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Evaluation of pre-breeding reproductive tract scoring as a predictor of long term reproductive performance in beef heifers

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ABSTRACT

In a 7-year longitudinal study 292 Bovelder beef cows in a restricted breeding system in South Africa were observed from 1 to 2 days before their first breeding season, when reproductive tract scoring (RTS, scored from 1 to 5) was performed, until weaning their 5th calves. The objective was to determine whether pre-breeding RTS in heifers is a valid tool to predict long-term reproductive performance. Outcomes measured were failure to show oestrus during the first 24 days of the first 50-day AI season (24-day anoestrus), failure to become pregnant during each yearly artificial insemination (AI) season (reproductive failure), number of days from the start of each AI season to calving, and number of years to reproductive failure. The effect of RTS on each outcome was adjusted for year of birth, pre-breeding age, BW and body condition score (BCS), and for 24-day anoestrus, bull, gestation length, previous days to calving and previous cow efficiency index, the latter two in the case of the 2nd to the 5th calving season. During their first breeding season, heifers with RTS 1 and 2 combined were more likely to be in anoestrus for the first 24 days (OR = 3.0, 95% CI 1.5, 6.4, $P = 0.003$), and were also more likely to fail to become pregnant even after adjusting for 24-day anoestrus (OR = 2.1, 95% CI 1.1, 3.9, $P = 0.025$), compared to those with RTS 4 and 5 combined. Animals with RTS 1 and 2 combined were at increased risk of early reproductive failure compared to those with RTS 4 and 5 combined (HR = 1.4, 95% CI 1.0, 1.9, $P = 0.045$) although RTS was not associated with calving rate or days to calving after the second calving season. Low RTS at a threshold of 1 had consistent specificity of ≥94% for both 24-day anoestrus and pregnancy failure, however its predictive value was lower in the age cohort with a higher prevalence of anoestrus. We conclude that RTS is a valid management tool for culling decisions intended to improve long-term reproductive success in a seasonal breeding system, by excluding heifers that are likely to fail to become pregnant or likely to calve late during their first calving season.

1. Introduction

Reproductive traits are 10 times more economically important than production traits in beef cows (Wiltbank, 1994). Restricted breeding and calving during the optimal season are key principles in good cow-calf management

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(Denham et al., 1991; Engelken et al., 1991). Proper management and selection of heifers (using body weight (BW), conformation, estimated breeding values, reproductive tract score (RTS) and pelvimetry) before breeding are essential to the success of such systems (Grass et al., 1982; Larson, 2005).

The onset of puberty in heifers is initiated by a decrease in oestradiol receptors in the hypothalamus and pituitary, ending the prepubertal negative feed-back and resulting in the first LH surge and ovulation (Day et al., 1984, 1987). This shift occurs at a specific critical BW (as a proportion of adult BW) and critical age which varies amongst animals (Pence et al., 2007). Various factors affect the age at puberty in individuals, and RTS provides an indirect measure of pubertal development (Andersen et al., 1991; Pence and BreDahl, 1998; Holm et al., 2009). Weaknesses of RTS include imperfect repeatability, subjectiveness and inconsistent associations with reproductive outcome (Rosenkrans and Hardin, 2003; Holm et al., 2009).

Short term reproductive performance may be predicted by RTS (Andersen et al., 1991; Pence et al., 2007; Holm et al., 2009) and we hypothesised that RTS may predict long-term survival in restricted bred heifers due to its association with pregnancy outcome and days to calving after first breeding, combined with reports that heifers calving early tend to calve early in subsequent seasons and have increased lifetime production (Lesmeister et al., 1973; Pence et al., 2007; Stevenson et al., 2008; Cushman et al., 2013). To the knowledge of the authors, a long-term study of the performance of heifers by RTS category has not been reported.

The objective of this study was to determine the usefulness of RTS as predictor of long-term reproductive performance.

