should be kept in mind:

- The early mating of extensively managed heifers should not be considered a standard management practice since it is unlikely that an early mating system can improve on the traditional practice where heifers, kept under an extensive grazing system with only lick supplementation, are mated for the first time at 26 months of age.
- The successful implementation of mating 14-month-old heifers under extensive farming conditions will depend on additional nutritional and managerial inputs, which may not be cost-effective given the availability and cost of additional nutrition.

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