2. Materials and methods

This was an observational study of 292 uniquely identified Bovelder cows born in either 2002 or 2003 (2002 and 2003 cohorts) that were followed from just prior to their first breeding season until they had weaned up to five calves. The farming system and breed type have been described previously (Paterson et al., 1980; Schoeman and Jordaan, 1998; Holm et al., 2008, 2009, 2014). In brief, the Bovelder is a South African composite beef breed, and Johannesburg Water Northern Farm is a semi-intensive system using irrigated ryegrass, kikuyu and clover pastures with additional maize or sorghum silage. The herd had been a closed female herd for more than 25 years prior to the onset of this study, and early breeding of heifers (breeding between 12 and 15 months of age) had been practiced for the same period of time prior to the onset of this study.

Reproductive tract scoring by trans-rectal palpation using a 5-point scale was performed by a single operator on all heifers either 1 or 2 days before the onset of their first breeding season (Andersen et al., 1991). Scores 4 and 5 were combined in the analyses, after assuming that both categories were pubertal at the time of scoring (Stevenson et al., 2008), and were used as the reference category in Cox proportional hazards and logistic regression models. It was further assumed that heifers with RTS 3 were peripubertal and that those with RTS 1 or 2 were prepubertal, which were also combined in the analyses (Stevenson et al., 2008). Body condition score (BCS) was determined at the same time by the same operator using a 9-point scale (Marston, 2005). For the purpose of regression models and survival analysis, BCS was categorised into 2 approximately equal sized categories: BCS ≤ 6 and BCS ≥ 7, because relatively few heifers were recorded to have BCS < 6 and BCS > 7. Farm management and staff were blinded to RTS data throughout the study.

Animals with parity 0, 1, 2, and ≥ 3 were managed in separate groups, assigned at the start of each yearly breeding season. Parity groups were managed in the same facility and inseminated by the same technician each year. The breeding season for heifers started on 15 October every year and consisted of 50 days of continuous visual oestrus observation, with once daily artificial insemination (AI) at 09h00. The breeding season for cows started on 1 November and consisted of 60 days of oestrus observation and AI in a similar way. Inter-oestrus periods of nulliparous heifers ranged from 16 to 24 days (mean 20 days). Days to first oestrus was defined as either the days to first insemination if it resulted in a pregnancy, or the days to the first insemination that was followed by a normal (16–24 days) inter-oestrus interval, or if neither of the above occurred it was the days to the last insemination.

Seventeen AI bulls originating from the same herd were allocated to 10–30 heifers each, and the ratio decreased to 1–10 cows per AI bull by the fifth parity. Five to 10 days after the end of the AI period different clean-up bulls were placed with cows and heifers for a period of 42 days in a multisire system.

Pregnancy diagnoses (PD) were performed by transrectal palpation (Sheldon and Noakes, 2002) between 23 March and 26 April of every year. Artificial insemination records of cows were available to the veterinarian during pregnancy diagnosis to assist in the differentiation between AI and bull pregnancies. Animals that were not pregnant to the AI season were sold as soon as their status was known. Those that aborted, or that were confirmed pregnant to AI but failed to calve during the expected calving season, were also removed from the herd.

Data collected per cow during every AI and calving season included the following: bull allocated, first to fourth AI date, pregnancy diagnosis, abortion and culling dates, calving date, dystocia score, twinning data, calf gender, calf BW at birth and BW of the cow and calf at weaning. Cow efficiency index (CEI) determined at each weaning event was defined as the weaning weight of the calf corrected to an age of 205 days divided by the metabolic weight of the cow at weaning ($BW^{0.75}$) (Kleiber, 1947).

Days to pregnancy was defined as the days from the start of the AI season to the last insemination for animals that were confirmed pregnant after the end of the breeding season. Gestation length (GL) was defined as the number of days from the last recorded AI until calving. Data cleaning consisted of the following procedures to ensure that heifers and cows that aborted, or that became pregnant during the bull breeding season did not contribute any further data to the study: animals with GL < 266 days were either changed from "calved" to "aborted" if the birth weight of the calf was below 25 kg and the calf did not survive, otherwise an